**COLLISIONAL PROCESSING OF OLIVINE AND PYROXENE IN COMETARY DUST.**
S. M. Lederer[1] M. J. Cintala[2], R. D. Olney[1], L. P. Keller[2], K. Nakamura-Messenger[3] and M. Zolensky[2], [1]Cal State Univ. SB, [2]NASA Johnson Space Center, [3]ESCG Jacobs Sverdrup.

**Introduction:** According to the nebular theory of solar-system formation, collisions between bodies occurred frequently early in the solar system's history and continue at a lower rate even today. Collisions have reworked the surface compositions and structures of cometary nuclei, though to an unknown degree.

The majority of the collisional history of a typical Jupiter-family comet takes place while it resides in the Kuiper Belt. Impacts occur on the surfaces of small bodies over a large range of velocities by impactors of all sizes, but typical encounter speeds within the Kuiper Belt are 1.5 to 2.0 km $s^{-1}$[1]. Durda and Stern suggest that the interiors of most cometary nuclei with diameters <5 km have been heavily damaged by collisions [2]. They estimate that over 3.5 Gy, a nucleus with a diameter of 2 km and an orbit between 35-45 AU will experience 90-300 collisions with objects greater than 8 m in diameter. In this same timeframe, collisions between a typical Trans-Neptunian Object (TNO) 200 km in diameter and objects with d > 8 m would rework up to one-third of that TNO's surface. In fact, it has been proposed that most short-period comets from the Kuiper Belt (90%) are collisional fragments from larger TNOs — not primordial objects themselves [3] — and that most short-period comets from the Kuiper Belt will be collisionally processed both on their surfaces as well as in their interiors.

**Experiments:** Because collisions have occurred frequently throughout the history of the solar system, one would expect them to influence various "signatures" of cometary dust (*e.g.*, in infrared spectra, including the size distributions of dust particles; fractal porosity of the grains; the crystalline-to-amorphous ratio for silicates; and shock effects observed in cometary-dust samples). Therefore, a set of impact experiments were designed to investigate the signatures that collisional processing might cause that could be detected in telescopic data of comets.

The impacts supporting this study were performed in the Experimental Impact Laboratory (EIL) at the Johnson Space Center. We conducted experiments at roughly 2.0, 2.45, and 2.8 km $s^{-1}$ using the vertical gun. Spectrally neutral ceramic spheres, 3.18 mm in diameter, were launched at mineral targets that were either (a) granular or (b) single fragments. Target materials included several of the most common constituents of cometary dust: Mg-rich olivine (forsterite), Mg-rich pyroxene (ortho-enstatite), and Fe-rich olivine (fayalite).

**Analysis:** The materials will be analyzed for evidence of shock metamorphism and alterations in spectral and transmission electron microscope (TEM) imaging signatures. Initial analyses of forsterite and enstatite impacted at 2.8 km/s show changes in 5-15µm FTIR (Fourier Transform Infrared Spectrometer) spectra (*e.g.*, darkening, shallowing of band depths, and new spectral lines). The changes can be explained in part by a decrease in the mean free path of signal due to shock damage and the possible presence of dissociation products. TEM images of an impacted forsterite grain from the same experiment in which the FTIR spectral changes occured show clear evidence of shock in the form of a high density of planar dislocations parallel to Burgers vector b=[001]. The density of dislocations is on the order of $10^{10}$ $cm^{-2}$. Such a high density of planar dislocations is known to be due to deformation at high strain rates and low temperatures [4]. Similar analyses will be conducted on minerals impacted at the lower speeds.

Ultimately, a database of shocked and unshocked mineral spectra [5, 6, 7] will be used as input for a linear mixing model designed to fit telescopic spectra of comets. This model combines a linear mix of over 80 species and includes effects of particle-size distributions, size, temperature, and porosity in generating a model emission spectrum. Modeling the 1.5-35 µm region allows one to constrain the following: the olivine, pyroxene, mass ratios, grain-size distribution, and possibly the crystalline-to-amorphous ratios for both olivine and pyroxene, etc. We will use our results to aid in analyzing ground based observations of comets (e.g., 9P/Tempel 1 and Hale-Bopp[5]).

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