American Mineralogist, Volume 109, pages 61–72, 2024

Formation of mixed-layer sulfide-hydroxide minerals from the Tochilinite-Valleriite group during experimental serpentinization of olivine

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Abstract

We report the formation of minerals from the tochilinite-valleriite group (TVG) during laboratory serpentinization experiments conducted at 300 and 328 °C. Minerals in the TVG are composed of a mixture of sulfide and hydroxide layers that can contain variable proportions of Fe, Mg, Cu, Ni, and other cations in both layers. Members of this group have been observed as accessory minerals in several serpentinites, and have also been observed in association with serpentine minerals in meteorites. To our knowledge, however, TVG minerals have not previously been identified as reaction products during laboratory simulation of serpentinization. The serpentinization experiments reacted olivine with artificial seawater containing ^{34}S-labeled sulfate, with a small amount of solid FeS also added to the 300 °C experiment. In both experiments, the predominant reaction products were chrysotile serpentine, brucite, and magnetite. At 300 °C, these major products were accompanied by trace amounts of the Ni-bearing TVG member haapalaite, Ni,Fe-sulfide (likely pentlandite), and anhydrite. At 328 °C, valleriite occurs rather than haapalaite and the accompanying Ni,Fe-sulfide is proportionally more enriched in Ni. Reduction of sulfate by H_2 produced during serpentinization evidently provided a source of reduced S that contributed to formation of the TVG minerals and Ni,Fe-sulfides. The results provide new constraints on the conditions that allow precipitation of tochilinite-valleriite group minerals in natural serpentinites.

Keywords: Tochilinite, valleriite, haapalaite, serpentinization, sulfate reduction