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Metastable nanodiamond linked to serpentinization of olivine

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Low pressure oceanic gabbros and chromitites from the Moa-Baracoa ophiolitic massif (eastern Cuba) contain olivine grains crosscut by trails of secondary CH_4 –bearing fluid inclusions. Some of these fluid inclusions host nanodiamond (200 – 300 nm) associated with magnetite and serpentine, and locally super-reduced metallic Si, suggesting that their formation took place during serpentinization of the host olivine at low pressure and temperature. Such solid-fluid assemblage is encapsulated well below the polished mineral surface, thus, ruling out anthropogenic contamination during sample preparation. We suggest a mass-balance model in which infiltration of ocean water into the oceanic lithosphere forms fluid inclusions in olivine which, once sealed, act as closed-system micro-reactors where precipitation of metastable diamond takes place upon serpentinization of olivine and associated coupled production of magnetite by oxidation of Fe^{2+} and strong reduction of infiltrated H_2O-CO_2 fluid mixtures. Progressive reduction of C-H-O-rich fluids eventually reaches C saturation, forming graphite or metastable diamond. Thermodynamic modelling suggest that metastable diamond in fluid inclusions can grow upon extreme reduction of the fluid ($\log fO_2$ (MPa) = -45.3; $\Delta \log fO_2$[Iron-Magnetite] = -6.5) at a reference P-T point typical for serpentinization (i.e., 350 ºC and 100 MPa). These findings imply that the formation of metastable diamond at low pressure in partially serpentinized olivine from mafic and ultramafic rocks can be a widespread process in modern and ancient oceanic lithosphere. However, the small size of diamond and its scarcity in fluid inclusions could explain its apparent absence in other case studies of altered oceanic rocks. The presence of diamond and other highly reduced phases in oceanic rocks, in particular chromitites, cannot hence be taken as a general indication of deep mantle recycling at ultra-high pressure conditions.