Contrasted effect of pyroxene and spinel on the production of molecular hydrogen (H_2) during serpentinization of olivine

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In recent years, serpentinization has received considerable attention as a source of molecular hydrogen (H_2) for communities of microorganisms in hydrothermal vent fields. However, the mechanisms controlling H_2 production, especially the influence of pyroxene and spinel, still remain poorly understood. We performed hydrothermal experiments at 311-500 °C and 3.0 kbar, showing a contrasted effect of spinel and pyroxene minerals on H_2 produced after serpentinization at 311 °C and 3.0 kbar, i.e., spinel promotes H_2 generation by around two times, whereas pyroxene minerals significantly decrease H_2 production by around one order of magnitude. The contrast may be attributed to releases of aluminum and chromium from spinel during hydrothermal alteration, and an increase in H_2 production was observed for experiments with mechanical mixtures of olivine and Al_2O_3 or Cr_2O_3 powders. Pyroxene minerals released not only aluminum but also silica during serpentinization, and silica may greatly decrease H_2 generation. A decline in the effect of spinel was observed with increasing temperatures (400-500 °C), but a slight increase in H_2 production was still found for experiments with the addition of spinel. In contrast, pyroxene minerals have negligible effect on H_2 production. Olivine in natural geological settings is commonly closely associated with pyroxene minerals and spinel, and therefore H_2 generation can be greatly influenced.