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LUNAR PHASE FUNCTION EFFECTS ON SPECTRAL RATIOS USED FOR RESOURCE ASSESSMENT; S.M. Larson, J. Collins, R.B. Singer, J.R. Johnson, and D.E. Melendrez; Lunar and Planetary Laboratory/ Department of Geo-sciences, University of Arizona, Tucson, AZ 85721

Groundbased telescopic CCD images of 36 selected locations on the moon were obtained in five "standard" bandpasses at 12 phase angles ranging from -78° to +75° to measure phase function effects on the ratio values we have used to quantify the abundance of TiO_2 and qualitatively indicate soil maturity [**1**, **2**]. Consistent with previous studies, we find that the moon is "bluer" at small phase angles, but that the effect on the ratio values for TiO_2 abundance for the phase angles of our data is on the order of the measurement uncertainties throughout the range of abundances found in the mare. The effect is more significant as seen from orbiting spacecraft over a range of selenographic latitude.

Spectral ratio images (400/560 and 400/730 nm) have been used to map the abundance of TiO_2 [**1**, **2**] using the empirical relation found by Charette et al [**3**] from analysis of returned lunar soils. Additionally, the 950/560 and 950/730 nm image ratios have been used to define the regions of mature mare soil in which the relation is valid. Although the phase function dependence on wavelength has been investigated and quantified for small areas and the integrated disc [e.g. **4**, **5**], the effect specifically on TiO_2 mapping has not been rigorously determined. For consistency and convenience in observing the whole lunar front side, our mapping has utilized images taken $-15^\circ < \alpha < 15^\circ$ when the moon was fully illuminated from earth; however, this includes the strong opposition peak.

CCD images with an approximate scale of 440 m per pixel were obtained with the 0.5 m Tumamoc Hill telescope from 11/91 to 2/92 through our usual filters having central wavelengths at 340, 400, 560, 730 and 950 nm. The 5 selected areas contained the full range of TiO_2 abundances, the MS-2 reference, pyroclastic deposits and highlands materials. The flat fielded images were registered, and counts were extracted from 2 by 2 pixel spots from homogenous areas as they appear in the 400/560 nm ratios. Extinction corrections for all filters were applied from nightly standard star observations.

Ratio values for all combinations of filters plotted against phase angle exhibit slightly asymmetric variations on either side of zero phase. The 400/560 nm curves used for TiO_2 mapping showed only the expected shift in ratio values according to TiO_2 abundance. The measurement uncertainties in shape of the curves are much smaller than the inherent uncertainty envelope of the Charette relation, so we conclude that phase corrections for our current maps are not necessary. It is clear, however, that for larger phase angles, such as might be experienced from orbiting spacecraft at high selenographic latitude, phase corrections will be important.

The phase curve at 950 nm was sufficiently different from the others as to suggest that the optical properties associated with the strong pyroxene absorption play an important role. McCord **[4]** had pointed out the connection of differential color with phase and the wavelength dependence of polarization of the moon as measured by Gehrels et al **[6]**. The strong polarization effects in pyroxene measured by Burns **[7]** is consistent with the pronounced phase effect on the 950 nm band.

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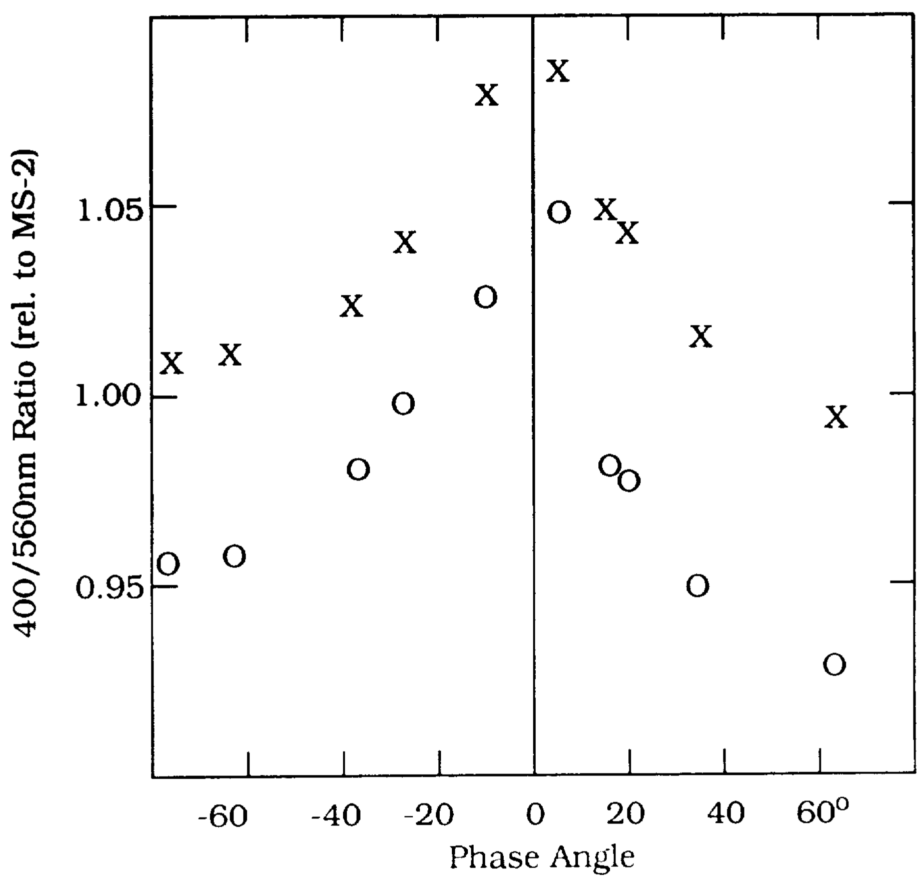

Ratio values for typically high (X) and low (O) TiO_2 areas in Mare Tranquillitatis over the range of observed phase angles.