Variations of the Shida number, horizontal displacement and virtual deformation over the Moon

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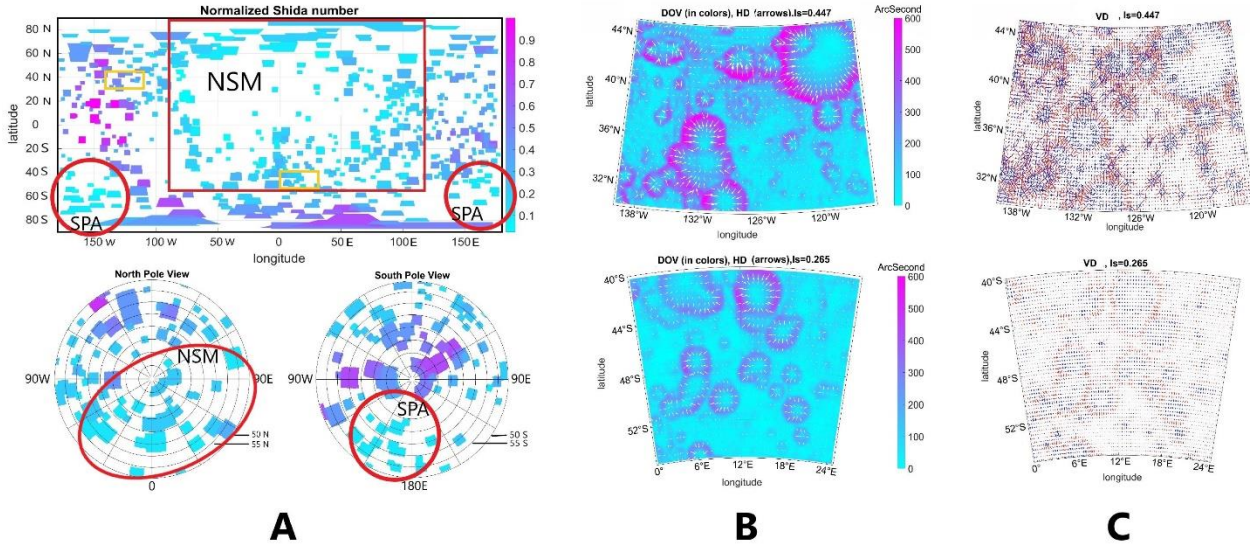
Introduction: The **D**eflection **o**f **V**ertical (DOV), and divergence of horizontal gravity field ($\nabla . \mathbf{T_H}$) parameters of the Moon in the location of six groups of impact craters, with diameter ranges- 60-80km, 80-100km, 100-120km, 120-140km, 140-160km and 160-180km- are much weaker inside the megabasins NSM and SPA, while they are stronger over the highlands. Based on this differing impact induced DOV and $\nabla . \mathbf{T_H}$ responses, we extract the relative variation of the horizontal compliance, normalized Shida number, of the lunar crust; The Shida number has already been proved to be susceptible to the terrain on the Earth [1]. We extend this idea to the terrain of the Moon, and it turns out that the Shida values are smaller on the near side, inside the NSM, as well as in south pole inside SPA. The variations of Shida number, in turn, give rise to the variations of **H**orizontal **D**isplacement (HD) and **V**irtual **D**eformation (VD) [2], owing to the gravity field of the Moon on its own crust. As with the Shida values, HD and VD are larger over the highlands, and smaller over the lowlands.



Figures (A) distribution of the normalized Shida number on the Moon in cylindrical and stereographic projection systems. Red outlines shows area of interest. **(B)** Deflection of vertical (in colors) in two zones of the lunar crust with l_s = 0.447 (upper) and l_s = 0.265 (lower). The exaggerated HD vectors are shown by white arrows. **(C)** VD in the two aforementioned districts with exaggerated horizontal deformation components.

Normalized Shida number: The lunar crust is heterogeneous in terms of the rigidity. After the collision of a meteorite with the crust, the area with lower rigidity (lower l_s) undergoes more modifications in comparison to a highly rigid (high l_s) district. The maximum values of DOV and $\nabla . \mathbf{T_H}$ are directly proportional to the generated impact induced modification which are more intense over the highlands than lowlands. The relative values of normalized Shida number ($0 < l_s < 1$), attained from all the six groups of craters, is depicted in Figure **A**. The squares/trapezoids are plotted in various colors showed in the legend and indicate specific craters. The cyan color scale signifies a low compliant (high elastic) state, and the magenta color-bar indicates the most compliant (least elastic) state. Both NSM and SPA has the l_s distribution with low values (l_s <0.2) relative to the elevated surrounding districts (l_s > 0.5).

HD, DOV and VD resulting from normalized Shida distribution: The distribution of normalized Shida number leads to formation of a specific HD and VD regimes on the Moon. We arbitrarily chose two zones on Moon (two yellow rectangles in Figure **A**) to qualitatively illustrate the HD and VD susceptibility to the difference in Shida number (Figures **B** and **C**). Figure **B** depicts the HD (white arrows) fitted on DOV (in colors). Figure **C** shows VD map with the zones under horizontal expansion in red lines, and zones under compression in blue lines. For the zone with ls=0.447, HD, DOV and VD parameters are larger in comparison to those in the area with l_s=0.265. This shows that the crust is affected more by the impact, as well as the gravity force of the Moon itself during the post impact processes.

References: [1] Beaumont C. & Boutilier R. (1978) Can. J. Earth Sci. 15(6), 9 [2] Klokočník, J., et al (2014), Earth Science Research, 88-101.