

CO₂ ionic trapping by water-rock interactions during a push-pull test in a basaltic-metasedimentary aquifer

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In order to investigate the extent of *in situ* CO₂-fluid-rock reactions relevant to the effectiveness of CO₂ geological storage, two push pull tests were performed at the Lamont-Doherty Earth Observatory test well site. A control test without CO₂ equilibration of the injection solution and a reactive test with CO₂ equilibration of the injection solution ($P_{\text{CO}_2} \approx 1$ bar). The solution, containing chemical and isotopic conservative tracers (NaCl and ¹⁸O), was injected in an isolated permeable depth interval, located at the contact zone between the chilled dolerites and the underlying Newark Basin metamorphosed sediments. Following a 3-week incubation period, the injection solution/background water mixture was pumped back. Physico-chemical parameters were measured ex-situ (pH, temperature, electrical conductivity) and water samples were collected for isotopic ($\delta^{13}\text{C}_{\text{DIC}}$, $\delta^{18}\text{O}$) and chemical (DIC, major ions) analyses.

For the control test, post-injection chemical and isotopic compositions of retrieved water samples display only a mixing between the background water and the injection solution. For the CO₂ test, the observed $\delta^{13}\text{C}_{\text{DIC}}$ increase and DIC, Ca²⁺, Mg²⁺, K⁺ enrichments allow to identify and quantify the chemical pathways through which H₂CO₃ is converted into HCO₃⁻. Neutralization of carbonic acid by mixing contributes only at a minute level ($\approx 2\%$) to the conversion of H₂CO₃ into HCO₃⁻. Dissolution of carbonate minerals is the dominant process ($\approx 50\%$), cationic exchange and dissolution of silicates minerals also contributes at a similar level ($\approx 47.5\%$) but it remains difficult to evaluate the relative contributions of these two latter processes. This data show the rapid dissolution kinetics of carbonate minerals compared to those of basic silicates minerals.

Sulfides, diamonds and eclogites: Their link to peridotites and Slave Craton tectonothermal evolution

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The cratonic lithosphere beneath the central Slave Craton has been affected by Meso- to Neoarchean amalgamation, repeated 2.2-1.8 Ga subduction events and younger emplacement of dike swarms. The A154 kimberlite at Diavik hosts abundant sulfide-bearing eclogitic diamonds and eclogite xenoliths, the latter dated to ca 2.1 Ga using lithophile element (Lu-Hf, Pb-Pb) geochronometers [1]. To shed light on their origin and relationship we are obtaining Re-Os isotope and major-element data on (i) single sulfide inclusions in diamonds (DI), which are closed systems, (ii) sulfides in eclogite xenoliths and (iii) whole rocks (WR), with the latter two being open systems.

Preliminary data show average Re/Os of DI and single sulfides in an eclogite xenolith to be ~ 8 , whereas that of WR is ~ 2 . In the Re-Os isochron diagram, DI fall about a ~ 1.9 Ga reference isochron with enriched initial ¹⁸⁷Os/¹⁸⁸Os (0.13), with some overlap from single sulfides in xenoliths. This may indicate that eclogitic diamond formation is temporally and spatially linked to the emplacement of eclogitic components into the lithosphere.

In contrast, WR and some sulfides in eclogite xenoliths plot about older reference isochrons. However, these samples show several mixing trends in 1/Os vs ¹⁸⁷Os/¹⁸⁸Os. One of the endmembers appears to be peridotitic sulfide and may indicate that mobile peridotite-derived sulfide melts [2] invaded eclogite domains in the lithospheric mantle. This is supported by the presence of Ni-rich sulfides in eclogite xenoliths from this study: whilst eclogite-hosted sulfides were mostly found to be Ni-poor (Ni < 10 wt%), some have Ni contents up to 28 wt%, more typical of peridotitic sulfides. These Ni-rich sulfides occur in otherwise "normal" eclogites suggesting that sulfide migration is not accompanied by other evident changes. The age of this event is not constrained; isochron relationships in eclogitic materials consistently show supra-chondritic initial ¹⁸⁷Os/¹⁸⁸Os, precluding the use of model age histograms to correlate sulfide precipitation with tectonic events.

[1] Schmidberger *et al.* (2007) *EPSL* **254**, 55-68. [2] Gaetani & Grove (1999) *EPSL* **169**, 147-163.