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LETTER

Terrestrial analogs of martian sulfates: Major and minor element systematics of alunite–jarosite from Goldfield, Nevada

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ABSTRACT

Alunite and jarosite from Goldfield, Nevada, show spectacular relationships between early alunite and later jarosite. In some cases, jarosite overgrows alunite with the same crystallographic orientation and sharp contacts. Electron microprobe analyses of these phases show that they fall in the alunite-jarosite quadrilateral defined by alunite, $KAl_3(SO_4)_2(OH)_6$; natroalunite, $NaAl_3(SO_4)_2(OH)_6$; jarosite, $KFe^{3+}_3(SO_4)_2(OH)_6$; and natrojarosite, $NaFe^{3+}_3(SO_4)_2(OH)_6$. A large compositional gap occurs between alunite-natroalunite and jarosite-natrojarosite. This gap has no crystal chemical basis because Al and Fe^{3+} can readily substitute for each other in octahedral site coordination. We believe the "on-off switch" behavior between early alunite and later jarosite is caused by an oxidant entering the system, oxidizing Fe^{2+} in solution to Fe^{3+}, raising the Eh and possibly oxidizing H_2S to lower the pH, and thus stabilizing jarosite relative to alunite. The activity of Fe (as Fe^{2+}) increased in the solution because of prolonged alunite crystallization but could not readily enter the crystal structure until it was oxidized to Fe^{3+}. The jarosite overgrowths show striking oscillatory zoning of Na- and K-rich bands. This reflects up to an order of magnitude change in the fluid K/Na ratio. These textures are interpreted to represent rapid growth and kinetic control of delivery of free Na and K to the crystal-fluid interface. This could be due to some combination of Na and K diffusion rates in the solution and complex ion breakdown involving Na and K.

Keywords: Jarosite, Mars, electron microprobe, terrestrial analogs