

Aerosol-cloud-precipitation interactions in the climate system

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Aerosols serve as cloud condensation nuclei (CCN) and thus have a substantial effect on cloud properties. Increased aerosol concentrations resulting from anthropogenic pollution lead to higher cloud droplet concentrations, but smaller droplet sizes. This in turn affects the physical processes inside clouds that lead to the initiation of precipitation. Depending on a number of factors, including aerosol composition, atmospheric stability and cloud water content, increasing CCN concentrations may either decrease or increase rainfall. In convective clouds, early rain formation is suppressed, which makes more water and energy available to rise higher in the atmosphere and form ice particles. This may invigorate the dynamics of convection, encourage the formation of hail and lightning, and enhance the transport of materials to the upper troposphere. In order to understand and quantify the effects of air pollution on climate, and precipitation in particular, knowledge of natural abundance and characteristics of aerosols is as essential as the observation of perturbed conditions. I will present recent advances in the conceptual understanding of aerosol-precipitation interactions, as well as measurements on pristine and polluted aerosol characteristics.

Iron speciation in serpentine during oceanic-type serpentinization

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Serpentinisation of ultramafic rocks at mid-ocean ridges is now well known to generate high amounts of H₂, CH₄ and to support novel biological communities. The abiotic production of hydrogen is attributed to the reduction of H₂O during oxidation of the ferrous component of primary minerals. The amount of hydrogen and hydrocarbons formed abiotically is thus directly linked to the amount and state of iron incorporated into product minerals, mainly magnetite and serpentine. However, magnetite is classically the only Fe³⁺-carrier considered for estimating bulk H₂ fluxes. This is mainly due to the scarce and scattered data on the iron redox state in serpentine minerals and its unknown relationship with both magnetite abundance and serpentinization degree.

To address these questions, we have realized punctual μ -XANES analyses at the iron K-edge (ID24, ESRF) of serpentine minerals in thin sections. Rock samples from 4 different localities (Mid-Atlantic Ridge and Pindos ophiolite) have been selected for their various degrees of serpentinisation and magnetite content.

The results show that Fe³⁺ is abundant in oceanic-type serpentine: it can represent up to 100% of the total iron in the structure but typically tends to 60-65% for sample showing more than 60% of serpentinization. Whole rock chemical analyses and petrographic characterization of the samples allowed us to establish that the Fe³⁺/Fe^{Tot} in serpentine evolve non-linearly with the local degree of serpentinization. The Fe³⁺ is more rapidly incorporated in serpentine during the first half of reaction, especially if magnetite is rare. This demonstrates the involvement of serpentine formation on natural H₂ production. We have estimated that at least 10% of the H₂ produced is related to serpentine (MARK) and that this value easily attain 30% (Pindos) or even 70% locally in some samples from Logatchev. Thus, evaluation of the raw H₂ production during serpentinization must take into account the Fe³⁺ incorporated in serpentine which is site-dependent. This also opens new perspective on the role of serpentine minerals on the redox state in subduction zones where the oceanic crust is recycled into the earth mantle.