

**WHAT LURKS IN THE MARTIAN ROCKS AND SOIL? INVESTIGATIONS OF SULFATES, PHOSPHATES, AND PERCHLORATES**  
**Detection of iron substitution in natroalunite-natrojarosite solid solutions and potential implications for Mars†**

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**ABSTRACT**

Natroalunite containing substantial amounts of Fe occurs as a prominent secondary phase during acid-sulfate alteration of pyroclastic basalts in volcanic fumaroles in Nicaragua and elsewhere, and has been observed in laboratory simulations of acid-sulfate alteration as well. Reaction path models constrained by field and experimental observations predict that Fe-rich natroalunite should also form as a major secondary phase during alteration of martian basalt under similar circumstances. Here, we evaluate the potential to use spectroscopic methods to identify minerals from the alunite group with chemical compositions intermediate between natroalunite and natrojarosite on the surface of Mars, and to remotely infer their Fe contents. X-ray diffraction and spectroscopic measurements (Raman, visible/near infrared, mid-infrared, Mössbauer) were obtained for a suite of synthetic solid solutions with a range of Fe contents ranging from natroalunite to natrojarosite. In the visible/near infrared, minerals with intermediate compositions display several spectral features not evident in end-member spectra that could be used to remotely identify these minerals and infer their composition. In addition, Raman spectra, mid-infrared spectra, and X-ray diffraction peaks all show systematic variation with changing Fe content, indicating that these methods could potentially be used to infer mineral compositions as well. The results suggest that alunite group minerals with intermediate Fe compositions may be able to account for some visible/near-infrared and Mössbauer spectral features from Mars that had previously been unidentified or attributed to other phases. Overall, our findings indicate that consideration of solid solutions may lead to new identifications of alunite group minerals on the surface of Mars, and raise the possibility that minerals with compositions intermediate between natroalunite and natrojarosite may be widely distributed on the planet.

**Keywords:** Mars, alunite group, visible/near infrared spectra, Raman spectra, hydrothermal, acid-sulfate alteration