Diamond growth from organic compounds in hydrous fluids deep within the Earth

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Subduction diamonds represent the sequestration of carbon from fluids released from lithospheric plates at mantle depths. In deep fluids, besides reactive molecular species (e.g., CO_2), inorganic, and organic aqueous ionic species have been proposed as a source of carbon in diamonds (Sverjensky et al., 2014). Unequivocal signatures of organic species, however, have not been found, neither a unified model for diamond nucleation and growth has been proposed. Here, I use Raman microspectroscopy to determine the structure and composition of carbon-based phases precipitated inside diamond-bearing fluid inclusions in metamorphic rocks from the Alps to reveal the spontaneous products on carbon saturation in deep Earth's aqueous fluids. I find that micro- and nano-sized diamonds are coated by sp^2-, and sp^3-bonded amorphous carbon that shows Raman modes of attached organic functional group structures (e.g., carboxyl, carboxylate, methyl, and methylene). Present data suggest that decomposition of complex carboxylic acids can induce diamond nucleation on the reduction of the carboxyl groups, whereas sp^3-bonded radicals can create structural intermediates allowing diamond growth (Frezzotti, 2019). This formation mechanism is consistent with nucleation models via metastable molecular precursors (Gebbie et al., 2018). The present study provides direct evidence that, deep within the Earth, dissolved inorganic carbon can spontaneously evolve to organic species in the absence of biologically catalyzed processes. Results suggest that the Earth's interior should be considered as a favorable environment for the origin of prebiotic organic compounds.

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Sverjensky DA, Stagno V, Huang F (2014) Nature Geo. 7: 909–913.