

In situ study of chondritic organics: the role of aqueous alteration

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Organic matter (OM) in chondrites consists of insoluble and soluble molecules which have been possibly processed in the interstellar medium, the proto-planetary disk and/or the parent bodies. Aqueous alteration has been suggested to lead to the formation of carboxylic acids, to aromatization, or to amino acids evolution, but its impact on organics remains poorly constrained. While acid demineralization techniques allow characterization of the bulk properties of soluble and insoluble OM, the spatial relationships between them and the inorganic phases is lost. We performed *in situ* studies by combining scanning transmission X-ray microscopy and TEM to investigate the functional chemistry of OM within its inorganic environment, in carbonaceous chondrites spanning the full range of aqueous alteration degree.

The least altered CRs show discrete OM particles (~ 500 nm) filling the porosity between silicates. All grains contain aromatic, ketone and carboxylic functional groups in similar concentrations. More altered CRs (Renazzo, GRO 95577) display more aliphatic and carboxylic-rich grains. In Murchison (CM) and Orgueil (CI) the OM grains are chemically heterogeneous and more aromatic than in type 2-3 CRs. In addition, “diffuse” OM occurs, which consists of carboxylic/aliphatic-rich grains entrapped in the nano-porosity (<100 nm) of the phyllosilicates. Chemistry, distribution and relationship of OM with inorganic phases evolve with aqueous alteration, within one chondrite group (CR) and between different groups (CI, CM, CR). The discrete grains are likely dominated by insoluble OM, while the “diffuse” OM may relate to the soluble fraction. We propose a scenario involving the accretion of OM-bearing ices and redistribution of soluble OM within phyllosilicates porosity as they crystallize. Aromatization and carboxylic acid synthesis is compatible with our observations. OM -phyllosilicates could have favored clay-catalyzed organic reactions.