QUANTIFYING THE INFLUENCE OF TOPOGRAPHIC-MODEL-RELATED DISTORTIONS ON CRATERING CHRONOLOGIES A. Neesemann[1], S. van Gasselt[2], R. Jaumann[3] [1]Freie Universität Berlin, Inst. of Geological Sciences, Planetary Sciences and Remote Sensing Group, Malteserstr. 74-100, 12249 Berlin, (Germany); adrian.neesemann@fu-berlin.de; [2]Dept. of Geoinformatics, University of Seoul, South Korea; [3]German Aerospace Center (DLR), Inst. of Planetary Research, Berlin, Germany

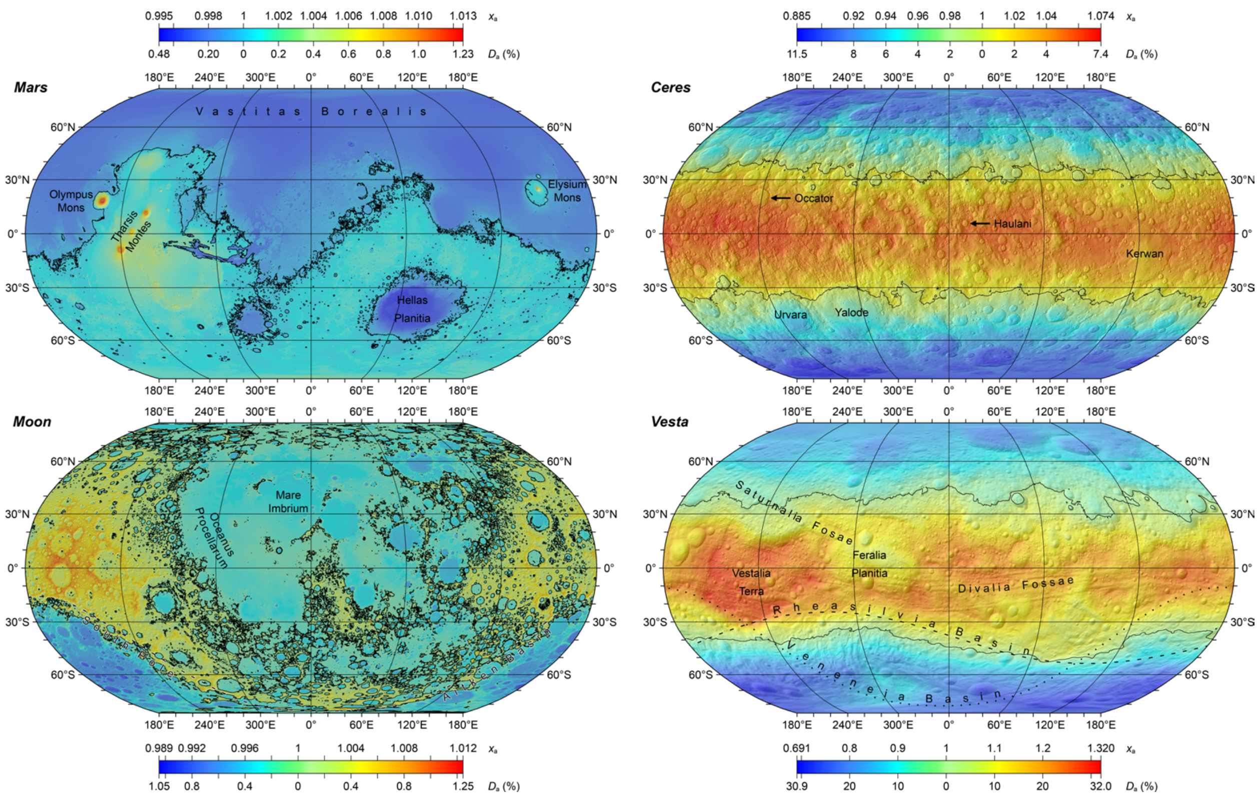

Figure 1: Deviation of heights between used reference ellipsoids. Here we expressed the deviation in the form of the areal correction factor x_a as color-coded, semi-transparent images superposed on hillshade models of the respective body. We demonstrate the effect for the most commonly used global DEMs converted to elevations above or below the corresponding reference ellipsoid. Mars: MOLA MEGDR - 3396 km sphere [20, 21]; Moon: LRO LOLA LDEM GDR - 1737.4 km sphere [21, 22]; Ceres: Dawn FC HAMO DTM - 470 km sphere [23]; Vesta: Dawn FC HAMO DTM - 255 km sphere [24]. The percentage of distortion D_a is given by $\sqrt{((x_a-1)\cdot 100)^2}$ accordingly. During the projection, reddish regions will be down-sized while bluish regions will be scaled-up. Black solid lines show the course of the 0-m isohypses or intersection lines between the reference sphere and the actual shape of the bodies. Only here, the topography related distortions are zero ($x_a = 1$).

Introduction: Analyzing crater densities and crater size-frequency distributions (CSFDs) is an established approach for dating planetary surfaces that cannot be directly linked to radiometrically dated rock samples [1-6]. Like in many scientific approaches, the accuracy of crater-based age dating also depends on a number of systematic errors. Imperfect calibration of empirically derived or modeled chronology systems (CSs) can be considered as the primary error sources. While the attempt to quantify such errors is challenging, secondary issues of statistical [7-10] and metrological [11] nature that influence the outcome of crater-based age dating were already addressed and basically solved in the past. Other influences, such as the inherent variability of crater identification among crater analysts [12] or the influence of secondary crater admixture [i.a. 13-18] were illustrated at great detail but are still under discussion.

Here we introduce another issue of metrological accuracy which, under certain conditions, can have an appreciable impact on measured crater diameters and area size and thus on the derived absolute model ages.

Background: In Geodesy, accurate distance or area calculations can be challenging as the real shape of a planetary body is often irregular. Instead, due to their relative simplicity, reference ellipsoids are used as a preferred surface on which geodetic calculations are performed. They generally constitute a close approximation to the true figure of large objects with low relief-to-size ratios, such as the terrestrial planets or large Jo-

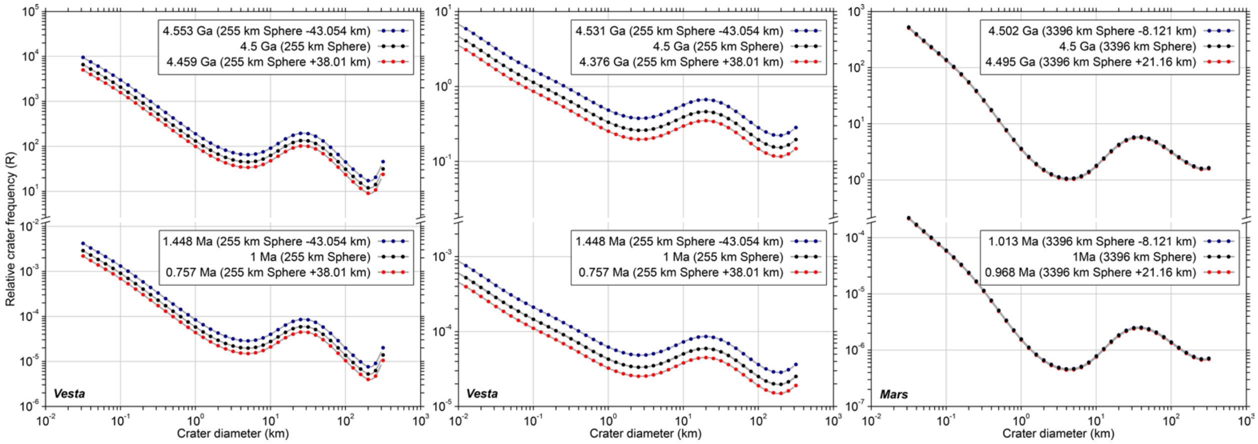

Figure 2: Relative crater frequency [5] of a hypothetical 1 Ma and 4.5 Ga measurement on a 255 km sphere for CSs of [28] (left) and [29, 30] (center) and on a 3396 km sphere for the CS of [26, 27] (right). Note that the impact on model ages is almost identical for ages below ~3 Ga between the two Vestan systems since chronology functions of [28] and [30] are also almost identical within that time interval.

vian and Saturnian moons. Especially for the well observed and most frequently investigated bodies such as the Earth, the Moon, and Mars, quite precise reference ellipsoids exist [*e.g. World Geodetic System* (WGS84), 19, 20] which are commonly used and already satisfactory for most purposes. While on the Earth a number of localized geodetic datums are available which can give a more accurate representation of the region of interest, it is customary in planetary science to maintain globally representative reference ellipsoids. As a consequence, remote sensing data on which we perform measurements become distorted depending on the local difference between the actual shape of the body and the applied reference ellipsoid (fig. 1).

In principle, correcting the projection distortions is, from a mathematical point of view, relatively simple. Linear (crater diameter) errors are proportional to the ratio of the radii of the actual shape to the reference ellipsoid while areal errors are proportional to their squared ratio. But how can the resulting ratios be translated into model age variation?

Methodology: Here we quantify and evaluate these effects directly on CSs proposed for four planetary bodies. The Moon and Mars were chosen to demonstrate the aforementioned effects on the most frequently investigated bodies in terms of crater-based age determination. Additionally, due to their relatively low relief-to-reference-ellipsoid-size ratio (Mars ~0.6%, Moon ~0.6%) they constitute as something like end members (both are in hydrostatic equilibrium and have therefore a round shape) on which topography related distortions can almost be considered negligible. For demonstration purposes, we used the still most widely used CS of [25] for the Moon, and [26, 27] for Mars. At the other end of the relief-to-size ratio scale we have asteroid Vesta and dwarf planet Ceres (fig. 1) with high relief-to-size ratios (16.9%, 5.9%).

Results: In fig. 2, we show the impacts on two chronologies proposed for Vesta [28-30] for two scenarios: A hypothetical measurement of a 1 Ma and a 4.5 Ga old surface on a 255 km reference sphere. If the hypothetical measurements were performed in high (Vestalia Terra) or low (Rheasilvia basin) regions, then CSFDs and related model ages would change as shown.

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Acknowledgements: This work was partly supported by the German Aerospace Center (DLR) on behalf of the Federal Ministry of Economic Affairs and Energy, grant 50 OW 1101.