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Diamond growth in the lithosphere

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Diamonds are the subject of great interest, first because of their value, their beauty, but also because they are, for the geologist, the unique natural witnesses of the deep cycling of volatiles, and of the deep Earth mineralogy, thanks to their mineral inclusions. Still today, there is no real consensus about the growth of diamonds in the upper and lower mantle except that this growth takes place in fluids (possibly C-H-O fluids). Experimental petrology can play in understanding the formation of natural diamond and recent progresses were achieved in characterizing diamond growth under conditions relevant for the Earth's lithosphere (Luth et al., 2022).

The first part of this presentation will be devoted to show how replicating lithospheric diamonds in the laboratory at high pressures and high temperatures HPHT helps reveal their histories at depth, which may be complicated by successive growth and dissolution episodes (Bureau et al., 2023). A particular attention will be paid to the process of formation and trapping of mineral and fluid inclusions in diamonds, witnesses of the mineralogy of the mantle but also vestiges of the parent fluids of the diamonds in some cases.

A second part of the presentation will focus on the three major impurities (N, H, B) trapped in the diamond lattice by combining analytical approaches such as Fourier Transform InfraRed spectroscopy FTIR, Elastic Recoil Detection Analysis ERDA and Nanoscale Secondary Ion Mass Spectrometry NanoSIMS analyses. It will be shown that hydrogen is the second major impurity in diamond after nitrogen and before boron (Vangu et al., 2023).

A third part of the presentation will show that the comparison of the impurities present in natural and synthetic HPHT diamonds makes it possible to use these impurities as indicators to characterize the diamond growth environment.

References

Bureau et al. (2023) Growing Diamonds in the Laboratory to investigate Growth, Dissolution, and Inclusions Formation processes. https://doi.org/10.1016/j.gca.2023.12.032

Luth, Y.N. Palyanov, H Bureau, (2022) Experimental Petrology Applied to Natural Diamond Growth. https://doi.org/10.2138/rmg.2022.88.14

Vangu, et al. (2023) Combination of ERDA, FTIR spectroscopy and NanoSIMS for the characterization of hydrogen incorporation in natural diamonds https://doi.org/10.1016/j.diamond.2023.110007