Aqueous alteration of organic matter and amorphous silicate in pristine chondrites: A multiscale study

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Amorphous silicates have been observed in accretion disks of young stars[1]. On the other hand, amorphous silicates are also found in chondrites[2]. Therefore, the study of nanoparticles contained in the matrices of pristine chondrites may provide major insights into the nature of the nebular dust. We have explored the relationships between organics, water and silicates *in situ* by FIB-TEM, fluorescence microscopy, NanoSIMS and STXM (Scanning Transmission X-Ray Microscopy) in four carbonaceous chondrites with various alteration degree. Our goal is to assess the nature of the precursors (i.e. the dust) as well as the subsequent hydrothermal interactions which modified the accreted components.

We evidence the presence of hydrated amorphous silicate in MET00426 (CR3.0) and, for the first time, in Renazzo (CR2). Using ATEM, we estimate that this phase contains from 5 to 10 wt. % of water and has a very heterogeneous Fe/(Fe+Mg) ratio ranging from 30 to 75 at.%. Adjacent phyllosilicates which are probably genetically derived from the amorphous silicates have similar water contents and heterogeneous Fe/(Fe+Mg) ratios.

The spatial distribution of the organics shows a clear evolution with increasing aqueous alteration degree, detectable by TEM and fluorescence microscopy. In the least altered meteorites (CRs), mainly isolated grains are found (<500 nm) which sometimes share a preferential spatial relationship with phyllosilicates. In contrast, the more highly altered Murchison (CM2) and Orgueil (CI1) show a clear dichotomy between i) isolated grains and ii) a diffuse nanoscale mixture of organics and phyllosilicates. STXM results demonstrate the strong molecular heterogeneity of both types of grains at the sub-micrometer scale.

To explain these observations, we propose a scenario where organics trapped in water ice grains are mixed with amorphous silicates during accretion. Later, water melts, hydrates the amorphous silicate and redistributes the organic constituents which are entrapped within forming phyllosilicates during aqueous alteration.

[1] W. J. Forrest *et al*. (2004) *ApJS* **154**, 443. [2] N. Abreu & A. J. Brearley. (2010) *GCA* **74**, 1146–1171.

The assumption of a low pCO_2 during the Archean investigated with a 3D climate model

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A new controversial assumption, based on banded iron formation mineralogy, supposes that the Archean atmosphere was potentially characterized by low concentrations of CO_2 [1]. To solve the young Sun problem, it hypothesized that a reduced albedo associated to less reflective clouds were able to prevent the early Earth to jump into a snowball state [1]. We have investigated the early Earth climate, using a general circulation model (GCM), to test this scenario including the ice albedo feedback [2]. Accounting for this feedback, we demonstrate that the faint young Sun problem is not solved. Hence we face again to the difficulty of maintaining a clement climate before 3Ga.

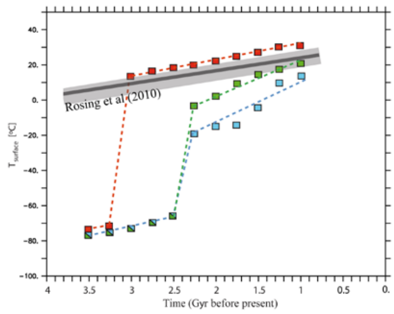

Figure 1: Surface temperature versus time assuming increasing irradiance**,** linear continental growth and a pCO_2 and pCH_4 of 900ppmv [1]. Blue, and red lines were obtained using liquid droplets size of 5 to 10μm (modern clouds), and 20μm (archean clouds), respectively [1]. The green line represents the no-clouds scenario.

[1] Rosing, M.T. *et al.* (2010) *Nature* **464**, 744-U117. [2] Kasting, J.F (2010) *Nature* **464**, 687-689.