EVOLUTION OF THE ORGUEIL METEORITE THROUGH ASTEROIDAL CONDITIONS.

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Introduction: Orgueil meteorite fell more than 150 years ago in southwestern France, and remains one of the most precious record of early Solar System materials. Recent analyses on samples from the Hayabusa2 mission indicate a clear mineralogical and compositional resemblance between Ryugu C-type asteroid and the CI Orgueil [1], minus the extensive oxidation observed in Orgueil [2]. The mineralogy of Orgueil is dominated by very fine-grained phyllosilicates [3], attesting for the circulation of fluids on Orgueil parent-body, with underconstrained effects on the organic content. Clay minerals are often intermixed with organic grains in primitive chondrites [4], and their influence on organic matter evolution may range from the catalysis of organic reactions [5] to the inhibition in IOM production [6]. Recent experimental alteration of CM2 Paris insoluble organic matter confirms compositional and molecular trends observed in natural objects [7], while the structural evolution clearly diverges from the natural objects. One possible reason for this divergence is the absence of mineral phases, especially clay minerals, in the aforementioned laboratory experiments. In that scope, we submitted bulk grains of Orgueil to laboratory alteration at low temperature, in presence of water having with three different H-isotope ratios.

Methods: Three water samples were used, namely the Standard Light Antarctic Precipitation 2 water (SLAP2, δD= -427‰), an ultra-pure laboratory water (δD=-40‰) and a D-rich water (δD=+2900‰), initially diluted from pure D2O solution (Merck). A mixture of 50µL of water and 50 mg of crushed (ethanol leached) Orgueil was loaded into three pure gold capsules. They were put into a 23 mL PTFE reactor, filled with 12 ml of the ultrapure water, and heated at 150°C for 30 days. Mineralogy evolution was montored using X-ray diffraction (XRD) and Mid-infrared (MIR) spectroscopy. XRD analysis were performed on a Panalytical X'pert Pro MPD 2 circles operating at IMPMC (Paris, France). The bulk XRD measurements were performed on powder preparations throughout the 3-75 °2θ $CoK\alpha_{1,2}$ angular range, for a 0.033 °2θ step size and 300 s counting time/step. Evolutions of organic (though the aliphatic C-H stretching) and mineral functional groups were recorded using FITR spectroscopy. Sample powders were deposited on IR transparent CaF_2 windows at the SMIS beamline of the SOLEIL synchrotron (France) using an Agilent Cary 670/620 micro-spectrometer equipped with a 128x128 pixel Focal Plane Array detector (3900-800 cm^{-1}) and with a single point MCT detector (4000-900 cm^{-1}), for a 4 cm^{-1} spectral resolution. The hydrogen isotope distribution were investigated by NanoSIMS imaging, at the Natural History Museum, Paris (France).

Results: Our results indicate a decorrelated evolution between the mineralogy and the organic matter. The mineralogy phases (mainly clay minerals) are only marginally modified during the experiment, with no new phases and little influence from the water isotope signature. Conversely, the organic matter is affected, upon alteration. The modifications are revealed by the decrease of CH_2/CH_3 ratio, evidencing a shortening of carbon chains, a feature observed after the experimental alteration of CM2 Paris IOM, in similar conditions [7]. Also, the deuterium hotspot distribution is strongly influenced by the signature of the fluid, erasing in part (but not totally) the starting hydrogen signature. Altogether, it appears that while the mineralogy does retain only limited information about the latest alteration event, the carbon grains can be affected, at molecular and isotopic levels, leaving its original molecular and isotopic signature partially shaded by the fluid circulation episodes.

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