Joint M^3 and Diviner analysis of the mineralogy, glass composition, and country rock content of pyroclastic deposits in Oppenheimer Crater

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Here we present our analysis of the near- and mid-infrared spectral properties of pyroclastic deposits within the floor fractured Oppenheimer Crater that are hypothesized to be Vulcanian in origin. These are the first results of our global study of lunar pyroclastic deposits aimed at constraining the range of eruption processes on the Moon. In the near-infrared, we have employed a new method of spectral analysis developed in Horgan *et al*. (2013) of the 1 μm iron absorption band in Chandrayaan-1 Moon Mineralogy Mapper (M^3) spectra. By analyzing both the position and shape of the 1 μm band we can detect and map the distribution of minerals, glasses, and mixtures of these phases in pyroclastic deposits. We are also using mid-infrared spectra from the Lunar Reconnaissance Orbiter Diviner Lunar Radiometer Experiment to develop ~200 m/pixel Christiansen Feature (CF) maps, which correlate with silica abundance. One of the benefits of using CF maps for analysis of pyroclastic deposits is that they can be used to detect silicic country rock that may have been emplaced by Vulcanian-style eruptions, and are sensitive to iron abundance in glasses, neither of which is possible in the near-infrared.

M^3 analysis reveals that the primary spectral endmembers are low-calcium pyroxene and iron-bearing glass, with only minor high-calcium pyroxene, and no detectable olivine. The large deposit in the south shows higher and more extensive glass concentrations than the surrounding deposits. We interpret the M^3 spectra of the pyroclastic deposits as indicating a mixture of low-calcium pyroxene country rock and juvenile glass, and no significant olivine. Analysis of Diviner CF maps of the Oppenheimer crater floor indicates an average CF value of 8.16, consistent with a mixture of primarily plagioclase and some pyroxene. The average CF values of the pyroclastic deposits range from 8.31 in the SW to 8.24 in the SE. Since CF values within the deposits are as high as 8.49, the lower average CF values of the deposits suggest that each deposit is a mixture of crater floor material and highly mafic juvenile material consistent with either olivine or Fe-bearing pyroclastic glass.

Synthesizing our M^3 and Diviner results indicates that the crater floor consists of plagioclase with some pyroxene, and the pyroclastic deposits are a mix of this substrate and a glass-rich juvenile material. While we cannot determine the iron content of the glass from M^3 spectra alone, the high Diviner CF values suggest that the glass is relatively iron-rich. Indeed, FeO abundances inferred from CF values using the method of Allen *et al*. (2012) imply that the large southern deposit exhibits a significant enhancement in iron content. This supports our hypothesis that the glass in this deposit is relatively iron-rich.