Fluid-assisted hydration processes on chondrite parent-bodies: Low-temperature experimental alteration

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The formation of FeO-rich olivine is a first order problem in cosmochemistry and has been the subject of intense debate for more than three decades with nebular and asteroidal scenarios having been proposed [1-5]. Although there are a lot of studies of the occurrence of FeO-rich olivine in chondrites, its origin is poorly understood. Our first preliminary experiments provide clear evidence that hydrothermal growth of elongated, iron-rich olivine can occur during thermal metamorphism in the presence of a fluid (220°C, 0.4 W/R mass ratio, 6 days), as described previously in meteorites [3, 6]. So far, hydrothermal alteration experiments have been successful at forming FeO-rich olivines with the compositions and textures observed in the matrices of chondrites only at 220°C [6]. Therefore, understanding the formation conditions of FeO-rich olivines at lower temperatures, durations, and water-to-rock (W/R) mass ratios remains a key problem to understanding the effects of hydrothermal alteration on chondrite matrices. In this study, we performed twelve hydrothermal alteration experiments in an attempt to synthesize FeO-rich olivines at low-temperatures (50°C, 100°C, and 150°C). New minerals were formed in all the experiments analyzed (magnetite, ferrihydrite, and greenalite). Our transmission electron microscopy observations show that the W/R mass ratio controls the abundance of phases; however, the temperature and the duration have an important role in the type of phases formed during the experiments.

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