POLYGONAL IMPACT CRATERS ON GANYMEDE. N. R. Baby[1], T. Kenkmann[2], K. Stephan[1] and R. J. Wagner[1]. [1]Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany (Email: Namitha.Baby@dlr.de), [2] Institute of Earth and Environmental Sciences, University of Freiburg, Freiburg, Germany.

Introduction: Polygonal impact craters (PIC) are impact craters that have at least one straight rim segment in planform [1-8]. Among all impact craters, PICs represent a small percentage. They exist on both rocky and icy planetary bodies [9]. Studies on PICs of icy bodies of outer solar system started mainly during Galileo and Cassini missions. To our knowledge no studies on PICs have been carried out for Ganymede. Here we are examining the straight segments of PICs and their relationship with adjacent lineaments or fractures.

Methodology: For mapping PICs globally, we used the global mosaic prepared by [10], which combines the best high-resolution images from Voyager 1, Voyager 2, Galileo and Juno spacecrafts (Fig.1). To ensure accurate diameter measurement and analysis of straight segments, PICs are reprojected by centering on each crater and are manually digitized in ArcGIS. In instances, for PICs in areas poleward of 60°, the global mosaic is reprojected into stereographic projection and centered into each crater and other areas are mapped in equidistant cylindrical projection. PICs, which were superimposed by other craters or terrains are not considered for this study. Geometrical measurements like diameter, angularity, perimeter, area, number of straight segments and length of straight segments are estimated. Rose diagrams are prepared for the straight rim segments of PICs and compared it with the orientation of adjacent linear features.

Results: We identified and mapped 459 PICs across Ganymede (Fig.1) whose diameter range from 5 km to 153 km, despite the resolution limits and different illumination angles. The number of straight segments possessed by PICs ranges from 1 to 9 with quadrangular, hexagonal and octagonal shapes being common. Most of these PICs exhibit a central peak or a pit, with a minor fraction of them showing a dome (Fig.2). Since majority of them are complex craters, their formation was in a way that the rim attains straight segments during modification stage via slumping or normal faulting along the pre-existing fractures within crater wall [7,11, 12]. However, studies from [5, 6, 7] showed that straight rim segments can be obtained during excavation stage via thrust faulting along pre-existing fractures.

Straight rim segments of PICs align with the linear features adjacent to them (Fig.3) and indicate that such lineaments are not exclusively surface features but lead to a localization of deformation and influence the cratering process. In particular, within light terrain, PICs are mostly found adjacent to light grooved terrains. In case of the dark cratered terrain (dc), straight rim segments of PICs are oriented along furrows and fractures. For instance, Galileo Regio have many PICs because of the NW-SE trending furrows and a high density of faults and fractures. Here, most of the PICs have hexagonal shape with two of the straight segments parallel to the orientation of furrows and rest of the segments are at approximately perpendicular angle. Also, the presence of PICs suggests that they formed after formation of the linear features. Furthermore, majority of linear features on anti-Jovian hemisphere trends in NW-SE direction while the preferred orientation of linear features on sub-Jovian hemisphere is in NE-SW direction [13]. However, the preliminary orientation analysis of straight segments of PICs using rose diagrams does not show a preferred orientation for the anti-Jovian and sub-Jovian hemispheres. Nevertheless, from the available global distribution of PICs, we find higher PIC density in regions within and around Uruk Sulcus region. It was found that transpressional strike-slip tectonics affected the Uruk Sulcus region [14] and probably this region was tectonically active during the emplacement of craters.

Conclusions: PICs are found on all terrain types. PICs within light terrain appear majorly affected by ridges and grooves which are indications of different types of faults developed during the formation of the light terrain. PICs in dark terrain are found to be majorly affected by furrows which are remnants of ancient large impacts and minorly affected by fractures. Straight rim segments are observed for PICs irrespective of bright/ dark ejecta and pedestal /rampart like impact features (Fig.3). On the whole, the even distribution of PICs may indicate a very tectonically active past for Ganymede.

References: [1] Fielder, G. (1961) PSS. 8(1), 1-8. [2] Kopal, Z. (2013) Springer. [3] Shoemaker, E.M. (1962) Academic Press, New York, pp. 283-359. [4] Roddy, D.J. (1978) LPSC Proc. 9, 3891-3930. [5] Öhman et al. (2005) Impact Tectonics. Springer, pp. 131–160. [6] Öhman et al. (2008) Meteorit. Planet. Sci. 43, 1605–1628. [7] Beddingfield et al. (2016) Icarus 274, 163-194. [8] Beddingfield and Cartwright (2020) Icarus 343, 113687. [9] Öhman et al. (2010) Geolog. Soc. Am. Special Papers 465, 51–65. [10] Kersten et al. (2022) pp. EPSC2022-450. [11] Eppler et al. (1983) Geolog. Soc. Am Bulletin, 94(2), 274-291. [12] Schultz, P. H. (1976) The Moon, 15(3), 241-273. [13]

Rossi et al. (2020) Journal of Maps, 16(2), 6-16. [14]
Rossi et al. (2018) Tectonophysics, 749, 72-87. [15]
Collins et al. (2013) p. 3237, US Geolog. Survey.

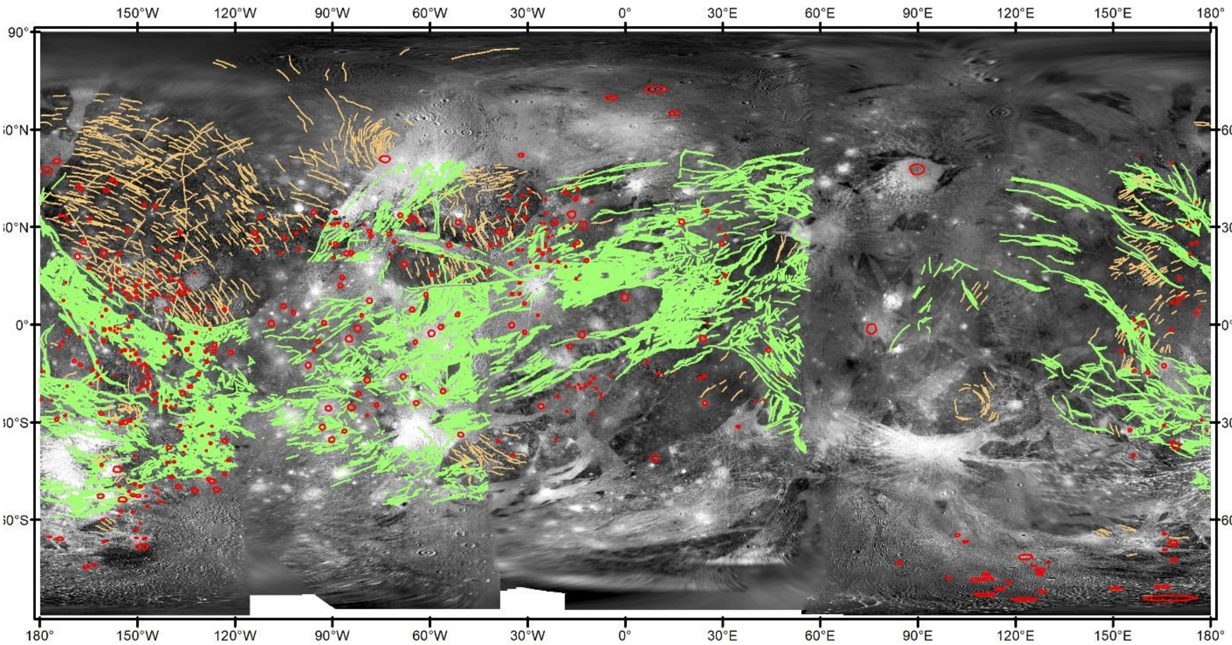

Figure 1: Global base map of Ganymede in equidistant cylindrical projection (from [10]) showing mapped PICs (red) in association with all the linear features (green and orange). The linear features on light terrain are mainly grooves (green, from [13]) and linear features on dark terrain are mainly furrows (orange, from [15]).

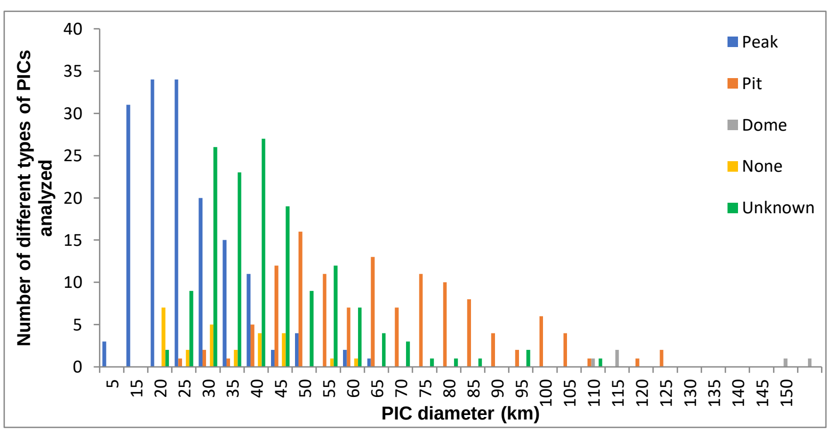

Figure 2: Histogram showing the distribution of different types of PICs across Ganymede. 'None' represents those that lack any central features and 'unknown' represents those whose central features are unable to be detected due to low resolution.

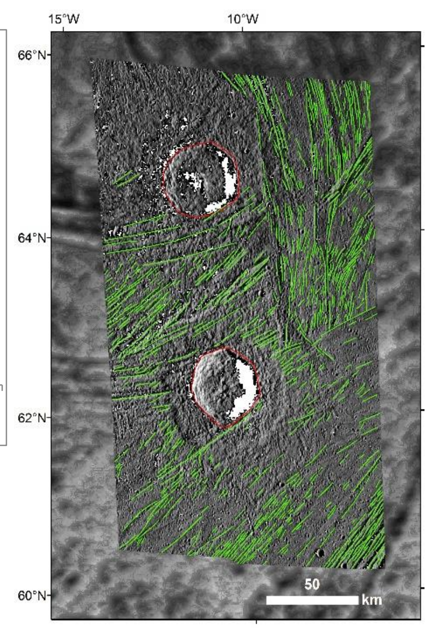

Figure 3: High resolution image (175 m/pxl) showing PICs Achelous and Gula (red) located at 62°N, 12°W. Achelous (a pedestal pit crater) displays 8 straight rim segments while Gula has 2 straight rim segments. Lineaments are mapped (green) which aligns with the crater rim segments.