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THE SECOND CONFERENCE ON THE LUNAR HIGHLANDS CRUST AND NEW DIRECTIONS

Reflectance spectroscopy of plagioclase-dominated mineral mixtures: Implications for characterizing lunar anorthosites remotely†

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ABSTRACT

Anorthositic rocks dominate the Moon's upper crust. As remnants of the lunar magma ocean (LMO), small variations in the mineralogy of these rocks may hold key information about the homogeneity of LMO composition and solidification processes. Orbital near-infrared (NIR) sensors are sensitive to mineralogy, but technologic advances have only recently enabled detection of the plagioclase component in crustal rocks based on an absorption band centered near 1250 nm. Anorthosites occupy a unique mineralogic range that is well suited for NIR studies: the highly transparent component, plagioclase, is present in high abundances while the spectrally dominant mafic or oxide minerals are present in only minor abundance. As a result, spectra of anorthosites are more likely than many other rock types to contain visually discernable signatures from more than one mineral component, facilitating their identification and characterization in NIR data.

In support of new NIR measurements for the Moon, we present laboratory spectral analyses of well-controlled plagioclase-dominated mineral mixtures. We focus on the spectral effects of varying mafic and oxide composition and abundance in mixtures with a common plagioclase end-member. The results demonstrate that plagioclase can be a significant contributor to reflectance spectra when strongly absorbing minerals are present in low abundance. We show that the contribution of plagioclase is more pronounced in mixtures with pyroxenes and certain spinels, but more easily masked in mixtures containing small amounts of olivine. Differences in minor mineral composition are clearly expressed in bulk spectra. Modeling of mixtures using a Hapke nonlinear approach accurately estimates mineral abundances in laboratory spectra to within 5 vol% for mixtures with ≥90 vol% plagioclase. Together, these results imply that not only should orbital NIR data sets be able to discern the presence of plagioclase in anorthositic crustal exposures, but also that detailed information about anorthosite mineral assemblages can be reliably accessed in reflectance spectra.

Keywords: Moon, anorthosite, near-infrared spectroscopy, minerals, plagioclase