CERES' LARGEST CRATERS: AGE ANALYSIS OF KERWAN AND YALODE. Jonathan A. Castillo[1], Andrew J. Dombard[1], Lauren R. Schurmeier[1], [1]Dept. of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, IL 60607 (jcasti26@uic.edu).

Introduction: The dwarf planet Ceres is a celestial body with a cratered surface. The craters Kerwan and Yalode are the two largest craters (~285 and ~260 km) on the surface and have interesting characteristics [1, 2]. Perhaps most peculiar is a smoothly varying central depression that results in a topographic bench between the center of the basin and the rim (Fig. 1) [3]. Ideas for this peculiar topography involve evolution of an initial, more classic impact-crater basin shape into the morphology seen today [4, 5]. For this reason, the ages of Kerwan and Yalode are important variables in determining their origin, as well as the overall history of Ceres. To that end, we have performed crater counts, independent of other researchers [1, 2, 6], in hope of constraining the ages of the two craters.

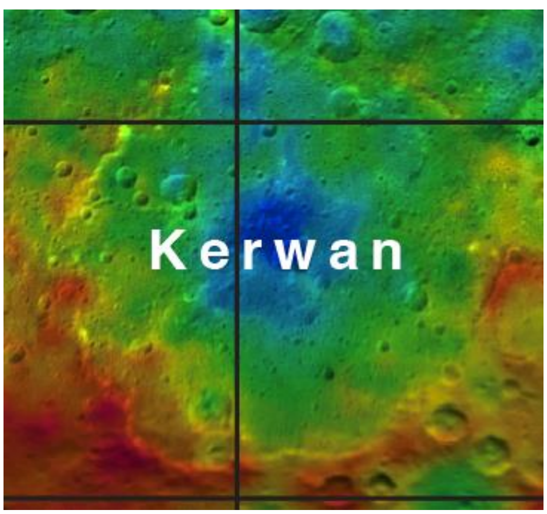

Figure 1. The topography of Kerwan, with its peculiar central depression and surrounding topographic bench. Courtesy NASA/JPL-Caltech.

Methods: Images (primarily a colorized shaded-relief map [7] and a global mosaic [8]) of Ceres, taken from the Dawn Framing Camera, are acquired and imported into ArcGIS. Craters within the rims of these basins are counted with the specialty add-on Crater Helper Tools made available by the US Geological Survey Astrogeology Science Center. The tool facilitates the indexing of crater location, rim diameter, the major axis azimuth, and the minor axis length. Additional benefits of the tool include marking previously counted craters on the map itself. Generally, only craters with a diameter larger than 0.25 km are counted and included in the calculations. ArcGIS is also used to measure the area within the rims of Kerwan and Yalode. Cumulative Size Frequency Distributions (CSFDs) and their associated errors are then calculated using standard techniques [9].

Results and Discussion: CSFDs are shown in Fig. 2. Our results for Kerwan compare very well with the counts of Wagner et al. [6], but curiously, we both count about an order of magnitude more craters per diameter than in Area 1 of Williams et al. [1]. The source of this discrepancy is not known.

The Absolute Model Ages (AMA), however, seem to be consistent. Our counts, when referenced to an asteroid flux-derived crater production model [3], yield an AMA of 240 $\pm$ 50 Myr, identical to the age presented in Williams et al. [1] that used the same production function. An AMA based on a lunar extrapolated production function yielded an AMA of 1300 $\pm$ 160 Myr. Thus, it appears that Kerwan is in the range of several hundred million years to ~1 billion years old.

Yalode appears less cratered, and again, our counts are consistent with others [2]. S. Marchi again provided an AMA of 100 $\pm$ 50 Myr, again consistent with the comparable asteroid derived AMA in Crown et al. [2]. An AMA based on a lunar production model is older at ~580 $\pm$ 40 Myr [2]. Here, it appears Yalode is one to several hundred million years old.

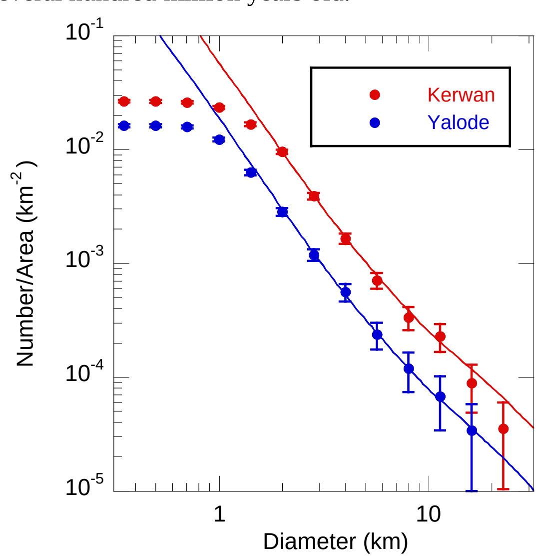

Figure 2. Crater counts (points with error bars) for Kerwan (red) and Yalode (blue). The lines are Absolute Model Age fits provided by S. Marchi, using only diameters of only 2 km and bigger; AMAs for Kerwan and Yalode are 240 $\pm$ 50 and 100 $\pm$ 50 Myr.

Of course, these reported ages are not necessarily the age of the craters' formation, but could be a retention age. We do not expect the craters themselves to be significantly older, though. Detailed geologic mapping of the different units within and around Kerwan show some variability in AMAs [1], yet all ages are within the range of several hundred to about a thousand million years. Similarly, Yalode's floor was likely covered by ejecta from the neighboring, younger crater Urvara, but again counts within and around Yalode (notably, Yalode ejecta distal to Urvara) show a similar consistency in age [2].

Thus, it would appear that evolutionary models for the peculiar topography of these 2 largest craters on Ceres need to evolve these craters over 100 Myr to 1 Gyr time scales. Fixing a time range could permit constraints on the viscosity within Ceres, and thus by proxy constrain the composition and structure of Ceres' interior [cf. 10].

References: [1] Williams, D.A. et al. (2018), *Icarus*, in press. [2] Crown, D.A. et al. (2018), *Icarus*, in press. [3] Marchi, S. et al. (2016) *Nature Comms.*, 7:12257. [4] Bland, M.T. et al. (2017) *LPS XLVIII*, Abstract #2040. [5] Wang, Y. (2017) Master's Thesis, U. Illinois at Chicago. [6] Wagner, R.J. et al. (2016) *LPS XLVII*, Abstract #2156. [7] https://astrogeology.usgs.gov/search/map/Ceres/Dawn/DLR/FramingCamera/Ceres_Dawn_FC_HAMO_ClrShade_DLR_Global_60ppd_Oct2016. [8] https://astrogeology.usgs.gov/search/map/Ceres/Dawn/DLR/FramingCamera/Ceres_Dawn_FC_DLR_global_59ppd_Feb2016. [9] Analysis Techniques Working Group (1979) *Icarus*, *37*, 467-474. [10] Bland M.T. et al. (2016) *Nature Geo.*, *9*, 538-542.