ANALYSES OF THE HYDROGEN DISTRIBUTION IN THE SOUTH CIRCUMPOLAR CRATER FLOORS: IMPLICATIONS FOR THE SURFACE ROUGHNESS. Yuan Li[1], A. T. Basilevsky[2], M. A. Kreslavsky[3], A. B. Sanin[4], I. G. Mitrofanov[4], M. L. Litvak[4], [1]Suzhou vocational University, SuZhou, 215009, China, lysongly@sina.com, [2]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAN, 119991, Moscow, Russia, atbas@geokhi.ru, [3]Earth and Planetary Sciences, University of California Santa Cruz, Santa Cruz, CA, 95064, USA, [4]Institute for Space Research, RAN, Moscow 117997, Russia.

Introduction: Water ice and other volatiles in both polar regions of moon have been the most attractive exploration objects since their initial prediction and detection. They help understand lunar geological and surface processes at the both polar regions, and dynamic material exchange in solar system [1]. In this contribution, we test whether there are variations in surface topographic characteristics related to variation of ice content in the lunar surface layer.

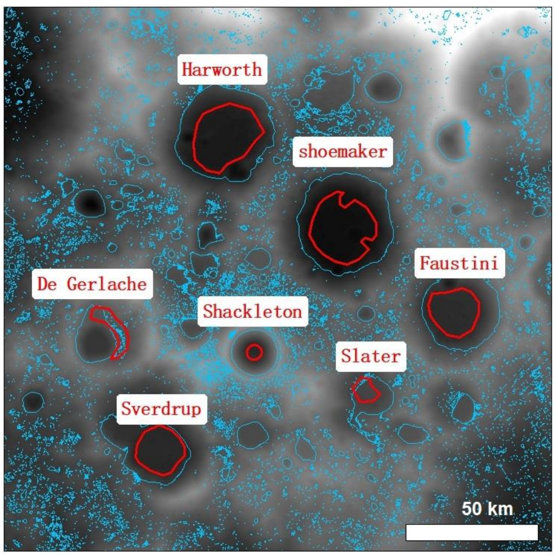

Fig.1. Topography of the south circumpolar region; brighter shades denote higher elevation. Seven crater floor areas studied in this work are outlined in red. Permanently shadowed regions (PSRs) are outlined in blue.

Strategies, Data and Methodology: To test whether the properties of topography correlate with volatile content in the regolith, we focus on the floors of seven large craters in the lunar south polar region: Harworth, Shoemaker, Fausitini, Shackleton, Slater, Sverdrup, and De Gerlache (Fig.1). All topography characteristics are estimated using the topographic map derived from Lunar Orbiter Laser Altimeter (LOLA) (LOLA GDR data set from the PDS). The surface slope at 10 m baseline is estimated with an ArcGIS tool. The topographic roughness map is calculated using Laplacian at 20 m baseline as a filter and interquartile range in 320 m circle window as detector in line with suggestions from [2] (Fig.2). The water equivalent hydrogen (WEH) is adopted as a proxy of ice content in the top meter of regolith. We used WEH data from [3] with standard resolution of 10 km/pixel. All estimated parameters are summarized in Tab.1.

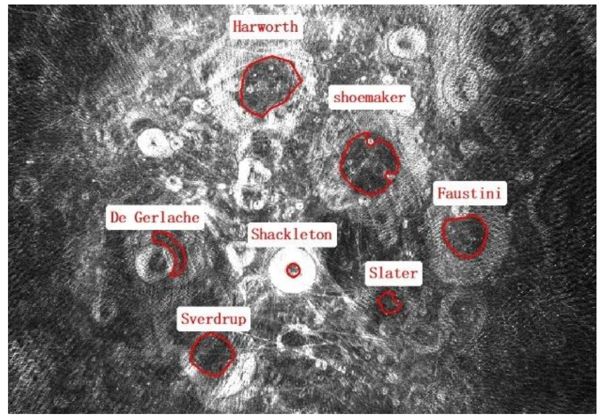

Fig.2. Topographic roughness for the south circumpolar region; brighter shades denote rougher surface. The study areas are outlined in red.

Crater name	Median Slope (degree)	Median Roughness	Mean WEH (wt. %)	Absolute age (Ga)
Haworth	3.95	0.40	0.36	4.18±0.02 [4]
Shoemaker	3.68	0.29	0.46	4.15±0.02 [4]
Faustini	3.39	0.28	0.25	4.10±0.03 [4]
De Gerlache	5.58	0.27	0.26	3.9±0.1 [5]
Slater	2.95	0.24	0.25	3.8±0.1 [5]
Sverdrup	3.20	0.27	0.29	3.8±0.1 [5]
Shackleton	6.42	0.47	0.24	$3.15^{+0.05}_{-0.08}$ [5]

Tab. 1. The summary of slope, roughness, WEH content and model absolute age for studied crater floors.

Comparison: We inter-compare the slope, roughness and WEH in the study areas (Fig. 3, 4). We found that the WEH does not seem to correlate with the surface roughness (Fig. 3), and the roughness correlates well with the surface slope (Fig. 4). The crater De Gelache is a special case as shown in Fig. 5: its roughness and slope values at the study area are probably affected by the formation of inner small crater (~17 km, see Fig. 5).

Discussion: Fig.3 shows that WEH content has no direct correlation with surface roughness. Generally, the decameter-scale roughness is mostly controlled by the presence of deca- to hectometers-size craters and surface regolith movement that subdues and eventually obliterates them.

The formation and evolution of crater population mainly depend on the terrain exposure age where craters locate at and the mechanical strength of target material. The studied carter floors are of Imbrian- and Nectarian ages. It is reasonable to suppose the deca- and hectometer-size craters on these crater floor areas are in the equilibrium state.

Two recent studies [10, 11] independently indicated that small craters in the southern polar area are systematically shallower than outside it. This effect was attributed to crater fill with massive ice [11]. If the presence of massive ice in craters correlate with the observed WEH abundance in the upper meter of regolith, we would expect small craters in higher-WEH regions to be systematically shallower, and roughness to be lower, which is not observed. This is in line with observations [6] that permanently shadowed and not shadowed parts of a large crater floor bear identical populations of small craters.

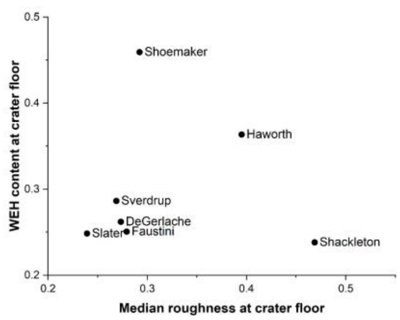

Fig.3 WEH vs. roughness at crater floors

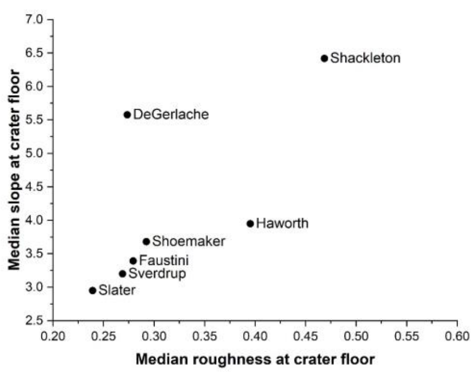

Fig. 4 Slope vs. roughness at crater floors

The presence of appreciable amount of ice in the regolith might cause its cementation; this would make regolith slightly stronger mechanically and more resistant to gardening; this in turn would slow down degradation and obliteration of small craters. If this were the case, we would expect denser equilibrium populations of deeper small craters, and higher roughness. This is not observed, therefore, cementation with ice is not sufficiently strong to cause observable effects.

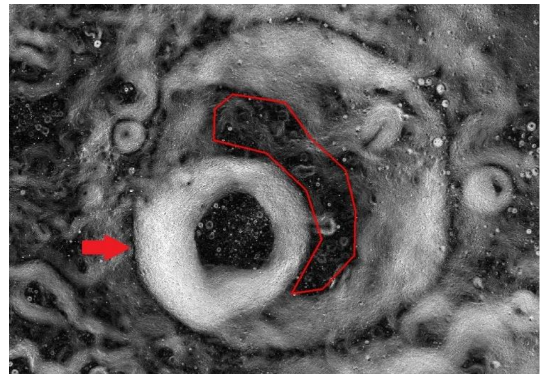

Fig. 5 Slope map of crater De Gerlache; brighter shades denote steeper slopes. The red arrow indicates a 17 km-sized crater at the crater floor of De Gerlache. The study area is outlined in red.

Fig.4 shows surface roughness values increase with surface slope in the study crater floor areas, which is consistent with that for other low latitude regions of lunar surface [7, 8]. Strong correlation between roughness and slope is natural: On the generally flat and horizontal floors of large craters, short-baseline slopes responsible for the median belong to smaller superposed topographic features, mostly small craters, and the median slope for such flat areas is another measure of roughness.

Conclusion: We do not see any correlation between ice abundance in the uppermost meter of the regolith and small-scale topography in the southern polar area. It is likely that the ice abundance is too low to affect mechanical properties of the regolith significantly, and the observed shallow ice is not associated with deeper massive ice deposits assume by [11]. These two factors would explain our observations.

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