PRELIMINARY REGIONAL ANALYSIS OF CENTRAL PEAKS ON CERES USING THE NEAR-GLOBAL CRATER DATABASE AND IMPLICATIONS FOR CRUSTAL STRENGTH. M. F. Zeilhofer
mfz3@nau.edu

Introduction: Dwarf planet Ceres is located at ~2.77 AU and has a density of 2162 kg/m³ [1]. Based on Ceres’ low-density and its location in the asteroid belt, pre-Dawn predictions suggested the surface of Ceres would display a minimal number of impact craters due to viscous relaxation which would erase these craters over time [2]. The Framing Camera (FC) onboard the NASA Dawn spacecraft (resolution of 400 m/pixel) attained images of a heavily cratered Cerean surface which posed an interesting question as to the composition of the Cerean crust [1,3]. The Dawn observations suggest a stronger crust than the overall density of Ceres would imply. The presence of clathrates in the crust have also been proposed which may help explain these observations [4-5]. The focus of this investigation will be to determine if there are any regional variations in crustal strength across Ceres by investigating the central peaks within impact craters.

Central peaks (Pk) can provide insight into the crustal strength of Ceres because they are influenced by excavation into different target types (rock versus ice). Central peaks on volatile-rich bodies tend to have larger basal diameter with respect to the parent crater diameter than central peaks found on volatile-poor bodies [7-8]. Furthermore, the peak-to-crater diameter ratio (Dpk/Dc) increases with a decrease in target strength which has been observed for the icy body Ganymede [7]. Therefore, the regional analysis of central peaks (i.e. latitude and longitude, parent crater diameter, basal diameter and Dpk/Dc) will provide details on crustal strength difference across Ceres.

Methodology: Data for this preliminary study were attained from a near-global crater database for Ceres containing 44,394 craters ≥ 1.0 km in diameter [9]. This dataset contains several interior morphologies, but for the purpose of this study central peaks were chosen due to their higher abundance found in the dataset [9]. Data were collected using the Java Mission-planning and Analysis for Remote Sensing (JMARS) crater measurement application with the Low Altitude Mapping Orbit (LAMO) global mosaic for Ceres (resolution of 35 m/pixel) [10]. The longitude, latitude, and crater diameter were obtained using the 3-point crater counting routine in JMARS and exported into an Excel spreadsheet. The average basal diameter was reported in the database after taking three measurements across the central peak [Fig. 1]. The Dpk/Dc was then reported. The crater depths were measured using the two topography models (mean sphere topography model and oblate sphere topography model) found within JMARS [11].

Previously central peaks were investigated on a global scale [12] and by 10° latitude zones [13]. For the purpose of this study the central peaks were analyzed in 30°x30° blocks (starting at 60-90°S and 0-30°E) to look for variations on more regional scales. Craters which displayed a summit pit (a central pit on top of a central peak) were also included in this study Fig. 2. The central peak portion of the summit pit were measured in the same manner as the central peaks without a pit.

Initial Observations: Central peaks are the most abundant interior morphology observed within the crater database [9]. 264 of 918 complex craters display a central peak while 4 of 918 complex craters display a summit pit. Central peaks are found globally whereas summit pits are evenly distributed between both the northern and southern hemispheres. Similar to the latitudinal analysis of central peaks [13] there appears

Fig. 1: a) A 26.6 km crater centered at 63.20°S 143.60°E containing a central peak. Image obtained from the LAMO global mosaic [6]. b) The corresponding topographic profile shows the measurement of the crater diameter (Dc) and the central peak diameter (Dpk). These measurements were then used to calculate the Dpk/Dc.
to be an increase in the median $D_{pk}/D_c$ with increasing latitude at similar depth-diameters (d/D) ratios. The summit pit data did not influence the median $D_{pk}/D_c$ or the general trends observed within their regions due to their small sample size. The median $D_{pk}/D_c$ results along with the similar d/D results are further indicating that central peaks in the northern hemisphere are excavating into a weaker and/or more fractured target than craters displaying central peaks in the southern hemisphere. These results suggest that there are regional variations of a weaker and/or more fractured layer at depths $\geq$ 1.8 km.

The 60-90°N block over a majority of the longitudes investigated have larger median $D_{pk}/D_c$ with the exceptions of 90-120°E and 270-300°E [Fig. 3]. The reason there are deviations in the median $D_{pk}/D_c$ value at 270-300°E are due to the larger number of craters displaying central peaks between 30-60°N (8 craters) than at 60-90°N (3 craters). The 30-60°N 90-120°E block has only one crater with a central peak present opposed to the 60-90°N 90-120°E block where there are two craters displaying central peaks. The difference seen between these two 30°x30° blocks may be a result of how these data were separated and not a representation of a weaker and/or more fractured target within the area.

Conclusions: The preliminary analysis of the median $D_{pk}/D_c$ on a more regional scale does show larger values in in the northern hemisphere which are consistent with past observations [12-13]. These observations suggest a more fractured crust and/or higher volatile content in the northern hemisphere consistent with findings from the Gamma Ray and Neutron Detector (GRaND) onboard the Dawn spacecraft which show a higher hydrogen content north of 60° [14]. Further investigation with other interior morphologies, such as central floor pits, lobate flows and wall terraces within these regions are needed to understand these observations as well as determining different 30°x30° blocks where there are more central peaks and provide additional regional information. Additionally, the investigation of PICs in 30°x30° blocks will help identify regions which are more fractured within the crust and how these fractures may be influencing the results in this preliminary study.