

Insights into water-rock interactions in carbonaceous chondrites from μ /nano-xrd-ct

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Serpentinization processes are widespread across the solar system. They provide a context that is favorable to the emergence of life. From several points of view, analogies can be found between serpentinization in small bodies as evaluated from the chondritic record and on Earth, such as parallel evolutions of Fe partitioning as water-rock interactions proceed [1]. However, temperatures were probably very low, and the undifferentiated Fe-rich system gave rise to original crystal chemistries [2]. What are the mechanisms of mineral formation in such a context?

We combined x-ray diffraction computed tomography (xrd-ct) measurements of mm-sized whole fragments of CM carbonaceous chondrites at a 10 μ m-scale with xrd-ct experiments at a 100nm-scale (Nanoscope station) of selected areas of the same samples prepared by FIB milling, at ID11 beamline, ESRF [3]. We observed structural variations among serpentines associated with different primary objects / alteration stages. In some cases, we could relate structural evolution to changes in chemistry and Fe valence state with alteration (Murray chondrite [4]). At a larger scale, we will show that using data on whole fragments it is possible to map the distribution of nanophases that are difficult to observe even by TEM (serpentines and associated hydrated phases) and to highlight their relation to primary minerals and objects (chondrules, refractory inclusions). Such an approach can bring important clues to the nature of water-rock interactions in a non destructive way. Finally, combining scales of observation allows bridging the gap between the mesoscale relevant to the circulation of the fluid and the much smaller scale at which mineral formation and transformation occur.

[1] Elmaleh, Tarantino, Zema, Devouard & Fialin (2012), *G-cubed* Q05Z42. [2] Zolensky, Barrett & Browning (1993) *Geochim. Cosmochim. Acta* 51, 3123-3148. [3] Bonnin, Wright, Tucoulou & Palancher (2012) *Appl. Phys. Lett.* 105, 084103 and Wright et al. Goldschmidt 2018. [4] Elmaleh, Bourdelle, Caste, Benzerara, Leroux & Devouard (2015), *Geochim. Cosmochim. Acta* 158, 162-178.