

The oxidation state of sulfur in lunar apatite

**MARYJO BROUNCE^{1,*}, JEREMY BOYCE², FRANCIS M. MCCUBBIN², JENNIFER HUMPHREYS¹,
JUSTIN REPPART², EDWARD STOLPER³, AND JOHN EILER³**

¹Department of Earth Sciences, University of California Riverside, Riverside, California 92592, U.S.A.

²Astromaterials Research and Exploration Science Division, NASA Johnson Space Center, Houston, Texas 77058, U.S.A.

³Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125, U.S.A.

ABSTRACT

Lunar apatites contain hundreds to thousands of parts per million of sulfur. This is puzzling because lunar basalts are thought to form in low oxygen fugacity (f_{O_2}) conditions where sulfur can only exist in its reduced form (S^{2-}), a substitution not previously observed in natural apatite. We present measurements of the oxidation state of S in lunar apatites and associated mesostasis glass that show that lunar apatites and glass contain dominantly S^{2-} , whereas natural apatites from Earth are only known to contain S^{6+} . It is likely that many terrestrial and martian igneous rocks contain apatites with mixed sulfur oxidation states. The S^{6+}/S^{2-} ratios of such apatites could be used to quantify the f_{O_2} values at which they crystallized, given information on the partitioning of S^{6+} and S^{2-} between apatite and melt and on the S^{6+}/S^{2-} ratios of melts as functions of f_{O_2} and melt composition. Such a well-calibrated oxybarometer based on this the oxidation state of S in apatite would have wide application.

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