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An experimental study of the replacement of leucite by analcime

CHRISTINE V. PUTNIS,[1,*] THORSTEN GEISLER,[1] PETER SCHMID-BEURMANN,[1] THOMAS STEPHAN,[2] AND CIRIACO GIAMPAOLO[3]

[1]Institut für Mineralogie, University of Münster, D-48149 Münster, Germany
[2]Institut für Planetologie, University of Münster, D-48149 Münster, Germany
[3]Dipartimento di Scienze Geologiche, Università degli Studi Roma Tre, 00146 Roma, Italy

ABSTRACT

Leucite and analcime have open framework aluminosilicate structures, where ion exchange by cation substitution has been previously used to explain the replacement of one phase by another. Using ^{18}O-enriched NaCl solutions in hydrothermal reactions and run-product analyses using scanning electron microscopy, infrared and Raman spectroscopy, and time-of-flight secondary ion mass spectrometry, we show that the replacement of leucite by analcime is not a solid-state reaction involving cation exchange by volume diffusion. Textural features such as nano-pores and clusters, as well as the detection of high amounts of ^{18}O in the framework of analcime, suggest that the reaction proceeds by dissolution of leucite and reprecipitation of analcime, where structural O atoms of the leucite framework are exchanged and a new analcime structure forms at a moving interface through the leucite parent crystal. The characteristic high porosity (on a nano-scale) in the analcime product phase results from some of the parent phase being lost to the solution to give a volume deficit reaction. However, external dimensions are maintained during the process to result in the pseudomorphic replacement of an open framework aluminosilicate structure by a coupled dissolution-reprecipitation mechanism.

Keywords: Dissolution-reprecipitation, pseudomorphism, analcime, Raman, TOF-SIMS, zeolite, replacement