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VNIR spectral variability of the igneous stratified Stillwater Complex: A tool to map lunar highlands†

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Abstract

Lunar highlands are plagioclase-rich terrains produced by crystal floating in a Magma Ocean system. Lunar samples revealed the presence of anorthositic (plagioclase > 90%) samples from the Highlands, associated to more mafic rocks. Recently, remote sensing data permit mapping those terrains with high spatial and spectral resolution allowing detection of plagioclase and mafic crystal field (C.F.) absorptions.

In this paper we have studied bidirectional spectral characteristics in the visible near-infrared (VNIR) of rocks from the Stillwater Complex, a cumulitic igneous stratified complex, with composition varying from mafic to sialic (e.g., pyroxenite, anorthosite). We investigated both slabs and powders of these rocks to give indication of the spectral variability of rock analogs of lunar crust, from a mineralogical point of view. Samples have been spectrally separated in four main groups considering the different C.F. absorption association, reflectance and spectral shape for both slab and powder spectra. More spectral details can be obtained from the analysis of powder spectra than from the slab spectra.

The composition of rocks can be addressed by studying spectral parameters, such as the position and the intensity of the absorption (e.g., band center and band depth). The analysis of our plagioclase-pyroxene-bearing samples indicates that mafic composition can be clearly obtained for samples characterized by one pyroxene phase, even for few amounts of pyroxene, from powder spectra. On the other hand, slab spectra show clear pyroxene absorptions only for rocks with mafic abundance at least >20%. The intensity of the mafic absorptions of these samples shows a linear trend with respect to the abundance of pyroxenes (orthopyroxene + clinopyroxene, for samples with ferrosilite amount less than ca. 25%). Considering all pyroxene-bearing samples, the band depth of slab spectra are linearly related to the volumetric distribution of ferrous iron in pyroxenes.

Keywords: Lunar and planetary studies, terrestrial analogs, optical spectroscopy, VNIR reflectance spectroscopy, surface studies, highlands particulate, rock analogs