COMPOSITIONAL AND GRAIN-SIZE VARIATIONS IN ILMENITE REFLECTANCE SPECTRA

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Introduction

- Lunar ilmenite (FeTiO3) (and related Fe-Ti-oxides) occurs in concentrations up to 25% (by volume) in lunar mare basalts [1].
- Ilmenite reduction has been investigated over past decades as a means to generate O3 for support life and propulsion [2], with the potential to yield metal byproducts for construction [3], and aid in lunar 4He detection [4].
- Previous work has related spectral properties, such as 402/564 nm ratios were acquired from 350-1100 nm at a spectral resolution of 0.47 nm. Biconical-directional reflectance spectra were acquired from 350-1100 nm at a spectral resolution of 0.7 nm (resampled to 1 nm) with an ASD FieldSpec Pro HR spectrometer (emission = 0° and incidence = 30°). Reflectance spectra were acquired at the Planetary Spectrophotometer Facility at the University of Winnipeg.
- Ultraviolet (200-400 nm) and visible near-infrared reflectance (350-1100 nm) were acquired from 350-1100 nm at a spectral resolution of 0.7 nm (resampled to 1 nm) with an ASD FieldSpec Pro HR spectrometer (emission = 0° and incidence = 30°). Reflectance spectra were acquired at the Planetary Spectrophotometer Facility at the University of Winnipeg.

Methods

- Terrestrial ilmenite has been shown to be a good spectral analogue of lunar ilmenite [10].
- Twenty-two ilmenite samples (from a variety of localities including St. Urbain, Quebec, North Carolina, Italy, Madagascar, Norway, and synthetically produced) were collected, crushed, and sieved to a variety of grain sizes ranging from <45 μm to 500-1000 μm.
- Ultraviolet reflectance (200-400 nm) spectra were measured with an Ocean Optics Maya2000 pro miniaturized spectrometer (emission = 0° and incidence = 0°) equipped with a HC-1 grating and a 30 μm slit width, yielding an effective spectral resolution of 0.47 nm. Biconical-directional reflectance spectra were acquired from 350-1100 nm at a spectral resolution of 0.7 nm (resampled to 1 nm) with an ASD FieldSpec Pro HR spectrometer (emission = 0° and incidence = 30°). Reflectance spectra were acquired at the Planetary Spectrophotometer Facility at the University of Winnipeg.
- Composition of Fe2+/Fe3+ ratios were acquired at Franklin and Marshall College by X-ray fluorescence and wet chemistry [11].

Results

- Results – Grain Size
  • Reflectance spectra of synthetic ilmenite (ILM201, Figure 1) and ilmenite sample ILM103 (Figure 2) presented for various grain sizes.
  • Band depth at 500 nm appears to increase with grain size independent of general brightness differences in five grain sizes of ILM103 (from <45 μm to 500-1000 μm).

- Results - Composition
  • Spectral variations of four compositionally distinct species are presented in Figure 3, including a sample with notable hematite bands (ILM101), spectrally comparable to hematite sample HEM105 (Figure 1).
  • Deeper absorption bands at 220 nm and 300 nm (at Fe2+/O and Ti3+/O charge transfers) in compositionally-purest ilmenite species (ILM103).

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References