The mineralogy of late stage lunar volcanism as observed by the Moon Mineralogy Mapper on Chandrayaan-1

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[1] The last major phases of lunar volcanism produced spectrally unique high-titanium basalts on the western nearside of the Moon. The Moon Mineralogy Mapper (M^3) on Chandrayaan-1 has provided detailed measurements of these basalts at spatial and spectral resolutions necessary for mineralogical interpretation and mapping of distinct compositional units. The M^3 imaging spectrometer acquired data in 85 spectral bands from ~430 to 3000 nm at 140 to 280 m/pixel in its global mapping mode during the first half of 2009. Reflectance data of several key sites in the western maria were also acquired at higher spatial and spectral resolutions using M^3's target mode, prior to the end of the Chandrayaan-1 mission. These new observations confirm that both fresh craters and mare soils within the western high-Ti basalts display strong 1 μm and weak 2 μm absorptions consistent with olivine-rich basaltic compositions. The inferred abundance of olivine is observed to correlate with stratigraphic sequence across different mare regions and absolute ages. The apparent stratigraphic evolution and Fe-rich compositions of these basalts as a whole suggest an origin from evolved residual melts rather than through the assimilation of more primitive olivine-rich sources. Mare deposits with spectral properties similar to these late stage high-Ti basalts appear to be very limited outside the Procellarum-Imbrium region of the Moon and, where present, appear to occur as small areas of late stage regional volcanism. Detailed analyses of these new data and supporting measurements are in progress to provide further constraints on the mineralogy, olivine abundance, and compositions of these final products of lunar volcanism and the nature and evolution of their source regions.

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1. Introduction

[2] The history of volcanism on the western nearside of the Moon is unique in both its duration and the basaltic compositions it left exposed on the lunar surface. Together, Oceanus Procellarum and Mare Imbrium compose the largest regional expanse of the lunar maria, with deposits ranging from the early history of mare volcanism through its last major phases [e.g., *Hiesinger et al.*, 2003]. Various remote sensing techniques have dated many of the flows in these regions as younger than 3.0 Ga [*Boyce*, 1976; *Schaber*, 1973a; *Bugiolacchi and Guest*, 2008] with some areas having been dated as young as ~1.2 Ga [*Hiesinger et al.*, 2003] and <1 Ga [*Schultz et al.*, 1976; *Schultz and Spudis*, 1983]. Such flows are believed to represent the final products of mare volcanism emplaced almost 2 Gyr after the youngest basalts collected by sample return missions.

[3] The last major phases of lunar volcanism cover large areas of Oceanus Procellarum and Mare Imbrium as well as smaller regions within several surrounding maria [*Hiesinger et al.*, 2000, 2003]. These flows have high inferred titanium contents due to their relatively blue ultraviolet to visible reflectance properties [e.g., *Charette et al.*, 1974; *Pieters*, 1978; *Johnson et al.*, 1991; *Blewett et al.*, 1997] and orbital elemental measurements [*Davis*, 1980; *Elphic et al.*, 2000, 2002]. Telescopic studies first identified a relatively strong 1 μm feature and a weaker 2 μm absorption associated with these mare regions, suggesting the presence of a significant component of olivine or Fe-rich glass in western high-Ti

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