High pressure serpentinization and abiotic methanogenesis in metaperidotite from the Appalachian and Alpine subduction

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Serpentinization is the process of hydroxylation of olivine-rich ultramafic rocks to produce minerals such as serpentine, brucite, magnetite. This process is commonly accompanied by Fe oxidation and release of H_2, which can be involved in abiotic reaction pathways leading to the genesis of abiotic light hydrocarbons such as methane (CH_4). Examples of this phenomenon exist at the seafloor, such as at the serpentinite-hosted Lost City hydrothermal field, and on land in ophiolites at relatively shallow depths. However, the possibility for serpentinization to occur at greater depths, especially in subduction zones, raises new questions on the genesis of abiotic hydrocarbons at convergent margin and its impact on the deep carbon cycle. This work aims to provide insights on the genesis of H_2 and abiotic CH_4 at depth, as well as their fluid sources and migration pathways. High-pressure ultramafic bodies exhumed in metamorphic belts can provide insights on the mechanisms of high-pressure serpentinization in subduction zones and on the chemistry of the resulting fluids. This study focuses on the ultramafic Belvidere Mountain complex belonging to the Appalachian belt of northern Vermont, USA, and on the Lanzo massif, western Italian Alps. These ultramafic complexes recorded serpentinization in the antigorite stability field, and include graphite veins and CH_4-rich fluid inclusions. This project combines field work, petrological investigation, fluid inclusion study with Raman spectroscopy, and isotopic analysis on $\delta^{13}C$ of solid and fluid phases. Decreasing oxygen fugacity during serpentinization and related abiotic reduction of carbon at high-pressure conditions is proposed at the origin of methane in the fluid inclusions. Complementary, numerical modelling of carbon isotopic evolution is being developed to predict the systems isotopic evolution.

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