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# Spectroscopic investigations of late-stage lunar volcanism

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## Abstract

In this work, the late-stage lunar volcanism is investigated using the Moon Mineralogy Mapper infrared spectrometer. Efforts are concentrated in the Imbrium and Marius Hills regions, which both exhibit various mineralogical compositions characteristics of the evolution of the lunar volcanism.

## 1. Introduction

The last major phases of lunar volcanism produced compositionally unique, high-titanium basalts that are not observed elsewhere on the Moon's surface or earlier in its history [1,2]. These volcanic deposits include some of the Moon's most extensive flows and age estimates suggest that these basalts are among the youngest [3].

New data acquired by the Moon Mineralogy Mapper ($M^3$) imaging spectrometer [4] are capable of measuring the diagnostic reflectance properties of individual flows within these basalts, providing the observations necessary for detailed interpretation of their mineralogy and petrologic evolution. $M^3$ is an infrared spectrometer with a spectral range from 500 to 3000 nm, and a spectral resolution of 20 to 40 nm. This range allows detailed investigations of the 1 and 2 μm absorption bands characteristic of mafic minerals on the lunar surface.

## 2. Previous work

Among the western basalt of the lunar surface, the Marius Hills volcanic Complex (MHC) exhibits an incredible variety of mineralogical composition [5]. Volcanic flows richer in olivine are interpreted as young basaltic flows, while the pyroxenes rich flows are older. Among the youngest and olivine-rich flows, the crater Marius has a basaltic-filled floor extremely rich in olivine (Figure 1). The MHC has the advantage to have preserved the early volcanism of Procellarum and is consequently an important are to study in order to understand the evolution of the lunar volcanism.

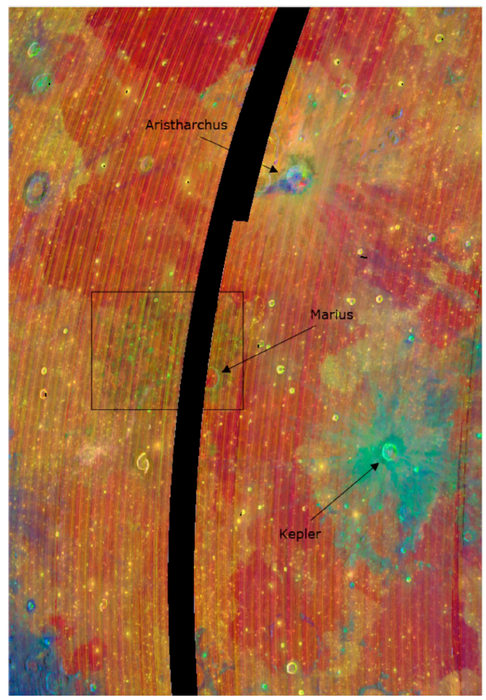


Figure 1: $M^3$ integrated band strength color composite in which the Procellarum basalts are red due to a strong 1 μm integrated band depth (red is 1 μm IBD, green is 2 μm IBD, and blue is reflectance at 1.58 μm). The MHC appears different from the surrounding basalts; the floor of Marius crater is the same red (olivine rich) as some of the surrounding mare basalts.

On a more global scale, investigations of the Imbrium and Procellarum regions have shown the diversity of mineralogical compositions of the basaltic flows [6] (Figure 2). The boundaries of the mare units can be clearly delimited and are different than many of the units defined by [3] using Clementine UVVIS data due to the expanded wavelength range observed by M$^3$.

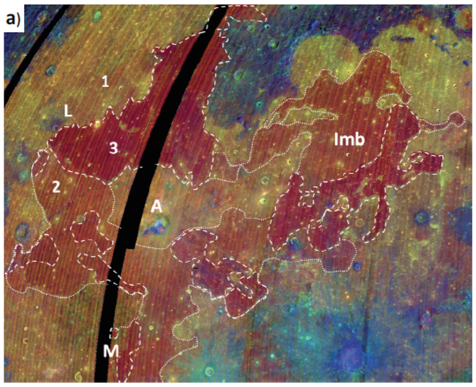


Figure 2: Boundaries of spectral units observed in M$^3$ data, the color composite is the same as Figure 1.

## 3. New investigations and results

In this work, we continue the preliminary investigations by [5,6] to examine the mineralogical composition of the basaltic flows and, when appropriate, their thickness. Of paramount importance is the variation of the olivine content of these basalts and their possible correlation with stratigraphic and absolute ages of the flows. Therefore, the regional stratigraphy of basaltic flows needs to be identified based on their spectral characteristic and ages relative to observed boundaries need to be determined.

The relation between the late-stage volcanism of the MHC, in particular the crater Marius, and the surrounding basaltic flows will be presented. The characteristics of the Imbrium lava flows, in particular the mineralogical composition and the thickness of the stratigraphic units, will also be investigated.

## Acknowledgements

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