A LROC WAC ALGORITHM FOR TIO2 ABUNDANCES IN THE LUNAR HIGHLANDS AND LOW-TI MARIA. B. Hapke[1] and S.Sato[2], [1]Dept. of Geology and Environmental Science, Univerity of Pittsburgh, Pittsburgh, PA, hapke@pitt.edu, [2]Japanese Aerospace Exploration Agency.

Introduction: Several algorithms for the abundances of TiO_2 in the Lunar maria have been published (e.g., [1] and references therein), but no comparable algorithm for the highlands has been forthcomimg. We show that the ratio r(4/7) of the reflectances in band 4 (565nm) to band 7 (690nm) of data taken by the Lunar Reconnaissance Orbiter Camera (LROC) wide angle camera (WAC) provides such an algorithm.

Spectral Systematics: The Ti systematics of r(1/3), the ratio of the reflectance in band 1 (320nm) to band 3 (415nm), and r(4/7) in Lunar regolith can be understood in terms of absorption of light in three materials: ilmenite, augite and glass. The regolith spectral reflectance has a positive slope due to nanometer-sized metallic Fe particles in coatings on the grains of soil [2]. Absorption bands are superposed on this reddish slope.

All Lunar materials that contain Feo and/or TiO_2 have absorption bands at 250nm, which causes their reflectances to be low in the UV [3]. Because lmenite is an opaque mineral its reflectance is low and relatively flat at all wavelengths. Its 250nm band is manifeated as a maximum, causing its reflectance to increase as the wavelength decreases in the uv-blue. Thus, adding ilmenite causes the r(1/3) and r(4/7) ratios to increase. Ti in augite and glass has weveral bands in the 300-500nm region [3], which causes their visible reflectance to decrease as wavelength dereases. Thus, adding Ti to augite or glass decreases the ratios. The spectral effects of augit and glass compete with the ilmenite.

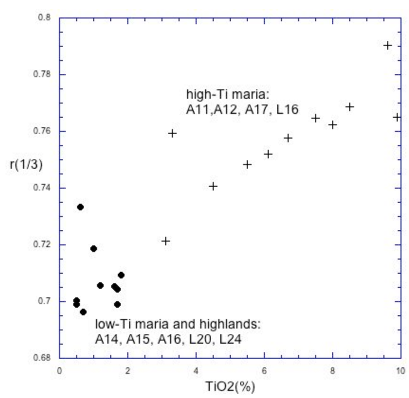

Fig. 1. r(1/3) vs TiO_2

Sato et al [1] showed that r(1/3) is a good proxy (fig. 1, cosses) for TiO_2 abundance in ilmenite in high-Ti maria ($TiO_2 > 2.5\%$). The reason is that the reflectances of all the regolith materials are low at short wavelengths, so that the ilmenite has a strong influence on the reflectance. However, in the highlands and low-Ti maria ($TiO_2 < 2.5\%$) the ilmenite content is so low that it cannot dominate the spectrum (fig 1, dots). The ratio points are bunched together with no clear trend, and r(1/3) is a poor TiO_2 proxy.

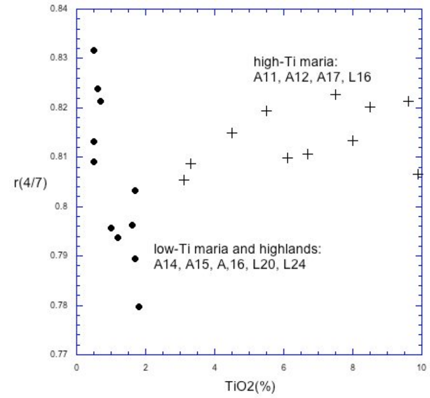

Fig. 2. r(4/7) vs TiO_2

At longer wavelengths the reflectances of all the materials, except ilmenite, are high, which allows the augite and glass bands to compete with the ilmenite. In th high-Ti maria (fig.2, crosses) r(4/7) tends to increase with increasing TiO_2, but there is a large scatter in the points, making r(4/7) an unsatisfactory proxy for the TiO_2. However in the low-Ti maria and highlands the ilmenite content is low and the augite and glass bands dominate the spectrum. The r(4/7) ratio is a good proxy for TiO_2 (dots in fig.2 and fig. 3).

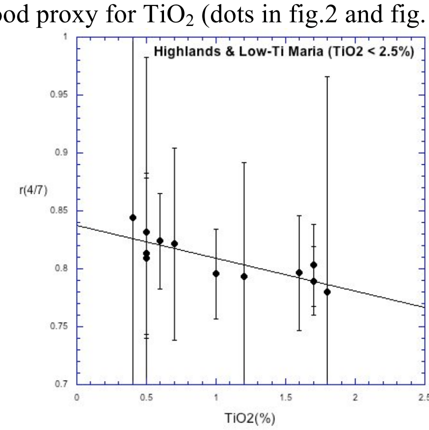

Fig. 3. r(4/7) vs TiO_2 for highlands and low-Ti maria

The TiO_2 Algorithm: The best fit line to the data of fig. 3 for $0 < TiO_2 < 2.5\%$: is

$$r(4/7) = 0.837 - 0.0284*TiO_2(\%). \quad (R = 0.83)$$

References:

[1] Sato H. et al (2017) Icarus 296, 216-238. [2] Hapke B. (2001) JGR 106, 10,039-10,073. [3] Wagner J. et al (1987) Icarus 69, 14-28.