



X-ray diffraction study of the mineralogy of microinclusions in fibrous diamond

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Fibrous diamond, occurring both as cuboids and as coatings over non-fibrous diamond nuclei, is translucent due to the presence of millions of sub-micron-sized mineral and fluid inclusions. Diamond is strong and relatively inert, making it an excellent vessel to preserve trapped materials. These microinclusions represent direct samples of natural diamond-forming mantle fluids, and are critical for our understanding of diamond genesis. Traditionally, infrared spectroscopy, Raman spectroscopy, secondary ion mass spectrometry, electron microprobe, and FIB-TEM techniques have proven to be effective for the study of microinclusions in diamond.

The abundance and random orientation of included minerals in fibrous diamond make them amenable to a powder-type X-ray diffraction (XRD) technique. This technique provides an accurate way to identify included minerals. It also has the advantage of analyzing thousands of inclusions simultaneously, rather than analyzing one inclusion at a time, as with common FIB-TEM techniques. XRD provides a bulk analysis, giving a superior measure of relative abundances of included minerals, as well as potentially accounting for small quantities of minerals that might otherwise be overlooked.

We studied fibrous cuboid diamonds with microinclusions from the Democratic Republic of Congo (DRC) (23 samples), Brazil (4 samples), Jericho (1 sample), and Wawa conglomerates (9 samples). XRD analysis was performed at the Bayerisches Geoinstitut (BGI), University of Bayreuth, Germany. The unique XRD setup consists of a RIGAKU FR-D high-brilliance source, OSMIC Inc. Confocal Max-Flux optics, and a SMART APEX 4K CCD area detector.

Preliminary XRD studies of microinclusions 8 fibrous diamonds from the DRC showed a prevalence of silicates with structural and coordinated H₂O. Sheet silicates constituted 9 out of 13 detected minerals, with phlogopite-biotite micas being present in 4 out of 8 samples. Other detected minerals were 2 chlorite minerals, 2 clay phyllosilicates, serpentine, zircon, a hydrous carbonate and an unidentified zeolite. Many of these phases are deuteritic, replacing high-T, high-P micas and carbonates that precipitate from the fluid in the diamond stability field. The ongoing XRD study will (1) elucidate the mineralogy of fluid inclusions in diamonds from Wawa, (2) compare XRD analyses to distinguish between diamonds with carbonatitic versus saline fluid compositions, and (3) reveal whether carbonates occur as crystalline phases or as dissolved or amorphous material in fibrous diamond.