Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20291

Subducting high-density diamond-forming fluids as metasomatic agents

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High-density fluid (HDF) microinclusions in diamonds provide a unique record of the compositions and nature of deep mantle carbon- and water-bearing (COH) fluids. Their high volatile content: 8-20 wt.% H2O and 4-32 wt.% CO2, and their enrichment in K2O (11-17 wt%) and other incompatible elements, typically between a few hundred to a few thousand primitive mantle values, make them a key player in mantle metasomatism. The most common HDFs vary in compositions between four major types: silicic, rich in Si, Al, K and water; low- and high-Mg carbonatitic, rich in Ca, Mg, Fe, K and carbonate; and saline, rich in Cl, K, Na and water (Weiss *et al.*, 2022).

The saline HDFs are the most intriguing as they do not resemble any mantle melts that erupt on Earth's surface. Few lines of evidence indicate a possible relation between such HDFs and subducted surface material: the K/Cl ratio of the saline HDFs overlaps the range of altered oceanic crust; pronounced positive Eu and Sr anomalies of such HDFs reflect the involvement of plagioclase during low-pressure crustal processes of protolith formation; and their, low 3He/4He isotope ratios (2.7–4.4 Ra) further strengthen a connection with recycled surface material. In addition, recent 87Sr/86Sr isotope data of silicic to low-Mg carbonatitic HDFs points to the involvement of old subducted components in their formation.

Due to their high mobility, the HDFs can migrate and react with different mantle lithologies over a range of depths. This HDFs-rock interaction leads to the formation of new metasomatic phases and enriches depleted mantle rocks in volatile and incompatible elements, thereby impacting their density, rheology and melting behavior. The mineralogy and chemical composition of xenoliths/xenocrysts and some alkaline magmas suggest a prevalent involvement of HDFs in mantle metasomatism. The most widely recognized geochemical feature is metasomatized garnets in both peridotite and eclogite mantle-derived xenoliths and diamond inclusions. Furthermore, the similarity in trace elements between HDFs and alkali-rich mantle melts, reflect the impact of HDFs on the deep lithospheric mantle and their role in deep Earth processes.

Weiss et al. (2022) Fluid inclusions in fibrous diamonds. *RiMG* 88, 475-532.