Patterns of high-P serpentinization at blueschist-to-eclogite-facies conditions and related genesis of H_2 and abiotic hydrocarbons

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Serpentinization of ultramafic rocks at high-P conditions has been invoked in geochemical and geophysical studies related to subduction zone processes. However, questions remain on the potential of high-P serpentinization to generate reducing fluids, as observed in low-P environments where this process controls the genesis of H_2 and abiogenic hydrocarbons and other compounds of central importance in geochemistry and microbiology. The identification of reduced fluid species in rocks included or adjacent to high-P serpentinites has led several authors to propose deep serpentinization as a source for these fluids. Nevertheless, other studies have suggested that subduction zone serpentinization should not produce H_2-rich fluids and related abiotic hydrocarbons. This debate is hampered by the difficulty in distinguishing subducted oceanic serpentinites reequilibrated at high-pressure conditions, from serpentinites that formed at depth in the subduction zone, virtually identical in their macroscopic and microscopic features.

In this study we provide robust structural, mineralogical and petrological data showing that intense serpentinization happened at blueschist-to-eclogite-facies conditions in the Alpine subduction zone. Our data also show that this serpentinization event was associated with reducing conditions favoring the conversion of dissolved C-bearing species into CH_4 and other hydrocarbons, as also corroborated by thermodynamic calculations. Our results indicate that the genesis and distrubution of reducing fluids can be widespread in subduction zones thanks to deep serpentinization processes.