olivines with remotely sensed VNIR reflectance spectra: the long-wavelength absorptions caused by chromite inclusions and the effect of continuum slopes common to remotely sensed spectra of planetary surfaces. *Isaacson and Pieters* [2010] addressed the former complication but explicitly did not address the latter, limiting their analyses to laboratory reflectance spectra in which flat continuum slopes are appropriate. In this study, we extend the *Isaacson and Pieters* [2010] approach to address the effect of continuum slopes. We propose a method for standardizing the continuum slope used to deconvolve remotely sensed olivine spectra, and evaluate the effect of this method on the established trends in MGM-derived band position found in both terrestrial olivine and chromite-bearing lunar olivine spectra. We apply this approach to predict olivine compositions from several locations on the lunar surface using VNIR reflectance spectra collected by the Moon Mineralogy Mapper (M^3) on Chandrayaan-1 from several locations on the lunar surface.

2. Background: The Moon Mineralogy Mapper

[8] The Moon Mineralogy Mapper is an imaging spectrometer covering visible to near-infrared wavelengths. It was a guest instrument on the Indian Space Research Organisation (ISRO) Chandrayaan-1 mission. M^3 collected global data in 85 spectral channels from 400–3000 nm at a spatial resolution of 140 m/pixel from a 100 km orbit. More complete descriptions of the M^3 instrument are provided by *Pieters et al.* [2009, 2011]. A description of the calibration of M^3 data is provided by R. O. Green et al. (The Moon Mineralogy Mapper (M3) imaging spectrometer for lunar science: Instrument, calibration, and on-orbit measurement performance, submitted to *Journal of Geophysical Research*, 2011), and a description of the operational history and spatial coverage of M^3 is provided by *Boardman et al.* [2011].

3. Methods

3.1. Variable Continuum Slopes: Continuum Removal

[9] Continuum slopes in remotely sensed spectra are highly variable, as they can be influenced by a number of parameters, including surface texture, grain size, viewing geometry, and alteration such as through the process of space weathering. On the Moon, continuum slopes are predominantly affected by the presence of vapor-deposited nanophase iron-bearing rims on grains of lunar soil [e.g., *Pieters et al.*, 2000; *Hapke*, 2001; *Taylor et al.*, 2001; *Noble et al.*, 2005, 2007; *Taylor et al.*, 2010]. The optical effects of this nanophase iron are complex, but one of the major effects is an increase in the slope of the continuum (i.e., “red” continuum slopes). This effect becomes more pronounced with increasing degree of weathering [e.g., *Pieters et al.*, 2000; *Noble et al.*, 2001]. Even relatively immature materials on the Moon exhibit moderately “red” continuum slopes. Prominent continuum slopes cause shifts in apparent band center [e.g., *Clark and Roush*, 1984; *Clark*, 1999]. Thus, flat continuum slopes such as those used in previous systematic treatments of olivine reflectance spectra will not be practical for the majority of remotely sensed spectra collected of the lunar surface.

[10] The ubiquitous but variable nature of continuum slopes in remotely sensed VNIR reflectance spectra of planetary surfaces is a major complication in quantitative analysis of diagnostic absorption features present in those spectra. To treat these variable continuum slopes fully with an MGM-based approach, the continuum for each individual spectrum analyzed must be modeled individually for each fit [e.g., *Sunshine and Pieters*, 1998; *Sunshine et al.*, 2007]. While this is the most rigorous method to treat continuum slopes, the drawback of this approach is the additional complexity of the models and the potential variable methods applied to individual spectra. This variability can introduce more sources of error into comparisons between model results. To avoid these complexities and sources of error, we chose to use a systematic approach that will enable comparisons between model results more readily. We employ the approach developed by *Isaacson and Pieters* [2010] (truncating spectra and enforcing flat continuum slopes), but we include additional steps to address, in a systematic way, spectra for which flat continuum slopes are not practical.

[11] Our approach to dealing with continuum slopes is to remove the continuum slope prior to conducting MGM fits. This differs from the traditional MGM approach in which the continuum is modeled concurrently with the absorptions. Because the continuum is removed prior to performing deconvolutions, the slope (first-order polynomial term in the expression of the continuum slope) is fixed at zero for the deconvolutions, with only the offset (zero-order term) allowed to vary. We make a simplifying assumption that the relative trends in band position with olivine composition established from terrestrial olivines [*Sunshine and Pieters*, 1998] remain valid after continuum removal. However, it is beyond the scope of this project to verify that the effect of the continuum slope on band position is constant across all olivine compositions. Our goal in simplifying the modeling of the continuum slope is to ensure that we can apply our methods in a consistent manner regardless of the nature and magnitude of the continuum slope in any given spectrum. It is possible that our simplifications may introduce new biases, particularly if the effect of continuum removal is composition dependent. The advantage of this approach is that our methods can be replicated easily and consistently. However, a disadvantage of this approach is the inability to compare the resulting deconvolutions to existing deconvolutions of laboratory lunar olivine spectra performed without continuum removal. Thus, although the trends in band position with olivine composition are assumed to be valid in a relative sense, we cannot use our deconvolutions to assign absolute olivine compositions. A direct comparison to laboratory spectra would require substantial new laboratory work, including a reanalysis of the full suite of terrestrial laboratory olivine reflectance spectra with this new approach to modeling the continuum.

[12] The continuum slope to be removed is determined by fitting a local continuum over the principle olivine absorption feature. This local continuum slope is determined by tangent points on the short- and long-wavelength side of the absorption. Our method is to pick the “high reflectance” points on either side of the absorption as the tangent points. In our experience, the long-wavelength inflection point typically falls near ~1700 nm, while the short-wavelength