TECTONIC MAP OF CERES FROM POLYGONAL IMPACT CRATERS. Hiu Ching Jupiter Cheng[1] and Christian Klimczak[1], [1]Center for Planetary Tectonics at UGA, Department of Geology, University of Georgia, Athens, GA 30602, USA (jupiterchc@uga.edu).

Introduction: Polygonal impact craters (PICs) provide important information about the tectonics of a planetary body. Impact craters commonly exhibit straight rim segments—creating planform polygonal geometries— in places where pre-existing fractures, such as joints, exist in the target rock [1,2]. Previous studies have shown that PICs abound on various planetary bodies [1–3]. Dwarf planet Ceres is a heavily cratered body with PICs identified on its surface [3–5]. A total of 258 PICs between 5 and 280 km in diameter were previously documented on Ceres [4]. The majority of the 76 craters officially named by the International Astronomical Union are PICs [3]. Zeilnhofer and Barlow [5] characterized 1466 PICs with diameter ≥ 1 km on Ceres considering their relationship with nearby structures, their distribution, number of straight rim segments per PIC, as well as length and angular relationships between rim segments.

Expanding on these findings, we investigate whether the planform shape of impact craters be used to identify joint sets and thus reveal local, regional, or even global tectonic patterns on Ceres. In this study, we used the same method that we previously applied to Vesta [6] to also identify straight portions of impact crater rims on Ceres. These straight rim segments of craters are then compiled as a tectonic map and rose diagrams are used to visualize the orientations of joints and their potential geographic variations in preferred orientation across Ceres.

Methodology: This project primarily used the Dawn Ceres FC image mosaics (Fig. 1a) and the digital elevation model, which both have a resolution of 140m/px [7]. We used the global crater catalogues of Ceres [8] for crater identification. Craters in this mapping effort include all impact structures with diameters ≥ 20 km, providing a total number of 531 craters to be studied. We map the rims of these craters. A crater rim is defined as the uppermost, raised edge surrounding the topographic depression caused by the impact. Mapping of all craters consists of those that are incompletely preserved because some, if not all, straight rim portions may still be preserved. All mapping was carried out using ESRI ArcGIS software with a fixed mapping scale of 1:200,000. The projection was set to stereographic projection and centered at every crater so that angles are preserved and length distortions are kept to a minimum. All rims were mapped as polylines with regularly spaced vertices set to 1 km by using the streaming function of the ArcMap Editor to assure consistent sampling of crater rims across the dwarf planet (Fig. 1b).

After all the crater rims were mapped, we simplified the polylines to detect the straight portions of crater rims. In particular, we used the *line simplification function* in ArcGIS, which, given some specified tolerances, simplifies polylines by removing redundant vertices. Following the polyline simplification, a curved line will retain more vertices than a straight line, such that after splitting polylines at vertices, the individual polylines will be longer along rim segments

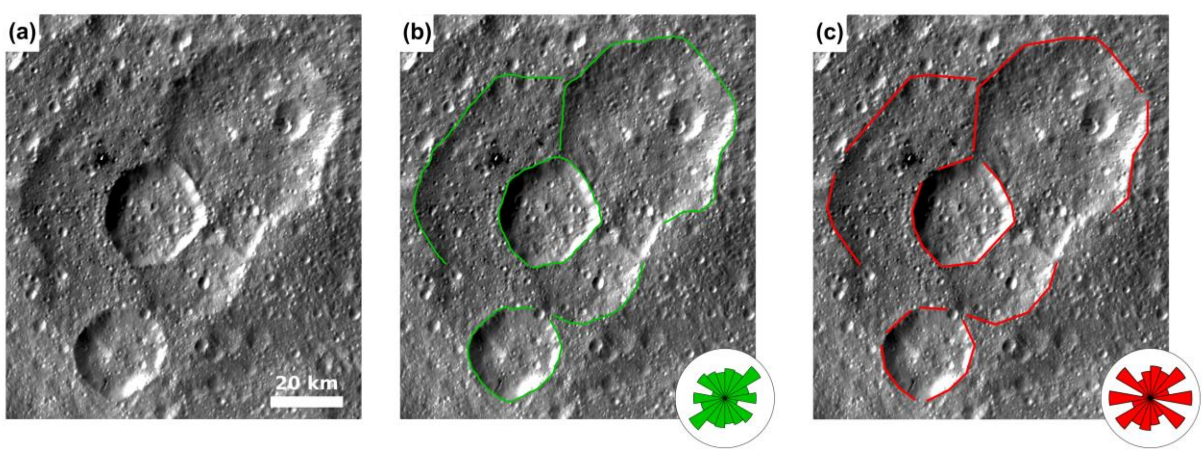

Figure 1. Planform shapes of typical impact craters on Ceres with mapping of rims and simplification of linework. (a) View of typical PICs on Ceres on Dawn Ceres FC image centered at 23.657°N and 64.473°W. (b) The crater rims are mapped as polyline (green line) with 1 km spaced vertices. (c) After preforming line simplification on (b), straight crater rim segments are extracted (red lines) as those longer than 5 km. Length-weighted rose diagrams of (b) and (c) are plotted in green and red, respectively, for comparison.

that are straight and shorter where rims are curved. We then extracted the azimuths of all polylines longer than 5 km (Fig. 1c) as being representative of the orientation of a major structure in Ceres' lithosphere.

The mapped crater rim orientations were analyzed to detect regional/global patterns that then can be used to interpret tectonic patterns. For that, rose diagrams, which are histograms displaying circular distributions of directional data, were plotted in Fig. 2 for all crater rim data (in green) and extracted straight rim segments (in red) to visualize longitudinal and latitudinal distributions of straight crater rim orientations across Ceres. All longitudinal and latitudinal bins are chosen in 30° increments (Fig. 2). All rose diagrams show orientation weighted by the length of the segments.

Results: In total, 525 impact craters are mapped with six craters being too degraded to clearly identify a rim (Fig. 2). All mapped craters are found to have at least one straight segment, with the vast majority of them forming clear hexagonal planform shapes, consistent with previous literature [3-5]. All rose diagrams indicate one or more moderate preferred orientations. The preferred orientations for all crater rims and extracted straight rim segments are mostly similar, indicating the craters are dominated by straight rim segments. These observations suggest that Ceres's lithosphere is potentially fractured by several major joint sets. The northern hemisphere shows preferred NE-SW or N-S orientations whereas the southern hemisphere shows a preferred NW-SE orientation. No distinctive systematic variations in longitude are observed. Further analyses will allow us to explore orientation relationships of straight rim segments with respect to geologic or geophysical boundaries and their meaning for the tectonic processes causing the widespread fracturing that is responsible for the many PICs on Ceres.

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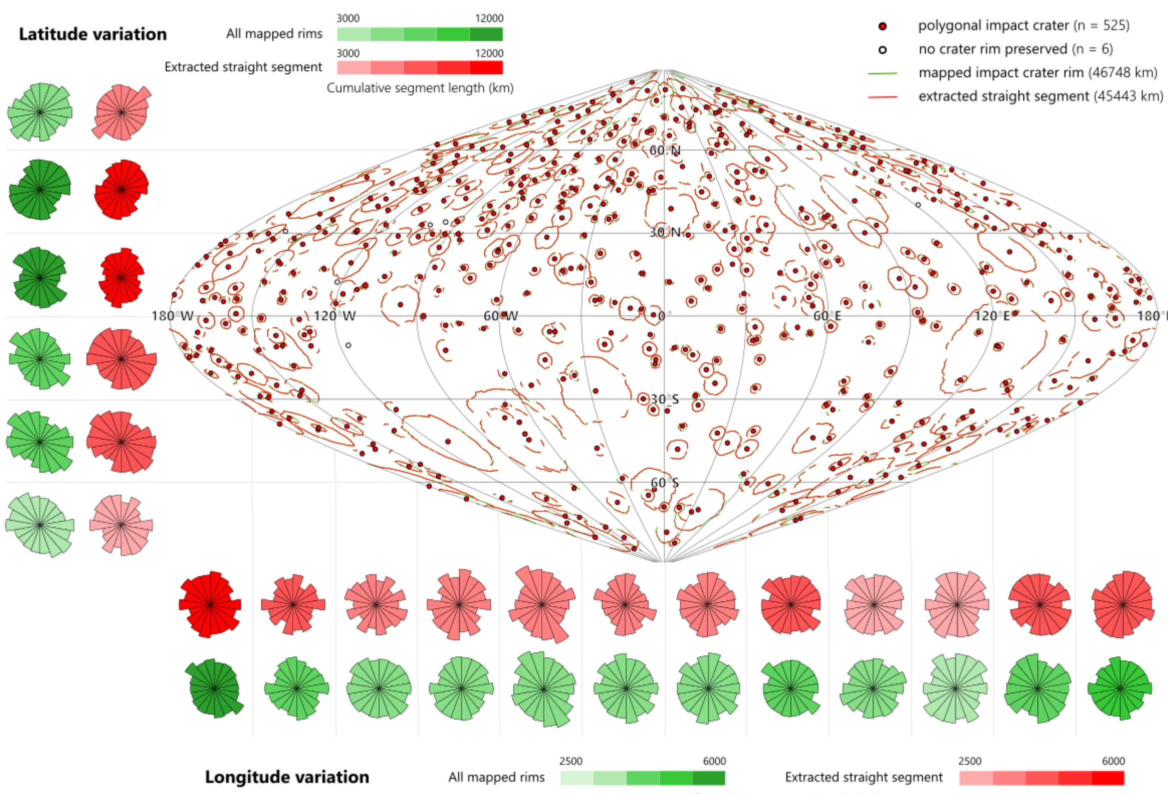

Figure 2. Tectonic map of Ceres in sinusoidal projection, showing the mapped crater rims (green) and extracted straight segments (red). The crater centers are plotted with a point symbol on the map. Length-weighted rose diagrams are plotted in ins of 30° across latitudes and longitudes. The color intensity indicates the cumulative length of segments in each bin.