Compositional variability of the Marius Hills volcanic complex from the Moon Mineralogy Mapper (M^3)

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[1] Using the Moon Mineralogy Mapper(M^3), we examine the Marius Hills volcanic complex for the first time from 0.46 to 2.97 μm. The integrated band depth at 1 μm separates the mare basalts on the plateau in two units: (1) a strong 1 μm band unit of localized lava flows within the plateau that has similar olivine-rich signatures to those of the nearby Oceanus Procellarum and (2) a weaker 1 μm band unit that characterizes most of the basalts of the plateau, which is interpreted as having a high-calcium pyroxene signature. Domes and cones within the complex belong to the high-calcium pyroxene plateau unit and are associated with the weakest 1 μm band observed on the plateau. This difference could be the result of higher silica content, more opaque minerals, and/or a weaker olivine content of the magma. Finally, the floor of Marius crater has one of the strongest olivine-rich signatures of the entire Marius Hills complex. These compositional differences are indicative of the long and complex volcanic history of the region. The first episode started before the emplacement of the surrounding basalts of the plateau and produced the high-calcium pyroxene flows present on the plateau and their associated domes and cones. The second episode occurred concurrently or slightly after the emplacement of the adjacent Procellarum basalts and produced the olivine-rich basalts seen within the plateau, outside the plateau, and in Marius crater. If the olivine content of the lava flows increases with time, the olivine-rich region on the floor of Marius crater may represent one of the latest episodes of volcanism exposed on the Marius Hills complex.

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1. Introduction

[2] The Marius Hills volcanic complex (MHC) is one of the largest volcanic complexes on the Moon. The diversity of the geologic features (e.g., cones, domes, rilles, lava flows) indicates that volcanic activity was very important and very complex in this area. The MHC is a 35,000 km^2 plateau located in central Oceanus Procellarum at 13.3N/306.8E and rising 100–200 m from the surrounding plains [*Head and Gifford*, 1980; *Whitford-Stark and Head*, 1977]. A Moon Mineralogy Mapper (M^3) mosaic of the MHC including the volcanic edifices and Marius crater is presented in Figure 1 at a resolution of 280 m/pixel (m/pix). Observations of the MHC with the Lunar Orbiter Laser Altimeter (LOLA) [*Smith et al.*, 2010] are presented in Figure 2. To understand the different volcanic episodes that built the MHC, it is necessary to study the domes, cones and lava flows of the MHC as well as to compare deposits them with the surrounding mare basalts of Oceanus Procellarum. The surface of the Moon is dominated by mafic minerals (e.g., olivine, pyroxenes) and plagioclase. These minerals present specific spectroscopic signatures and in particular absorption bands in the 1 μm region of the electromagnetic spectrum as described in Figure 3. The M^3 spectrometer onboard the Chandrayaan-1 spacecraft is a unique opportunity to examine in details the MHC with a high spectral resolution.

[3] The MHC has the highest concentration of volcanic features in Oceanus Procellarum [*Whitford-Stark and Head*, 1977]. A detailed study of 200 volcanic domes on the nearside by *Head and Gifford* [1980] demonstrated the Marius Hills domes are a unique class with irregular shapes, complex surface details, and a few summit craters or cones on top of some domes. The MHC contains 262 domes divided in two types, low domes and steep domes [*Whitford-Stark and Head*, 1977]. Low domes have a diameter up to 25 km and are 50–200 m high. Steep domes have a diameter of

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