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X-ray topographic study of diamonds: implications for the genetic nature of inclusions in diamond

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In recent years, several studies have focused on the growth conditions of the diamonds through the analysis of the mineral inclusions trapped in them (Howell, 2012 and references therein). Nevertheless, to obtain rigorous information about chemical and physical conditions of diamond formation, it is crucial to determine if the crystallization of the inclusions occurred before (protogenetic nature), during (syngenetic nature) or after (epigenetic nature) the growth of diamond (Wiggers de Vries et al., 2011). X-ray topography (XRDT) can be a helpful tool to verify the genetic nature of inclusions in diamond. This technique characterizes the extended defects and reconstructs the growth history of the samples (Agrosì et al., 2013 and references therein) and, consequently contributes to elucidation of the relationship between the inclusions and the host-diamond. With this aim a diamond from the Udachnaya kimberlite, Siberia, was investigated. The diamond crystal was the one previously studied by Nestola et al. (2011) who performed in-situ crystal structure refinement of the inclusions to obtain data about the formation pressure. The inclusions were iso-oriented olivines that did not show evident cracks and subsequently could not be considered epigenetic. Optical observations revealed an anomalous birefringence in the adjacent diamond and the inclusions had typical “diamond-imposed cubo-octahedral” shape for the largest olivine. The diffraction contrast study shows that the diamond exhibits significant deformation fields related to plastic post growth deformation. The crystallographic direction of strains was established applying the extinction criterion. Section topographs were taken to minimize the overlapping of the strain field associate with the different defects and revealed that no dislocations nucleated from the olivine inclusions. Generally, when a solid inclusion has been incorporated in the growing crystal, the associated volume distortion can be minimized by means the nucleation of dislocations and/or twinning (Agrosì et al., 2013). In our case, the specific and significant features – the olivine inclusions showing a “diamond imposed cubo-octahedral shape” and no dislocation nucleation – that characterize this sample will be discussed in detail.

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