Collisional Histories of Comets and Trojan Asteroids: Diopside, Magnesite, and Fayalite Impact Studies.

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Comets and asteroids have weathered dynamic histories, as evidenced by their rough surfaces. The Nice model describes a violent reshuffling of small bodies during the Late Heavy Bombardment, with collisions acting to grind these planetesimals away. This creates an additional source of impact material that can re-work the surfaces of the larger bodies over the lifetime of the solar system. Here, we investigate the possibility that signatures due to impacts (e.g. from micrometeoroids or meteoroids) could be detected in their spectra, and how that can be explained by the physical manifestation of shock in the crystalline structure of minerals.

All impact experiments were conducted in the Johnson Space Center Experimental Impact Laboratory using the vertical gun. Impact speeds ranged from ~2.0 km/s to ~2.8 km/s. All experiments were conducted at room temperature. Minerals found in comets and asteroids were chosen as targets, including diopside ($MgCaSi_2O_6$, monoclinic pyroxene), magnesite ($MgCO_3$, carbonate), and fayalite ($FeSiO_4$, olivine). Impacted samples were analyzed using a Fourier Transform Infrared Spectrometer (FTIR) and a Transmission Electron Microscope (TEM). Absorbance features in the 8-13 μm spectral region demonstrate relative amplitude changes as well as wavelength shifts. Corresponding TEM images exhibit planar shock dislocations in the crystalline structure, attributed to deformation at high strain and low temperatures. Elongating or shortening the axes of the crystalline structure of forsterite (Mg_2SiO_4, olivine) using a discrete dipole approximation model (Lindsay et al., submitted) yields changes in spectral features similar to those observed in our impacted laboratory minerals.

Results on forsterite and orthoenstatite can be found in Jensen, et al., this meeting.

Funding was provided by the NASA PG&G grant 09-PGG09-0115, NSF grant AST-1010012, and a Cottrell College Scholarship through the Research Corporation.