NEW SHOCK RECOVERY EXPERIMENTS ON LUNAR-COMPOSITION PLAGIOCLASE

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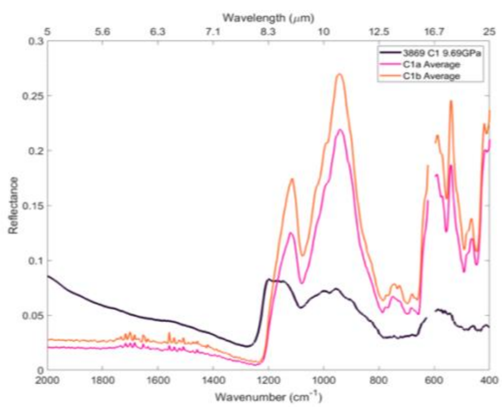
Introduction: The Moon has undoubtedly been transformed by impact cratering, with much of the lunar surface consisting of an impact gardened regolith. The micro-scale processes of lunar space weathering – a combination of both irradiation and impacts – has been the focus of many recent studies, but largely centered on micrometeorite irradiation. Here we present new spectroscopic analyses of shock recovery experiments on plagioclase with a composition (An_{92}) consistent with what is found in the lunar samples. This is important because previous shock studies on feldspar have been conducted on less-calcic plagioclase [1] and primarily used for X-Ray and optical analyses. Our work is particularly relevant to recent and upcoming remote sensing missions which use visible and infrared spectroscopy [e.g., 2].

Methods: We conducted shock experiments on the Stillwater Complex, Montana, anorthosite is a medium grained (~2-6 mm) anorthosite comprised of highly calcic plagioclase grains (An_{92}) [3,4]. Starting material consisted of two suites: slices of the rock which preserve mineral fabrics, and powders designed to simulate the porous nature of the lunar regolith. Samples were cut into circular slices roughly 4 mm in radius and ~1 mm thick to comply with the experimental set-up. The particle size making up the powders is approximately 30 μm. Experiments are ongoing, using the flat-plate accelerator at the Experimental Impact Laboratory at NASA JSC. Ultimately, a range of shock pressures between 3 and 70 GPa will be covered. As of the time of abstract submission, we have recovered 11 samples: 6 from the powders and 5 from the slices.

Results: The powdered samples show an overall difference in spectral shape, which is expected when switching between fine particulate and solid/slab samples (as the post-shock samples are now compressed into slabs). These effects include the flattening of the region from 2000-1300 cm^{-1}, the increase in band depth for the reststrahlen band region (~1200-900 cm^{-1}), and the loss of the transparency feature near 850 cm^{-1}.

After accounting for the changes due to particle size/slab, we can see some of the changes caused by the shock pressures. With increasing pressure, there is a loss of the distinct peaks seen at 1850, 1800 and 1600 cm^{-1}, a shift in the Christiansen feature position from ~1300 to ~1250 cm^{-1}, and a shift from 2 reststrahlen band features to a broader 1 in both the 1200 and 500 cm^{-1} regions. The observed changes in spectral features are what we would expect to see as the crystalline structure is disrupted with increasing pressures.

For shocked slices, the post-shock spectrum shows a shift in both position to longer wavenumbers (shorter wavelengths) and band depth (weaker and broader, though still two peaks) of the major features. The increase in slope in the 2000-1300 cm^{-1} region is also detectable at this (relatively) low shock pressure of 10 GPa.



Example comparison of a slice, shocked to 10 GPa. C1a and C1b are front and back of the pre-shock slices.

References:

[1] Hörz and Quaide (1973). The Moon, 6, 45–82 [2] Pernet-Fisher et al., (2016) *Sci Reports 7* [3] McCallum, I. S., Raedeke, I. D., & Mathez, E. A. (1980) *AJS 280A,* 59-87 [4] Czamanske, M. L. & Zientek, G. K., (1985) *Montana Bureau of Mines and Geology Special Publication 92*.