Peering into the deep Earth through diamonds

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Inclusions in kimberlite-borne diamonds represent the deepest accessible samples of the Earth and provide unique materials to study deep mantle processes. Also, owing to their age (up to a few billion years) and exceptional preservation potential, natural diamonds represent snapshots of the deep, ancient portion of the global carbon and water cycles, which result from subduction and subsequent release and transfer of volatiles. Whereas lithospheric diamonds have been investigated to a high level of detail by multidisciplinary approaches, the much rarer sublithospheric diamonds are less thoroughly studied and have been the subject of major scientific advances in recent years.

Natural diamonds from Brazil are renowned for the abundance of inclusions of sublithospheric origin, which may be as deep as the lower mantle. With this project, we intend to study a large population (ca. one hundred) of Brazilian diamonds of alleged sublithospheric origin and explore their formation environment by studying their inclusions. This part of the work may be of unpredictable success, because the very presence of inclusions can generally be ascertained only after polishing the diamonds. Nonetheless, even limited targeted lab measurements on this material will in all likelihood allow us to fill gaps in our knowledge of the mineralogy and formation conditions of the deepest samples of Earth's carbon environment.

The research activity will initially involve sample preparation (polishing) and preliminary characterization of inclusions by single-crystal X-ray diffractometry and Raman spectroscopy. Major and trace element analysis, Fourier-transform infrared spectrometry (FTIR), and C and N isotopic analyses will be carried out on selected materials to obtain comprehensive information on the geochemical environment of the diamonds. Further XRD and Raman analyses will specifically be designed to retrieve information on the pressures of entrapment of the inclusions. Where possible, in presence of sulphide inclusions, the diamonds will be dated with the Re-Os method.

We expect that the extensive data set that will be produced during this project will provide new constraints for a better understanding of the deep carbon and water cycles.

Scientific collaborations
The work will be carried out in collaboration with an international consortium of renowned diamond scientists (Diamond and Mantle Geodynamics of Carbon, https://deepcarboncycle.org/home-dmgc/). Trace element and isotopic analyses will be carried out at the University of Alberta (Canada) in collaboration with Dr. D. Graham Pearson and at the Carnegie Institution for Science, Washington (USA) in collaboration with Dr. Steven B. Shirey.

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