MS18-O2 Super-deep diamonds and their mineral inclusions: an overview

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Natural diamonds and their mineral inclusions play a crucial role in Earth Sciences as they could be considered as open windows to the deep Earth. Indeed, they are thought to crystallize between about 120 and 1000 km depth. Diamonds formed between 120 and about 200-250 km depth are called "lithospheric", whereas those crystallized much deeper are the so called "super-deep diamonds". This last category of diamonds is extremely rare and represents only 6% of the diamond production. Among the most common mineral inclusions found in super-deep diamonds are ferropericlase (Mg,Fe)O, $CaSiO_3$ walstromite-type structure and jeffbenite $(Mg,Fe)_3Al_2Si_3O_{12}$ (Kaminsky 2012; Nestola et al. 2016). Although, such inclusions are considered stable at very high-pressure conditions reaching the Earth's lower mantle depth (below about 660 km depth), it is still questionable if their diamond hosts could be placed actually in the lower mantle (between 660 and 900-1000 km depth) or "just" in the deepest regions of the upper mantle (about 300-400 km depth). However, a very rare mineral, ringwoodite $(Mg,Fe)_2SiO_4$, was recently found included within a Brazilian diamond (Pearson et al. 2014) providing a strong constraint on their depth of crystallization being ringwoodite stable only between about 525 and 660 km depth. Here, I will provide an overview on the super-deep diamonds and their mineral inclusions focusing on the most recent discoveries and their geological meaning.

References

Kaminsky, F. (2012) Mineralogy of the lower mantle: a review of "super-deep" mineral inclusions in diamond. Earth Science Reviews, 110, 127-147.

Nestola, F., et al. (2016) Tetragonal Almandine-Pyrope Phase, TAPP: finally a name for it, the new mineral jeffbenite. Mineralogical Magazine, 10.1180/minmag.2016.080.059

Pearson, D.G., et al. (2014) Hydrous mantle transition zone indicated by ringwoodite included within diamond. Nature, 507, 221-224.

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MS18-O3 Water-rock interactions in carbonaceous chondrites: a meso to nanoscale study of alteration processes in an anoxygenic environment

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Here we will focus on the early processes of serpentinisation in small bodies of the solar system by presenting a mineralogical study of carbonaceous chondrites. CI-CM chondrites are among the most primitive objects of the solar system, with elemental compositions of refractory elements close to that of the solar photosphere. From a mineralogical point of view, these meteorites mostly consist of phyllosilicates attesting to early water-rock interactions. From mineralogical and petrological observations, it has long been proposed that the bulk of mineral hydration occurred in these meteorites parent bodies after ices that accreted with rock material have melted. CM chondrites, which are the most common among carbonaceous chondrites, have a particular interest for better understanding the processes involved, and their consequences in terms of the conditions that prevailed on small bodies that may have contributed to the water budget of terrestrial planets. Indeed, a relative preservation of primary anhydrous minerals (20-30 vol%), mostly Mg-rich olivine, pyroxene and Fe,Ni-alloys and minor sulfides and refractory oxides, gives the possibility to assess the reactions leading to secondary phases, mostly Fe^{2+},Fe^{3+}-rich Mg-,Al-bearing serpentines as well as carbonates, sulfates, oxides and sulfides. We will illustrate the complementarity of approaches based on one hand on nanoscale investigations of the structure, valence state of Fe and composition of secondary phases using STXM-XANES at the Fe $L_{2,3}$-edges coupled with TEM investigations, and on the other hand on an evaluation of the mineralogy of primary and secondary assemblages and their relationships as a function of the degree of alteration mainly using micro-focused XRD and preliminary results of computed tomography XRD (XRD-CT). From these results, we will specifically address the questions of the transformations of primary minerals by illustrating the role of the early alteration of Fe,Ni-alloys on the control of the mineralogy of serpentines, and that of the fluid-assisted evolution of secondary products as alteration proceeds, which presents an analogy with hydrothermal terrestrial processes. We will show how structural studies of serpentines can yield a better understanding of the oxidation processes that prevailed in this anoxygenic environment. Finally, we will briefly illustrate the insight provided into asteroidal processes by an experimental approach of the formation of chondritic serpentines.

Keywords: meteorites, serpentinisation, synchrotron radiation