

Global Fracture Pattern on Mercury revealed by Polygonal Impact Craters

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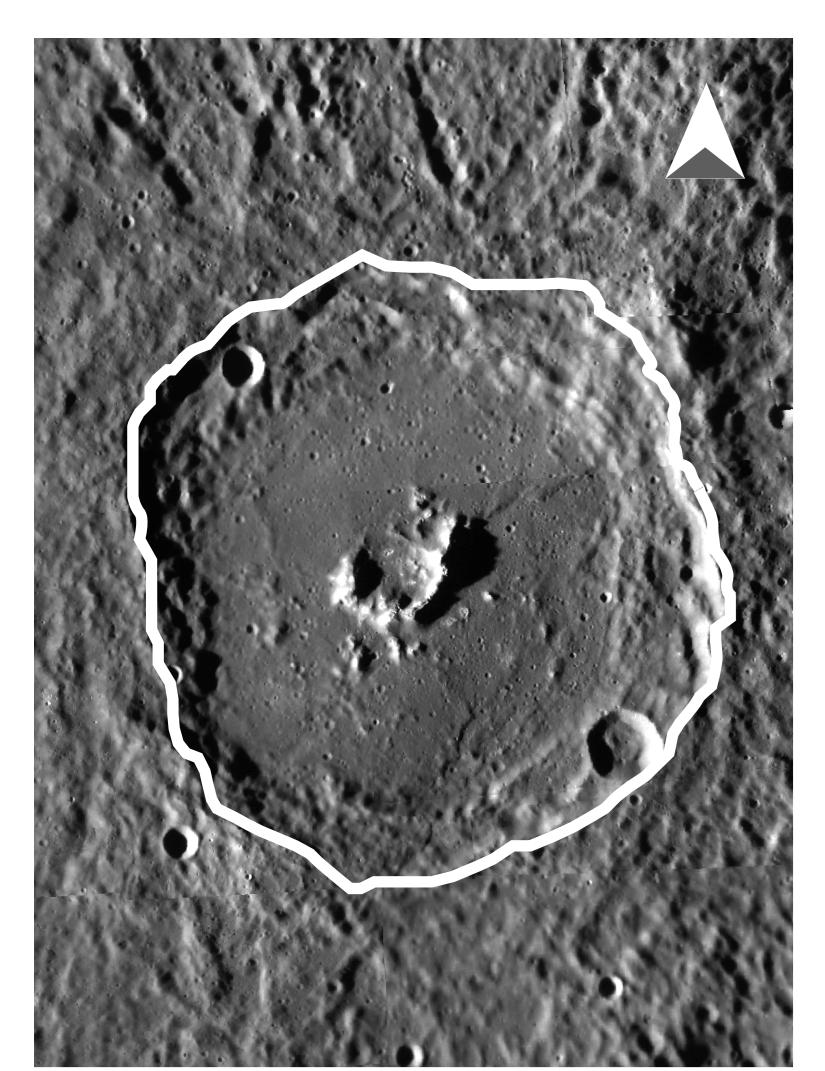


Introduction

- Mercury's surface displays impact craters and tectonic structures.
- Impact crater rims can form along pre-existing fractures, evident as straight rim segments.
- Mapping straight rim segments can be used to search for tectonic patterns.

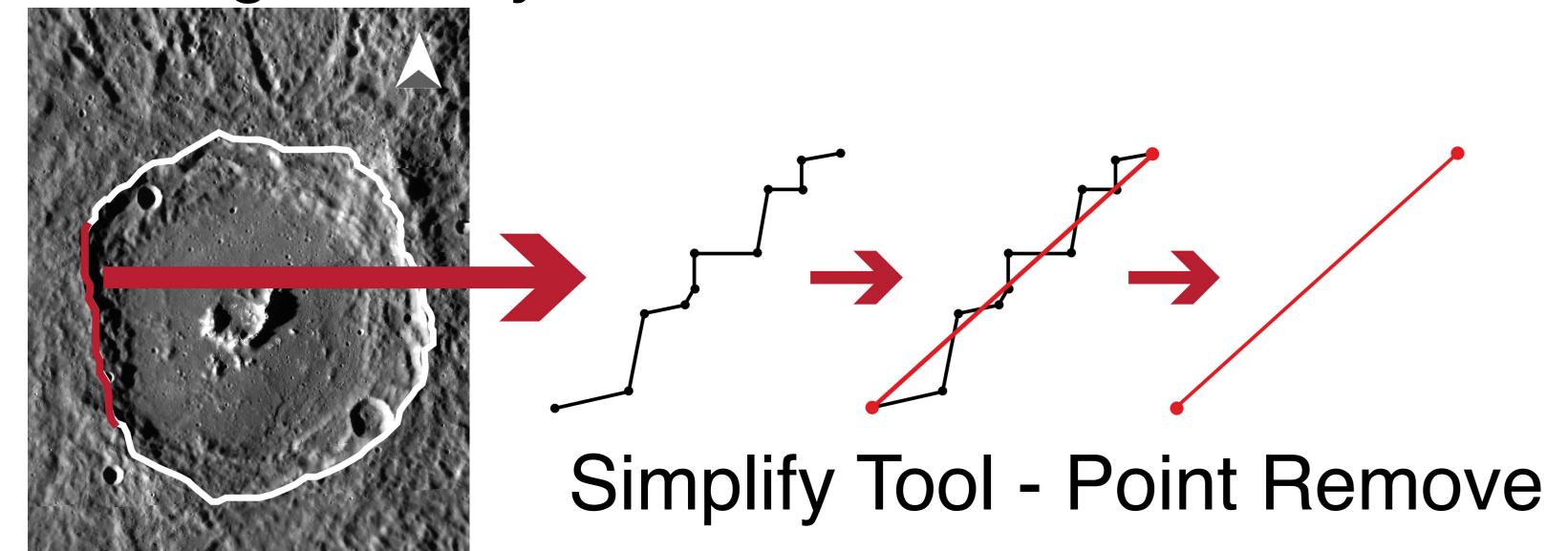
Methodology

• We mapped all the impact craters in the diameter between 20 and 400 km on Mercury using MESSENGER global image and topography datasets.

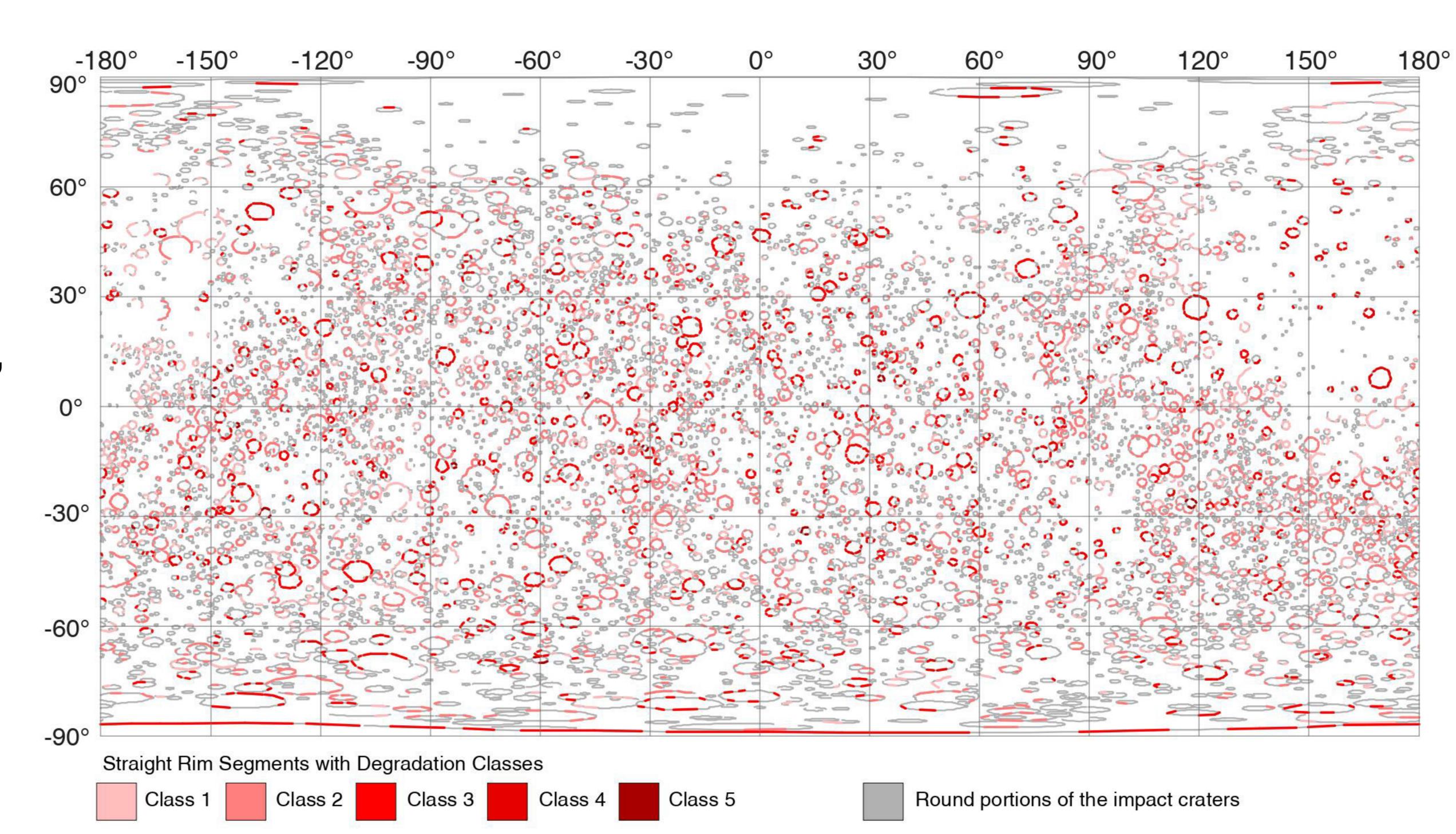


An example of a mapped crater with 44 km diameter.

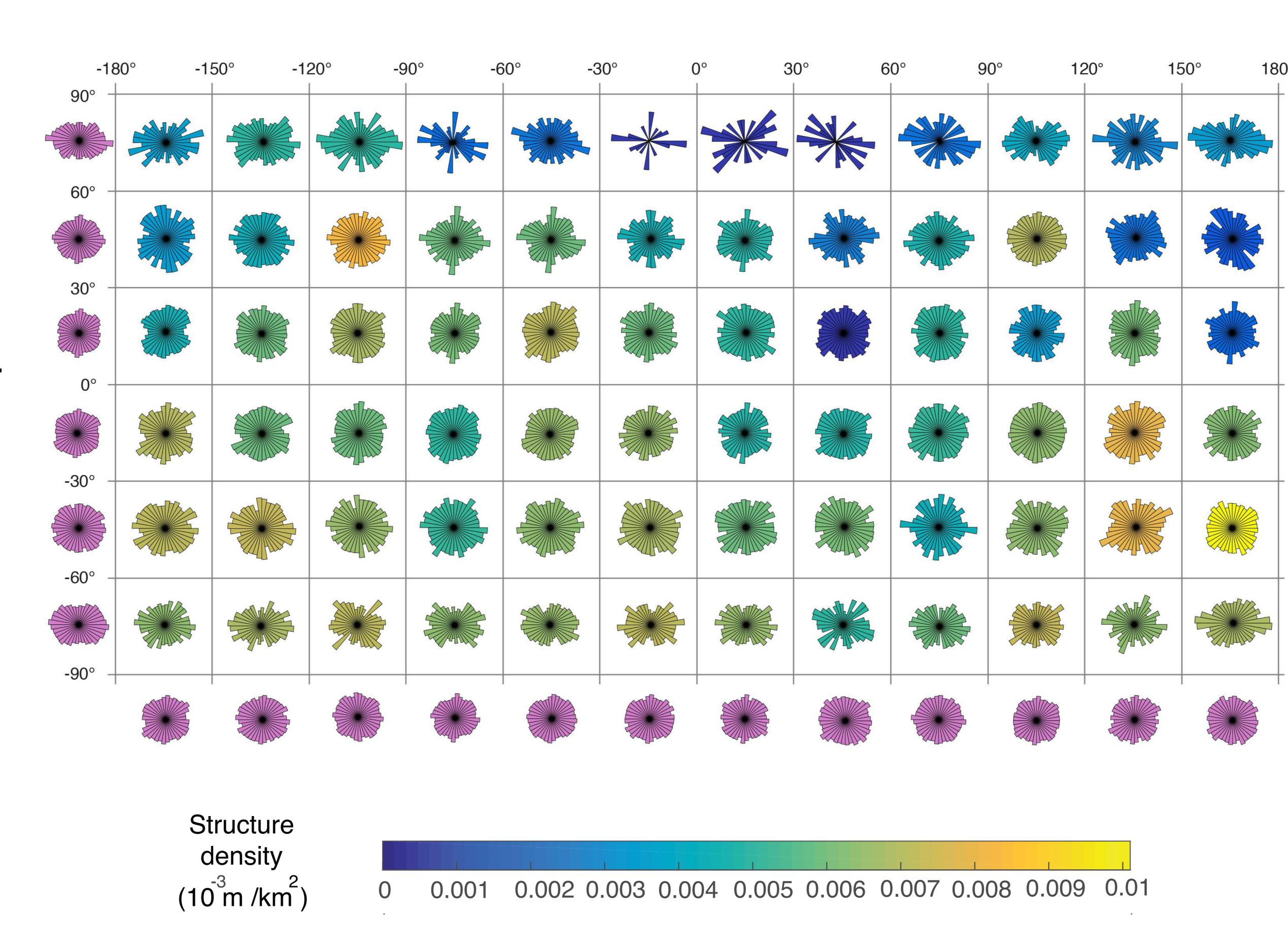
- The orthographic projection of the map area was centered every 10° by 10°.
- The crater rims were mapped using polylines with regularly spaced vertices of 2 km using the stream mode in ArcGIS.
- Craters were assigned ID, crater class, and center coordinates.
- The simplify tool in the ArcGIS Toolbox was used to remove the vertices that did not contribute toward the plan-view geometry of the craters.



• The polylines were split into individual segments and their geodetic length and orientations were calculated.



Global map of 7,146 impact craters in the diameter between 20 and 400 km of Mercury in equirectangular projection. The rim segments longer than 15 km are shown color-coded by crater class. Crater class 1 craters shown in light red are the most degraded. Class 5 craters, shown in dark red, are the freshest craters.

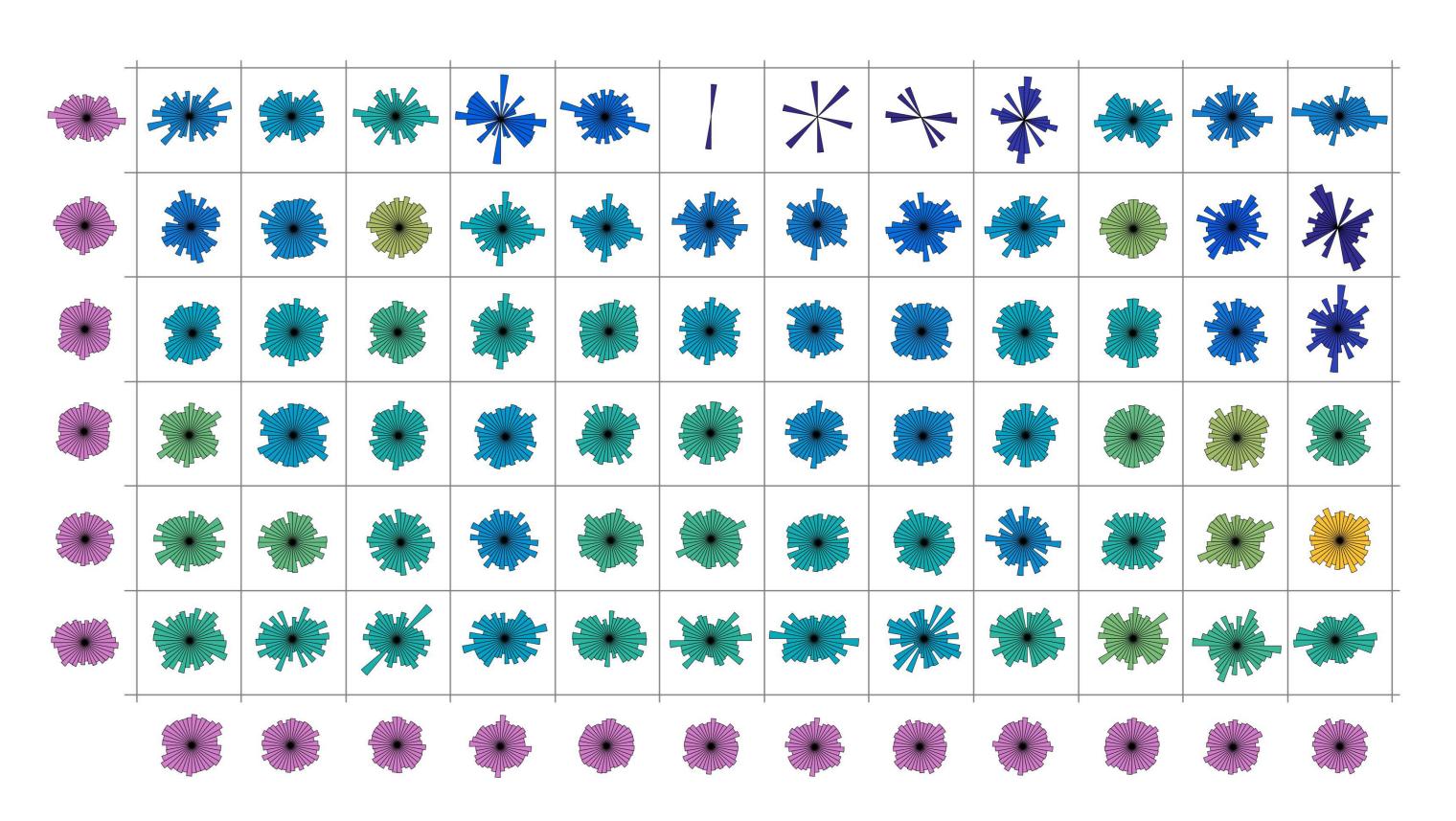


Distribution of the all straight rim segment orientations on Mercury in 30° by 30° bins are shown on equirectangular projection with rose diagrams, color-coded by density of measurements. Pink rose diagrams include measurements of entire longitudes (bottom row) or latitudes (left column). The color coding and the binning are the same for the all rose diagram maps.

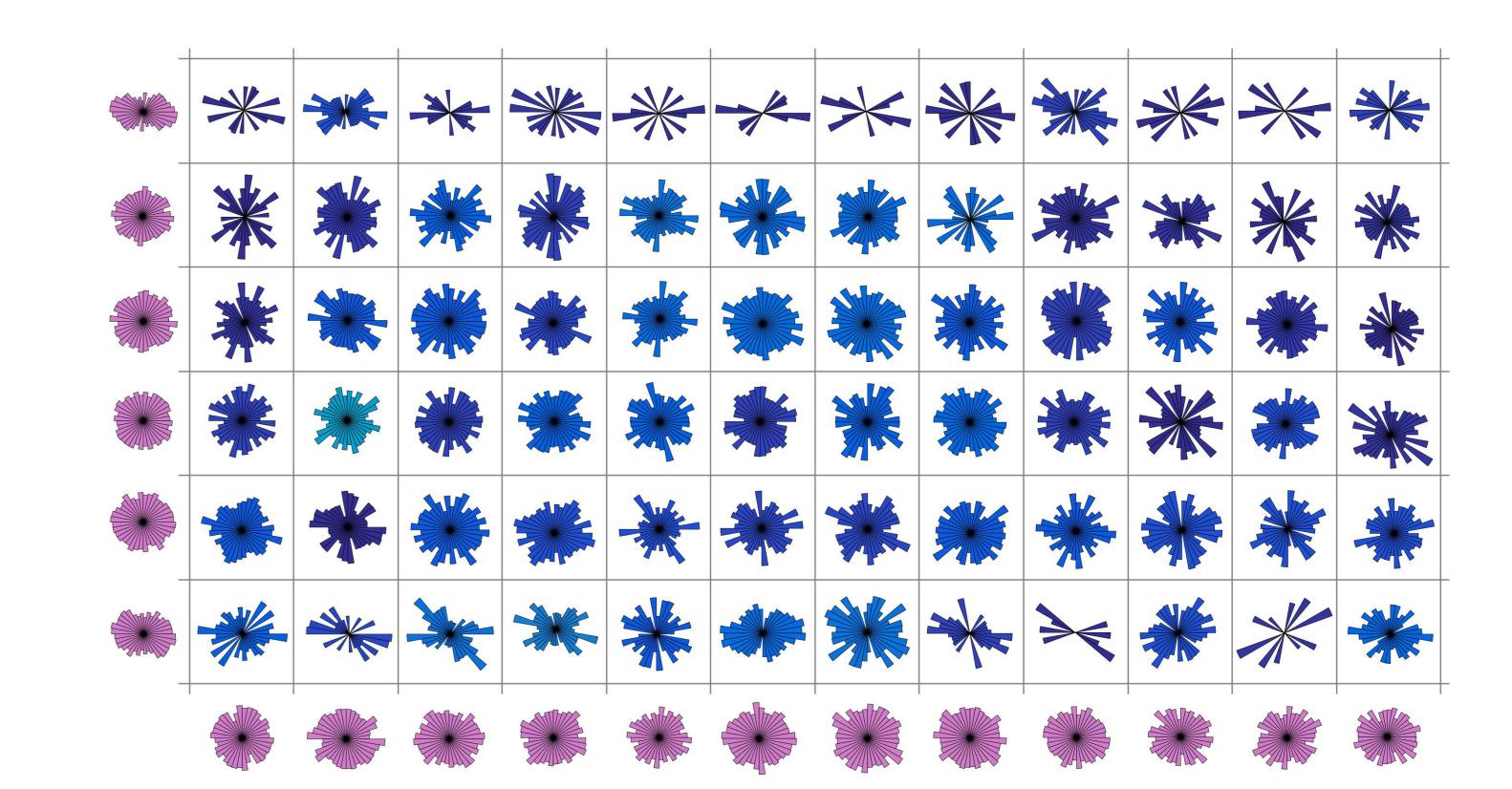
- The orientations of all straight rim segments longer than 10 km were analyzed by weighting with their length and plotted as rose diagrams.
- The rose diagrams are color coded by the structure density.
- We also sub-sampled the orientations of straight rim segments longer than 10 km according to crater class and also computed rose diagrams to assess if temporal.

Results

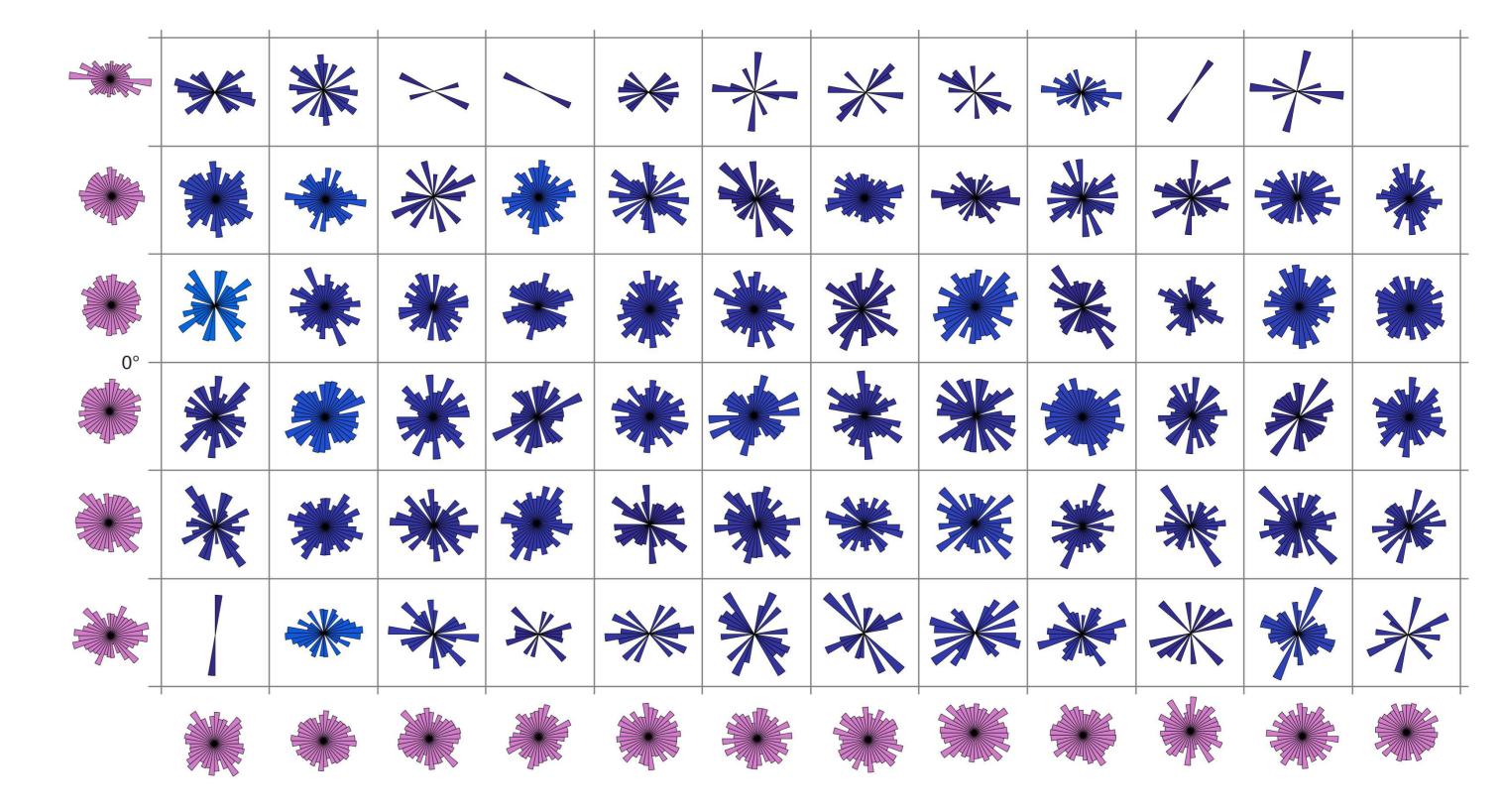
- We identified 28979 straight rim segments longer than 10 km.
- Those straight rim segment orientations display systematic orientations with strong E-W strikes at the poles, and weak N-S or random orientations at mid-latitudes and equatorial regions.
- Analysis of segments by crater class shows multiple regional trends for fresher craters.



Distribution of the straight rim segment orientations of the most degraded impact craters: crater classes 1 and 2.



Distribution of the straight rim segment orientations of the moderately degraded impact craters: crater class 3.



Distribution of the straight rim segment orientations of the freshest impact craters: crater classes 4 and 5.

Conclusion

- Crater rims reveal global and regional fracture patterns on Mercury.
- These fracture sets reveal previously hidden tectonic patterns that can be used to further interpret Mercury's tectonics.
- Comparisons can be made to fault orientation.