CAN WE DISTINGUISH BETWEEN SHOCK-DARKENED AND SPACE-WEATHERED ASTEROIDS?

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Introduction: Both lunar-type space weathering and impact shock-darkening are capable of significant darkening of asteroid spectra. Thus, question arises – are we able to distinguish between these processes from asteroid reflectance spectra?
The Chelyabinsk meteorite represents unique opportunity with delivery of large amount of meteorite material of various shock levels. The basic three lithologies include (1) slightly shocked light-colored lithology, (2) partly molten shock-darkened dark-colored lithology, and (3) entirely molten impact melt lithology. In order to compare shock effects to space weathering, the light-colored lithology was subjected to simulated space weathering and the spectral changes were compared to mixtures of the light-colored and shocked materials.

Results: Results indicate that shocked material shows no significant spectral slope change while both 1 and 2 μm bands are progressively reduced with a nearly constant depth ratio. In contrast, the space weathering causes a strong increase in spectral slope. Also, the ratio of 2 μm band depth to 1 μm band depth is progressively increasing with amount of space weathering, most likely due to higher resistance of pyroxene to space weathering compared to olivine. This is also seen in the principal component space by [1]. Fresh light-colored lithology plots into Q-type field. Both space-weathered and shocked materials show reduction in PC1' component related to decrease in 1 μm band depth. However, the addition of shocked material causes also significant reduction in PC2‘ component related to decrease in 2 μm band depth and transition from the Q-type field across alpha line into C/X complex. In contrast space-weathered material shows smaller PC2‘ component changes and moves along alpha line towards S-type field. Thus, 1 and 2 μm band depth ratio or PC2‘/PC1‘ ratio together with spectral slope may be indicator of shock darkening vs. space weathering in (ordinary chondrite) asteroid spectra.

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