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Crystallographic relationships between diamond and its inclusions

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The study of the crystallographic orientations of minerals included in diamonds can provide an insight into the mechanisms of their incorporation and the timing of their formation relative to the host diamond. The reported occurrence of non-trivial orientations for some minerals in some diamonds, suggesting an epitactic relationship, has long been considered to reflect contemporaneous growth of the diamond and the inclusion (= syngenesis). Correct interpretation of such orientations requires (i) a statistically significant data set, i.e. crystallographic data for single and multiple inclusions in a large number of diamonds, and (ii) a robust data-processing method, capable of removing ambiguities derived from the high symmetry of the diamond and the inclusion. We have developed software which performs such processing, starting from crystallographic orientation matrixes obtained by X-ray diffractometry. Preliminary studies indicate a wide variety of trends in the orientations of different inclusion phases in diamonds. In contrast to previous claims, olivine inclusions in lithospheric diamonds from Udachnaya do not show any preferred orientations with respect to their diamond hosts, but multiple inclusions in a single diamond often show very similar orientations within a few degrees (Nestola et al. 2014). Chromite (spinel) inclusions exhibit a strong tendency for a single (111) plane of each inclusion to be parallel to a (111) plane of their diamond host, but without any statistically significant orientation of the crystallographic axes a, b, and c. By contrast, 7 inclusions of ferropericlase studied in 2 different super deep diamonds (four inclusions in one diamond and three inclusions in the second diamond) from Brazil all exhibit the same orientation with their axes practically coincident with those of diamonds regardless of the position and the shape of the inclusions. The implications of these observations for the mechanisms of diamond growth will be explored.
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Nestola F., et al. (2014) Int Geol Rev, 56,1658-1667.