

SPACE WEATHERING OF LUNAR ROCKS AND REGOLITH GRAINS. L. P. Keller, Robert M. Walker Laboratory for Space Science, Code KR, ARES, NASA/JSC, Houston, TX 77058. E-mail: Lindsay.P.Keller@nasa.gov.

Introduction: The exposed surfaces of lunar soil grains and lunar rocks become modified and coated over time with a thin rind of material (patina) through complex interactions with the space environment. These interactions encompass many processes including micrometeorite impacts, vapor and melt deposition, and solar wind implantation/sputtering effects that collectively are referred to as "space weathering". Studies of space weathering effects in lunar soils and rocks provide important clues to understanding the origin and evolution of the lunar regolith as well as aiding in the interpretation of global chemical and mineralogical datasets obtained by remote-sensing missions. The interpretation of reflectance spectra obtained by these missions is complicated because the patina coatings obscure the underlying rock mineralogy and compositions.

Much of our understanding of these processes and products comes from decades of work on remote-sensing observations of the Moon, the analysis of lunar samples, and laboratory experiments. Space weathering effects collectively result in a reddened continuum slope, lowered albedo, and attenuated absorption features in reflectance spectra of lunar soils as compared to finely comminuted rocks from the same Apollo sites. Space weathering effects are largely surface-correlated [1], concentrated in the fine size fractions, and occur as amorphous rims on individual soil grains. Rims on lunar soil grains are highly complex and span the range between erosional surfaces modified by solar wind irradiation to depositional surfaces modified by the condensation of sputtered ions and impact-generated vapors [2]. The optical effects of space weathering effects are directly linked to the production of nanophase Fe metal in lunar materials [3]. The size of distribution of nanophase inclusions in the rims directly affect optical properties given that large Fe⁰ grains (~10 nm and larger) darken the sample (lower albedo) while the tiny Fe⁰ grains (<5nm) are the primary agent in spectral "reddening" [4,5].

More recent work has focused on the nature and abundance of OH/H₂O in the lunar regolith using orbital data [e.g. 6] and samples analyses [7]. Advances in sample preparation techniques have made possible detailed analyses of patina-coated rock surfaces [8]. Major advances are occurring in quantifying the rates and efficiency of space weathering processes through laboratory experimentation [e.g. 9-11].

References: [1] Pieters C. M. 1993. *JGR* 98, 20,817-20,824. [2] Keller L. P. and McKay D. S. 1997. *GCA* 61, 2331-2341. [3] Taylor L. A. *et al.* 2001. *JGR-E*, 106, 27,985-27,999. [4] Keller L. P. *et al.* 1998. *29th LPSC*, #1762. [5] Noble S. K. *et al.* 2007. *Icarus* 192, 629-642. [6] Pieters C. M. *et al.* 2009. *Science*, 326:569-572. [7] Liu Y. *et al.* 2012. *Nature Geo.* 5:779-782. [8] Noble S. K. *et al.* 2013. *44th LPSC*, #1298. [9] Sasaki S. *et al.* 2001. *Nature*, 410, 555-557. [10] Christoffersen R. *et al.* 2010. *41st LPSC*, #1532. [11] Zhang S. and Keller L. P. 2012. *MAPS*, 47, #5267.