Relatively small degree of surface ocean acidification during the PETM in the North Atlantic

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With an estimated 2,000 to 12,000 Gt of carbon released over ≤10 ka, the Paleocene-Eocene Thermal Maximum (PETM) is an excellent analogue for understanding the long-term effects of present-day fossil fuel carbon combustion. The carbon cycle perturbation during the PETM was initiated at ~ 56 Ma and lasted for less than 200 kyr. Temperature reconstructions indicate warming averaging ~5°C. However, to date, no constraints exist for the response of surface water *p*H through this fossil carbon release event. If the injection of several thousand Gt of carbon occurred sufficiently rapidly relative to the mixing time of the oceans, it should have resulted in a significant drop in surface water *p*H that subsequently recovered to near pre-event values. The existence of such a perturbation of surface water *p*H can be resolved by means of the boron isotopic composition of marine carbonates.

Here the first MC-ICP-MS based boron isotope record from both mixed-layer and thermocline dwelling foraminiferal species across the PETM from DSDP Site 401 in the North Atlantic will be presented. These results are complemented by elemental records and new carbon and oxygen isotope data generated from the same samples. Although we find perturbations in our various elemental and isotopic records across the PETM-related carbon isotope excursion (CIE), the degree of ocean acidification and, hence, inferred carbon release, is surprisingly small. Carbon cycle modelling using our new boron isotope records suggests that this comparatively small degree of ocean acidification during the CIE was driven by a methanogenic source of carbon.

CO_2: Waste or resource ? The role of mineral/water interfaces

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In the context of the anthropogenic destabilization of the carbon cycle, the CO_2 molecule is often considered as a waste to be captured and stored as far away as possible. Both nature and chemistry suggest, however, that, in some specific conditions, CO_2 can be turned into a useful resource. In this talk, I will examine how mineral/water interfaces present in several geological systems could possibly contribute to that purpose. Solid carbonates and hydrocarbonates produced by CO_2 carbonation of basic and ultrabasic minerals can sometimes be valuable materials. Their characteristics mostly depend on interfacial layers that develop at the surface of the primary minerals. Results of observations by focused ion beam coupled to transmission electron microscopy, in different contexts between 25°C and 180°C, will be given; the role of iron on their passivating properties will be shown. Abiotic hydrogen production and CO_2 reduction, a way of converting CO_2 into energetic resources, but also into strong greenhouse species, will be demonstrated at mineral/water interfaces by contrast with the fact that no such processes occur in pure aqueous phase. The actions of magnetite and of iron carbonate (siderite), will be investigated. The production yields of different organics ranging from formic acid to methanol and to methane in presence of iron-bearing mineral surfaces will be given and modeled. High resolution transmission electron microscopy of magnetite and siderite surfaces will be shown and discussed with respect to this question. Finally, recent intringuing mineral preferences concerning biological CO_2 reduction in the oceanic sub seafloor will also be examined. A tentative geomicrobiological and thermodynamic model will be proposed for understanding different routes of CO_2 reduction at those mineral/water interfaces.

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