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X-RAY DIFFRACTION TOPOGRAPHY, MICRO-TOMOGRAPHY AND MICRO X-RAY FLUORESCENCE OF DIAMONDS AND THEIR TRAPPED INCLUSIONS: A MULTI-ANALYTICAL APPROACH FOR NON-DESTRUCTIVE ANALYSES

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The study of diamonds and the mineral inclusions trapped within them is of great interest to the Earth Sciences, since it can provide insights into deep mantle conditions and evolution (Nestola et al. 2011). Conventional techniques commonly used are destructive and thus do not allow the integration of different methods to obtain complementary results. Significant information about the growth conditions of diamonds and their inclusions should be obtained preferably by non-destructive, in-situ investigations. In this study, the use of X-ray Topography combined with X-ray Tomography and Micro-X-ray Fluorescence allowed us to obtain minero-petrogenetic information on diamonds and their inclusions, while totally preserving the diamond hosts. In particular, X-ray Diffraction Topographic images, obtained in transmission mode, provide maps of spatial distribution of lattice imperfections in the whole sample volumes, without the need for cutting the samples into slices. This technique can provide useful information to reconstruct the crystal's growth history, in a similar fashion to diamonds from Finsch mine, South Africa (Agrosì et al., 2013) and from the Udachnaya kimberlite, Russia (Agrosì et al. 2016). In our study, this methodological approach was applied to diamonds from different provenances. Comparisons between the topographic images acquired on each studied sample allowed the characterization of structural defects and identification of different types of post-growth plastic deformation. Relationships between topographic features and different origin of diamonds were found. X-ray Tomography provided visualization of the spatial distribution and shape of the inclusions, allowing to distinguish inclusions constituted by a single crystal from polyphase inclusions or aggregates. Chemical maps, obtained by Micro-X-ray fluorescence, allowed the determination of the chemical compositions of the majority of inclusions. Correlations were made between the composition of the inclusions and their different density, obtained by the X-ray absorption observed in tomographic reconstructions. The results obtained show that the plastic deformation of diamonds, the nature of the inclusions and their shape are strictly related, contributing to the characterization of the different origins of diamonds.

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