Mineral inclusions in ophiolite-hosted diamonds provide strong evidence of a deep mantle origin

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When diamonds were first discovered in ophiolite-hosted chromitites and peridotites they were taken as evidence of a deep mantle origin. However, recent reports of diamonds in serpentinized chromitites and peridotites from ophiolites have led to suggestions that such minerals can form at relatively low temperatures and pressures in the uppermost mantle or even the crust. Such models ignore the widespread occurrence of associated UHP minerals that occur both as inclusions in many ophiolite-host diamonds and as isolated grains in the host rocks. Such inclusions include a wide variety of phases such as coesite, moissanite, metallic alloys. Mn-silicates and oxides, Al-silicates and oxides, Ca-perovskite, TiO_2 phases and walstromite ($Ca_{0.81}Mn_{0.19}SiO_3$). Coesite, a widely accepted UHP phase, is a common inclusion in ophiolite-hosted diamonds where it is typically associated with NiCoMn alloys. It also occurs as part of an assemblage recovered from a host chromitite where it is thought to be a pseudomorphic replacement of stishovite. Moissanite has been recovered from chromitites and peridotites of all ophiolites investigated by our group and has been reported as an inclusion in a diamond grain. Metallic alloys with various combinations of Fe-Ni-Co-Mn are very abundant as diamond inclusions and as phases in podiform chromitites. Mn-rich phases found as inclusions in diamonds include tephroite, almandine, galaxite ($MnAl_2O_4$), periclase and Mn-bearing alloys. The UHP phase of Ti-oxide (TiO_2 (II) has been found in the host chromitites. Orthorhombic Al_2O_3 occurs as inclusions together with FeNiCoMn alloys in a sample from the Luobusa ophiolite, and grains of Ca-perovskite have been found in one diamond. Although relatively low-temperature crustal minerals are widely present in podiform chromitites, they have not been found as inclusions in diamonds. Thus, the abundance and variety of UHP inclusions in many ophiolite-hosted diamonds provide strong evidence for their deep mantle origin.