CONSTRAINTS ON SPACE WEATHERING RATES BY THE SOLAR WIND AT 1AU.

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Introduction: Space weathering effects on airless bodies result largely from micrometeorite impacts and interaction with the solar wind. Here we use the accumulation of solar flare particle tracks in individual lunar grains to estimate their exposure age and compare this to their space weathered rim thickness, with a focus on solar wind amorphized rims. We then extend this analysis to grains from the Itokawa regolith.

Results and Discussion: The width of solar wind amorphized rims on lunar soil anorthite grains increases as a smooth function of exposure age until it levels off at ~180 nm after ~20 My [1]. Solar wind damage can only accumulate if the grain has a direct line of sight to the Sun, whereas solar flare particles can penetrate to mm depths. Thus, tracks can accumulate while the particle is not directly exposed at the lunar surface. In order to calibrate this relationship, we measured the amorphized rim width from the anorthite in lunar rock 64455 [2] that was never buried, and has a well constrained exposure age of 2 My based on isotopic measurements [3]. The 60-70 nm rim width formed over 2 My and plots within error of the trend for soil grains, suggesting that the solar flare track densities are accurately reflecting the surface exposure of the soil grains. The observed rate for lunar anorthite is 2-3 orders of magnitude longer than the rapid (~10^3 y) development of amorphized rims predicted by numerical models [4,5].

Space-weathered olivines from Itokawa show solar wind damaged rims that are nanocrystalline, but not amorphous [6] and have track densities indicating surface exposures of 10^4-10^5 years [7]. Space weathered rims on lunar soil olivines with high track densities(~10^{11}cm^{-2}) and long surface exposure (~10^7 y) are not amorphized – this observation is in stark contrast to irradiation experiments showing rapid formation of amorphous and blistered surfaces from a simulated solar wind exposure of ~5000 y, suggesting a disconnect between high flux laboratory experiments and the natural case [e.g. 8].

Conclusions: Additional measurements, experiments, and modeling are required to resolve the discrepancies among the observations and calculations involving solar wind amorphization of different mineral grains on airless bodies.

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