OPTICAL MATURITY OF INNER WALLS IN LUNAR CRATERS. Chae Kyung Sim[1], Sungsoo S. Kim[1], Paul Lucey[2], Ian Garrick-Bethell[1,3], and Gilho Baek[1], [1]School of Space Research, Kyung Hee University, Yongin, Gyeonggi 17104, South Korea (cksim@khu.ac.kr), [2]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, 1680 East West Road, Honolulu HI 96822, USA, [3]Earth & Planetary Sciences, University of California Santa Cruz, 1156 High Street, Santa Cruz, California, 95064, USA.

Introduction: It has recently been found that the maturity indices of the lunar regolith such as the optical maturity (OMAT) or mean grain size <d> are latitude dependent [1, 2]. This dependence is thought to be a result of reduced space weathering effects at high latitudes, where the flux of weathering agents such as micrometeoroids and solar wind particles is smaller. Here we extend our previous work [2] to the inner walls of lunar impact craters. We analyze the OMAT profile in craters as a function of distance from the crater center. We also analyze OMAT differences between the northern and southern inner walls as well as those between the eastern and western inner walls.

Methods: OMAT is a maturity parameter based on the reflectances at two wavelengths, 750 nm and 950 nm, developed by [3]. Since the reflectance is a function of both incidence and reflectance angles, it is critical to correct the effect of local topography on OMAT, particularly when the craters are the subjects of analyses. We use the topography-corrected, 1-km resolution OMAT data from the Kaguya Multiband Imager data [4] for our analyses.

The craters we considered in our analyses are from the Lunar Impact Crater Database 2015 [5] from the Lunar and Planetary Institute. We consider the craters whose latitude is between –58° and +58° and whose diameter is between 5 km and 120 km. We exclude the craters whose OMAT image has too many bad pixels. The total number of craters considered here is 6110, and 1202 of them have age information.

We divide the inner wall of a crater into four quadrants: North, East, South, and West. When comparing the OMAT values between these walls, we only consider the craters whose average wall slope is greater than 10°. The average wall slope of a crater is determined from the altimetry data of the LRO/LOLA [6].

Results: Figure 1 shows the mean OMAT profiles for six different age groups as a function of distance from the crater center for two diameter ranges: 5 km < D < 20 km and 20 km < D < 120 km. The OMAT values are scaled to the mean OMAT values between 2.5 R_c and 3.0 R_c, where R_c is the crater radius. Since the formation of a crater is more recent than its neighboring regions, it is natural to expect the craters to have generally larger OMAT values than its neighbors (the larger the OMAT, the fresher the regolith). What is interesting in Figure 1 is that the OMAT profile of the crater resembles the topography of the crater－The OMAT value is larger where the topography is steep (walls and central peaks) and OMAT profiles fluctuate much less for older craters, where the topography is generally flatter due to various diffusion mechanisms. This implies that as craters age, the OMAT values of the craters gradually decrease to neighboring values, but this takes place more quickly at flatter areas in the craters.

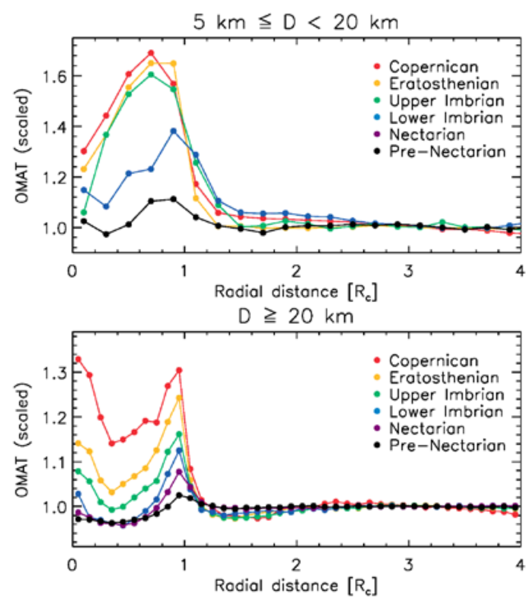

Figure 1. OMAT profiles for six different age groups.

Figure 2 shows the OMAT differences between the equator-facing (EF) and pole-facing (PF) walls as a function of cos(latitude) (top panel), and their latitudinal means (bottom panel). There is no significant OMAT difference at the equator, but as the (absolute) latitude increases, the EF walls have gradually larger (more mature) OMAT values. This is thought to be because the EF walls generally have a higher flux of space weathering agents, and this agrees with the global latitudinal dependence of the OMAT and <d> values found in [1] and [2]. Smaller craters show larger OMAT differences because they generally have steeper topographies.

Figure 3 shows the OMAT values of the northern and southern walls as functions of cos(latitude – ε x slope) (top panel), and their means (bottom panel).

"latitude – ε × slope" is the angle between the northern or southern wall's normal vector and the equatorial plane (e.g. this angle becomes zero for the northern wall in a crater at +30° latitude whose wall slope is 30°). "ε" has a value of +1 for the northern walls and −1 for the southern walls. This angle can be regarded as the "angle of attack" of the crater wall against the space-weathering agents. The figure shows that the crater walls continue to be fresher at angles of attack larger than 58°, which is the latitudinal upper limit of the craters considered here.

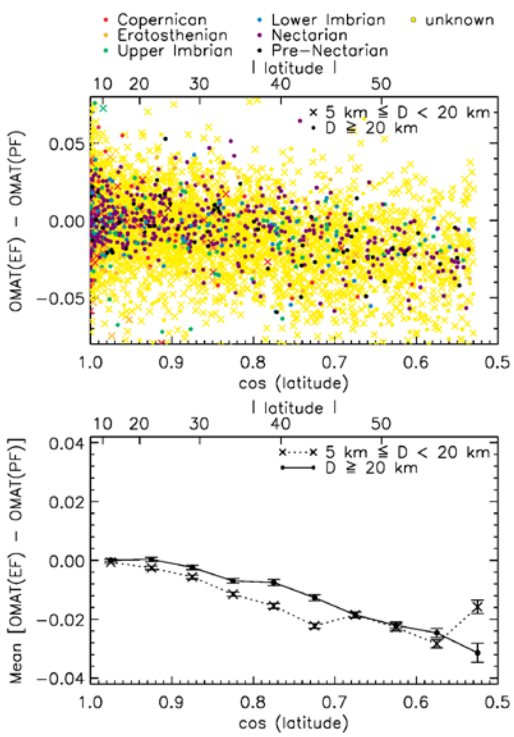

Figure 2. OMAT differences between the equator-facing (EF) and pole-facing (PF) walls.

Figure 4 shows the OMAT differences between the eastern and western walls as a function of longitude (top panel), and their longitudinal means (bottom panel). The overall mean value curve in the bottom panel leans toward the positive OMAT(E) – OMAT(W), and this is probably a result of the Moon's rotation and revolution. On top of this bias, the curve has a minimum near longitude –60° and a maximum near +60°. This is thought to be due to the gravitational focusing of the space-weathering agents by the Earth. Further analyses on the longitudinal dependencies of OMAT and <d> will give us insights on the relative importance of solar wind particles and micrometeoroids on the darkening/reddening and comminution of the lunar regolith grains.

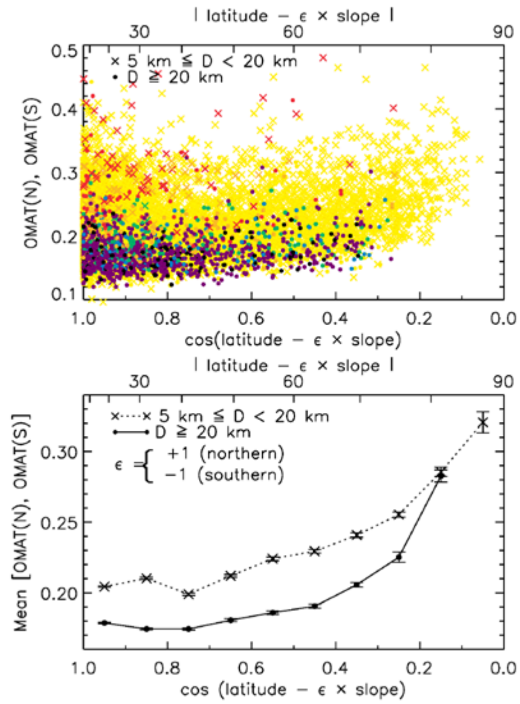

Figure 3. OMAT values of the northern and southern walls.

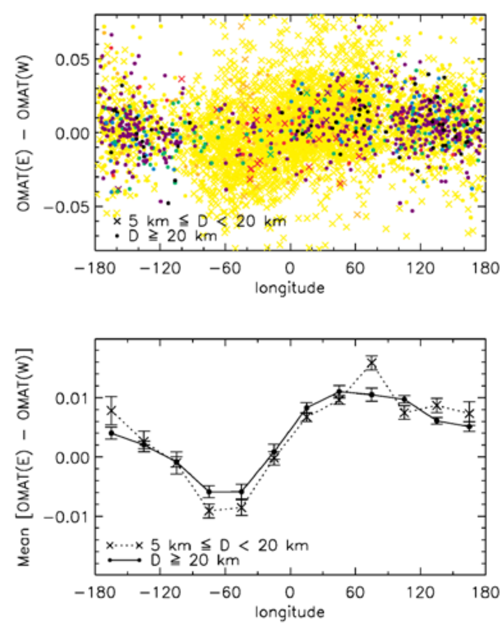

Figure 4. OMAT differences between the eastern and western walls.

References: [1] Hemingway D. et al. (2015) *Icarus*, *261*, 66-79. [2] Jeong M. et al. (2015) *ApJS*, *221*, 16. [3] Lucey P. G. et al. (2000) *JGR*, *105*, 20297. [4] Lemelin, M., personal communication. [5] Losiak et al., (2015) Lunar Impact Crater Database (2015) Revised by Öhman T., LPI. [6] Lunar Digital Elevation Model (LDEM) downloaded from Planetary Data System.