Sublithospheric diamonds: sampling plate tectonics at 300 to 700 km depths in Earth's mantle

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Diamonds are the premier container for mineral inclusions, effectively isolating them completely from reactions with fluids and magmas. A special class of diamond, estimated to comprise less than 10% of diamonds mined from kimberlite, derives from hundreds of kilometers below the lithospheric mantle. These sublithospheric or so-called "superdeep" diamonds carry distinctive mineral assemblages that give a valuable look at deep mantle mineralogy from the mantle transition zone region (300 to 700 km) that is not attainable any other way. Three different groups of superdeep diamonds can be distinguished by the fluids from which they are derived: carbonatitic, aqueous, and metallic. Recent studies show that carbonatitic superdeep diamond-forming fluids are derived from carbonate-bearing oceanic crust whereas aqueous and metallic superdeep diamond-forming fluids are derived from serpentinized peridotitic mantle. Diamonds thus provide evidence that the full oceanic lithosphere participates in the mantle recycling of volatiles such as B, C, H_2O to depths substantially beyond the ‘subduction factory’. Only the cooler oceanic lithospheric slabs can retain their carbonate or water to mantle transition zone depths and thus can participate in this deep recycling. As it is only the cooler slabs that contain deep focus earthquakes, we make an apparent association between deep diamond forming fluids and superdeep earthquakes. The study of sublithospheric diamonds permits the use of a remarkable combination of mineralogy, seismology, and geodynamics to understand the deepest aspects of plate tectonics.