

Hydrogen content of mineral inclusions in diamonds and the composition of diamond-forming media

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Diamonds carry pieces of the Earth's mantle to the surface in the form of mineral inclusions. Once trapped, these inclusions behave as a closed system and can provide valuable geochemical information about the mantle at the time of diamond formation. For this reason, mineral inclusions in diamond have been extensively studied in the past, to gain information on the composition of the mantle and of the diamond-forming media.

Recent studies have started measuring the H content of nominally anhydrous mineral (NAM) inclusions hosted in lithospheric diamonds, thereby obtaining information about the H₂O content of the cratonic lithosphere. These studies consistently showed that NAM inclusions have very low H₂O contents, in contrast to values measured in xenoliths where > 1000 ppm wt H₂O has been observed, the difference being attributed to metasomatic alteration of the xenoliths [1]. However, studies investigating the H content of NAM inclusions in lithospheric diamonds are still relatively scarce and mostly focus on peridotitic samples from the Siberian craton. Almost no data are available from eclogitic inclusions, specifically omphacites, which have a relatively high H₂O storage capacity [2].

In the present work we completed H₂O content analyses on 118 NAM inclusions (more than the entire available literature) in 76 diamonds, mostly from the Kaapvaal craton, but also from the Siberian, Tanzanian, Zimbabwe and North Australian cratons, focusing on eclogitic samples. Samples were analysed with X-ray microtomography to measure their size and confirm that no fractures, connecting the inclusions to the outside of the diamond, were present. The H content of inclusions enclosed in their diamond hosts was measured using FTIR spectroscopy. Furthermore, H diffusion modelling at conditions relevant to diamond formation was performed to assess the origin of the H measured in the NAM inclusions. The results are discussed in terms of the H₂O content and activity in the diamond-forming environment.

References:

- [1] Peslier AH et al. (2017) Space Sci Rev 212:743-810
- [2] Bromiley GD and Keppler H (2004) Contrib Mineral Petrol 147:189-200