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Experimental investigations into the silicification of olivine: Implications for the reaction mechanism and acid neutralization

Helen E. King,[1,*] Oliver Plümper,[2] Thorsten Geisler,[1,3] and Andrew Putnis[1]

[1]Institut für Mineralogie, Westfälische Wilhelms-Universität Münster, Corrensstrasse 24, 48149 Münster, Germany
[2]Physics of Geological Processes, University of Oslo, Sem Selands vei 24, 0316 Oslo, Norway
[3]Mineralogie–Department Geowissenschaften, Universität Hamburg, Grindelallee 48, 20146 Hamburg, Germany

Abstract

Neutralization of acidic fluids by means of fluid-olivine interactions is important in volcanic environments and has been proposed as a practical scheme for the neutralization of acidic sulfate-rich fluids. To understand the interaction of olivine with highly acidic fluids we have reacted whole olivine crystals and a dunite cube with different sulfuric acid solutions at temperatures ranging from 60–120 °C. Reaction of olivine with 2 and 3.6 *M* acid concentrations produced a layered amorphous silica pseudomorph of the original olivine grain. The mechanism of pseudomorphic replacement was studied by reacting olivine with an ^{18}O-enriched acid solution and examining the products using Raman spectroscopy. Peak shifts in the Raman spectra show that ^{18}O was incorporated into the silica rim, including the siloxane ring structures. The formation of a layered silica pseudomorph, the incorporation of ^{18}O into the silica rim and the dependence of the replacement rim strength on the acid concentration indicate that the pseudomorphic replacement occurred by means of an interface-coupled dissolution-reprecipitation mechanism. When olivine was reacted with 1 *M* sulfuric acid amorphous silica was produced but no longer formed a pseudomorph of the olivine grain. Reaction with 0.1 *M* acid, or solutions containing Na, encouraged the formation of hematite as well as amorphous silica. From the known Fe-phase stabilities for our experimental conditions and the dependence of hematite formation on the presence of Na we propose that initially jarosite phases precipitated, which transformed into hematite during the experiment.

Keywords: Silicification, acid neutralization, olivine, replacement