elsewhere (Figure 2, #8), we interpret this consolidated block to be comprised of plagioclase which has lost its crystalline absorption band in a shocked environment [e.g., *Adams et al.*, 1979].

[10] The sampling points along the traverse are separated by ~140–280 meters, indicating that the spinel-bearing zone is about 0.7–1 km wide at this location. The strongest signatures however, are concentrated in a much narrower zone. Mg-spinel-rich areas also occur to the NW lying above the traverse and further downslope of the sampling point (Figure 3b). The transition from Mg-spinel to plagioclase-rich outcrop (green arrow) is relatively sharp. Higher spatial resolution LRO-NAC images [*Robinson et al.*, 2010] of the area provide additional information and are presented in the auxiliary material (Figure S1).[1] These images together with M^3 observations suggest that the strongest spinel concentration illustrated in Figures 3b and 3d may result from accumulation of debris derived from a higher ledge. It is still unclear whether the Mg-spinel-rich lithology 1) is genetically related to the observed massive plagioclase, 2) is part of an intrusion into predominantly anorthositic rocks, or 3) was brought into contact with plagioclase along faults formed during uplift of the central peaks. Further insights into the geologic context of the Mg-spinel-rich lithology would benefit from high resolution compositional-morphological comparisons for other regions and non-linear mixture modeling [e.g., *Dhingra et al.*, 2011a, 2011b].

6. Summary

[11] This identification and documentation of a prominent Mg-spinel-rich lithology in the central peaks of Theophilus crater provides new insights into the character of this recently discovered rock-type, and brings the inventory to two basin-related occurrences, one on the farside and this one (Theophilus) on the nearside. The Mg-spinel-rich lithology at Theophilus occurs in a dominantly anorthositic setting, as prominent exposures in the central peaks, along with lesser exposures of pyroxene and olivine-bearing materials. Spectral variations documented along high spatial resolution traverses, together with the morphological attributes, reveal a close association of mafic-free plagioclase and Mg-spinel, likely occurring as pink spinel anorthosite (PSA). The size and geologic context of spinel exposures suggests that this PSA unit was relatively extensive at depth in the crust prior to incorporation in the central uplift of Theophilus crater.

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[1] Auxiliary materials are available in the HTML. doi:10.1029/2011GL047314.

References

Adams, J. B., F. Hörz, and R. V. Gibbons (1979), Effects of shock-loading on the reflectance spectra of plagioclase, pyroxene, and glass, *Lunar Planet. Sci. Conf.*, *10th*, 1–3.

Boardman, J. W., et al. (2011), Measuring moonlight: An overview of the spatial properties, lunar coverage, selenolocation and related level 1b products of the Moon Mineralogy Mapper, *J. Geophys. Res.*, doi:10.1029/2010JE003730, in press.

Cloutis, E. A., J. M. Sunshine, and R. V. Morris (2004), Spectral reflectance-compositional properties of spinels and chromites: Implications for planetary remote sensing and geothermometry, *Meteorit. Planet. Sci.*, *39*(4), 545–565, doi:10.1111/j.1945-5100.2004.tb00918.x.

Dhingra, D., et al. (2011a), Compositional diversity at crater Theophilus: Understanding the geological context of Mg-Spinel bearing central peaks, *Lunar Planet. Sci. Conf.*, *42nd*, Abstract 2388.

Dhingra, D., et al. (2011b), Non-linear spectral unmixing using Hapke modeling: Application to remotely acquired M^3 Spectra of spinel bearing lithologies on the Moon, *Lunar Planet. Sci. Conf.*, *42nd*, Abstract 2431.

Goswami, J. N., and M. Annadurai (2009), Chandrayaan-1: India's first planetary science mission to the Moon, *Curr. Sci.*, *96*(4), 486–491.

Haruyama, J., et al. (2008), Global lunar-surface mapping experiment using the Lunar Imager/Spectrometer on SELENE, *Earth Planets Space*, *60*, 243–255.

Lal, D., et al. (2011), Identification of spinel group of minerals on central peak of crater Theophilus, *Lunar Planet. Sci. Conf.*, *42nd*, Abstract 1339.

Lawrence, D. J., et al. (2000), Thorium abundances on the lunar surface, *J. Geophys. Res.*, *105*(E8), 20,307–20,331, doi:10.1029/1999JE001177.

Marvin, U. B., et al. (1989), Cordierite-spinel troctolite, a new magnesium-rich lithology from the lunar highlands, *Science*, *243*, 925–928, doi:10.1126/science.243.4893.925.

Milton, D. J. (1968), Geologic map of the Theophilus quadrangle of the Moon, *Publ. I-546*, U.S. Geol. Surv., Flagstaff, Ariz.

Ohtake, M., et al. (2009), The global distribution of pure anorthosite on the Moon, *Nature*, *461*, 236–240, doi:10.1038/nature08317.

Pieters, C. M., et al. (2009), The Moon Mineralogy Mapper (M^3) on Chandrayaan-1, *Curr. Sci.*, *96*, 500–505.

Pieters, C. M., et al. (2011), Mg-spinel lithology: A new rock type on the lunar farside, *J. Geophys. Res.*, *116*, E00G08, doi:10.1029/2010JE003727.

Prinz, M., E. Dowty, K. Keil, and T. E. Bunch (1973), Spinel troctolite and anorthosite in Apollo 16 samples, *Science*, *179*, 74–76, doi:10.1126/science.179.4068.74.

Robinson, M. S., et al. (2010), Lunar Reconnaissance Orbiter Camera (LROC) instrument overview, *Space Sci. Rev.*, *150*, 81–124, doi:10.1007/s11214-010-9634-2.

Smith, D. E., et al. (2010), Initial observations from the Lunar Orbiter Laser Altimeter (LOLA), *Geophys. Res. Lett.*, *37*, L18204, doi:10.1029/2010GL043751.

Spudis, P. D., B. R. Hawke, and P. G. Lucey (1989), Geology and deposits of lunar Nectaris basin, *Lunar Planet. Sci. Conf.*, *19th*, 51–59.

Taylor, L. A., et al. (2009), The role of spinel minerals in lunar magma ocean evolution, *Eos Trans. AGU*, *90*(52), Fall Meet. Suppl., Abstract P34A-07.

Tompkins, S., and C. M. Pieters (1999), Mineralogy of the lunar crust: Results from Clementine, *Meteorit. Planet. Sci.*, *34*, 25–41, doi:10.1111/j.1945-5100.1999.tb01729.x.

Whitford-Stark, J. L. (1981), The evolution of the lunar Nectaris multiring basin, *Icarus*, *48*(3), 393–427, doi:10.1016/0019-1035(81)90053-1.

Wieczorek, M. A., and R. J. Phillips (1998), Potential anomalies on a sphere: Applications to the thickness of the lunar crust, *J. Geophys. Res.*, *103*, 1715–1724, doi:10.1029/97JE03136.

Wilhelms, D. E. (1987), The geologic history of the Moon, *U.S. Geol. Surv. Prof. Pap.*, *1348*, 302 pp.

Yamamoto, S., et al. (2010), Possible mantle origin of olivine around lunar impact basins detected by SELENE, *Nat. Geosci.*, *3*, 533–536, doi:10.1038/ngeo897.

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