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Corundum inclusions in diamonds: a new tool for diamond geobarometry

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In 1981 [1], the first occurrence of a corundum inclusion associated with a low-Cr_2O_3 garnet within a diamond of unknown origin was reported. The corundum was characterized by 1.30 wt% Cr_2O_3 and assigned to an eclogitic origin. 12 years later, the second finding of corundum in a Type II diamond from São Luiz, Brazil, was reported [2], with extremely high Cr_2O_3 reaching over 8 wt%. An eclogitic paragenesis was indicated, and possible evidence of sublithospheric origin was hypothesized to explain the extreme Cr_2O_3 enrichment. Between 2001 and 2004 [3,4], new discoveries of corundum inclusions in Type II diamonds, from the Juina, Brazil, were reported, with again extreme enrichment in Cr_2O_3 (above 8 wt%), suggesting a very deep origin for these diamonds within the lower mantle at about 770 km depth. Since 2004, no additional finding of corundum inclusions in diamond has been reported. Based on these four initial publications, we could assume that Cr-rich corundum inclusions indicate a very deep origin.

Here, we identified the first corundum inclusions in four African diamonds (Premier, South Africa). The diamonds did not contain other types of inclusions. Single-crystal X-ray diffraction carried out before and after inclusion release from the diamond showed no residual pressure. The chemical composition of the inclusions indicated very-low Cr content. Although no residual pressure was detected, we attempted, for the first time, to apply elastic geobarometry to the diamond-corundum system to determine the minimum pressure of formation. Surprisingly, our results indicate that even for corundum inclusions characterized by low-Cr content, a minimum depth of 300(±30) km at 1250 °C is necessary to justify the presence of such inclusions in diamond. Therefore, both high- and low-Cr corundum may be of sub-lithospheric origin.

References

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