Constraints on Exposure Ages of Lunar and Asteroidal Regolith Particles

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Mineral grains in lunar and asteroidal regolith samples provide a unique record of their interaction with the space environment. Exposure to the solar wind results in implantation effects that are preserved in the rims of grains (typically the outermost 100 nm), while impact processes result in the accumulation of vapor-deposited elements, impact melts and adhering grains on particle surfaces. These processes are collectively referred to as space weathering. A critical element in the study of these processes is to determine the rate at which these effects accumulate in the grains during their space exposure. For small particulate samples, one can use the density of solar flare particle tracks to infer the length of time the particle was at the regolith surface (*i.e.*, its exposure age).

We have developed a new technique that enables more accurate determination of solar flare particle track densities in mineral grains <50 μm in size that utilizes focused ion beam (FIB) sample preparation combined with transmission electron microscopy (TEM) imaging [1, 2]. We have applied this technique to lunar soil grains from the Apollo 16 site (soil 64501) and most recently to samples from asteroid 25143 Itokawa returned by the Hayabusa mission. Our preliminary results show that the Hayabusa grains have shorter exposure ages compared to typical lunar soil grains. We will use these techniques to re-examine the track density-exposure age calibration from lunar samples reported by Blanford *et al.* (1975) [3].

[1] E. L. Berger & L. P. Keller (2014) *LPSC*, #1485. [2] E. L. Berger & L. P. Keller (2014) *Microscopy and Microanalysis Conference*, submitted. [3] G. E. Blanfor *et al* (1975) *Proc. Lunar Sci. Conf. 6th*, 3557-3576