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The growth of Blue Diamonds

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The genesis of natural type IIb diamonds remains controversial. Poor in nitrogen, type II diamonds can be subdivided in type IIa diamonds, the purest and most precious diamonds free of any detectable impurities, and the rare type IIb diamonds, which contain boron impurities. Type IIb diamonds exhibit a blue colour and are commonly known as blue diamonds. We used transmission electron microscopy (TEM) to investigate the complexity of inclusions trapped in type IIb diamonds from Cullinan, the former Premier mine in South Africa, during their journey through the mantle. In a previous study [1] we proposed that type IIb diamonds form in a mantle continuum, from sub-lithospheric to lithospheric depths. Here, we focused our attention on an exceptional diamond due to the variety of its inclusions. To preserve these inclusions, the diamond was polished by ion-beam cryo-milling under high vacuum and at -100 ◦C. Thin sections were prepared with a focussed ion beam (FIB), and their analysis was performed with a TITAN THEMIS transmission electron microscope. The results demonstrate the complexity of the inclusions, revealing the association of a reduced iron-nickel alloy and sulfides in contact with an iron oxide and a solute phase. They highlight the close relationships between reduced and oxidized phases trapped together with the residue of a hydrous fluid. These phases trapped within the inclusions likely reflect the redox reactions involved in the growth of type IIb diamonds within the Earth's mantle.

References

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