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The chemical and physical conditions recorded by fluid and mineral microinclusions in fibrous diamonds and their significance.

Yaakov Weiss

The Fredy and Nadine Herrmann Institute of Earth Sciences, The Hebrew University of Jerusalem, Jerusalem, Israel (yakov.weiss@mail.huji.ac.il)

Diamonds are natures' "time capsules", effectively protecting captured minerals and fluids from the deep Earth for billions of years and during ascent to Earth's surface. Their research has provided age and chemical information on the deep Earth over the last 3.5 Ga and contributed substantially to our understanding of the Earth's deep mantle mineralogy, composition and geodynamics. Diamond formation is mostly associated with metasomatism, a process whereby infiltrating fluids and melts rich in trace elements and volatiles interact and alter mantle rocks. Although metasomatism is a common process, as reflected by the mineralogy and chemical composition of mantle-derived samples from all continents, the metasomatic agent itself is only rarely available as fluid/melt inclusions for direct analyses; and thus, in many cases the nature of metasomatism remains elusive. This is not the case for fibrous diamonds which commonly contain microinclusions of their parental metasomatic melts or super critical-end-point fluids (HDFs, high density fluids). Occasionally, both mineral and fluid microinclusions are trapped in the same diamond, offering the opportunity to look directly at remnants of the diamond's metasomatized host rock together with a pristine sample of the metasomatic agent, and therefor allows to constrain the physical and chemical conditions during fluid–rock interaction. As an example, the temperature and oxygen fugacity (fO_2) conditions recorded by mineral and fluid microinclusions in diamonds from the southwest Kaapvaal cratoninc lithosphere are lower by 150–250oC and higher by about a $logfO_2$ unit, respectively, compared to P–T–fO_2 gradients recorded by peridotite xenoliths from the same locality. This discrepancy indicates that the last metasomatic event or kimberlite eruption had little impact on the temperature and redox state of the Kaapvaal lithosphere as a reservoir, that xenoliths did not equilibrate during these events and that the P–T–fO_2 gradients they record express conditions that were likely established during the last major thermal event in this lithospheric province. Microinclusions in diamonds also allow to unravel the origin of mantle metasomatic agents. For example, the trace elements and strontium isotopic compositions of HDFs trapped in a suite of diamonds from the Slave Craton, suggest that subduction-derived fluids impacted the composition of the deep lithospheric mantle and formed diamonds during the Mesozoic. Fluid and mineral microinclusions in fibrous diamonds therefore have a key role in exploring metasomatic processes in the deep Earth.