Alteration of amorphous Fe-silicate in meteorites

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Serpentine is ubiquitous in carbonaceous chondrites and likely the result of a hydrothermal reaction of amorphous precursors (at <100°C) as indicated by replacement textures in fine-grained matrices. To constrain the temperature and timescales of aqueous alteration, we study the mechanisms and kinetics of Fe-rich amorphous silicate serpentinization. Our approach is a combination of a novel experimental setup and multiple analytical techniques. A thin (~ 1 μm) layer of amorphous "$FeMgSi0_4$" is deposited on a substrate using a pulsed laser deposition system (laser ablation / deposition from the plasma). The film is reacted in deionized water (60°C to 190°C, 2h to 2 weeks, water to rock ratios of about 300). The geometry is ideal to follow the evolution of the reaction front by FIB/TEM, Rutherford Back Scattering (major elements composition) and Nuclear Reaction Analysis (water content) with nm scale depth resolution.

Our results reveal a systematic sequence of hydrated amorphous layers from the surface towards the pristine material: (1) silicon oxide (<50 nm); (2) a fibrous and porous layer with a composition close to Mg-serpentine; (3) thin (< 20 nm) Fe-oxide; (4) a compact layer with a composition close to Fe-serpentine. Depth profiles reveal that all layers are hydrated (10-15 wt. %). Layer boundaries are sharp. The formation sequence likely results from kinetically-controlled, interfacial dissolution-precipitation front, as previously described in glass alteration experiments. The Fe/Mg fractionation between layers may be due to the higher solubility of Mg, first leached and later precipitated after fluid had reached saturation.

Our findings of amorphous and hydrated Fe-rich silicates with a stoichiometry close to serpentine are to some degree comparable to observations made in chondrites. It may point towards shorter hydrothermal episodes as initially thought in chondrites.

Effect of coarse marine aerosols on stratocumulus clouds

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In contrast to fine anthropogenic aerosols (radii ~< 0.5µm), large aerosol particles are thought to enhance cloud droplet growth, promote precipitation formation and reduce cloud albedo. While shown in models, the impact of coarse aerosols on marine stratocumulus clouds lacks observational evidence. Combining satellite data from AMSR-E and MODIS, we link the amount of wind induced coarse marine aerosols (CMA), with droplet size of marine stratocumulus clouds over the southeastern Pacific.

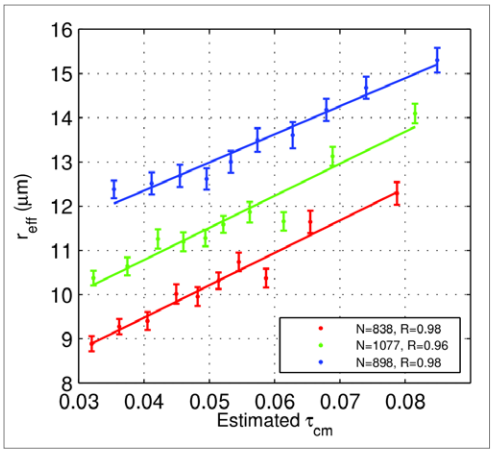

Figure 1. r_{eff} vs. τ_{cm} in a southeastern Pacific marine stratocumulus cloud field. Data are plotted for different ranges of LWP (25-50, 50-75 and 75-100 gr/m^2, red, green and blue, respectively).

For constrained meteorological conditions, approximately 1/2 of the change in droplet effective radius (r_{eff}) is attributed to increase in CMA optical depth (τ_{cm}), as surface winds intensify. Accordingly, a twofold increase in τ_{cm} is associated with a 1.4µm +/-0.11 increase in r_{eff}. Our results suggest that any attempt to quantify the impact of anthropogenic and biogenic marine aerosols on marine boundary layer clouds, should take into account the opposing effect of wind induced coarse marine particles.

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