Using Onset Diameter to Predict Surface Composition of Charon

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Objective

Indirectly find the surface composition of Charon by finding the ratio of onset diameter to surface gravity and comparing to ratios on other celestial bodies of known composition.

Simple vs Complex Craters

- Greater impact velocity causes a greater diameter.
- A simple crater is smooth and bowl-shaped while a complex crater has a central uplift.
- Simple craters generally have a smaller diameter than complex.

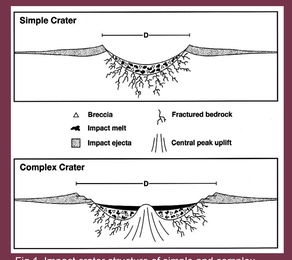

Fig 1. Impact crater structure of simple and complex crater

Onset Diameter vs Surface Gravity

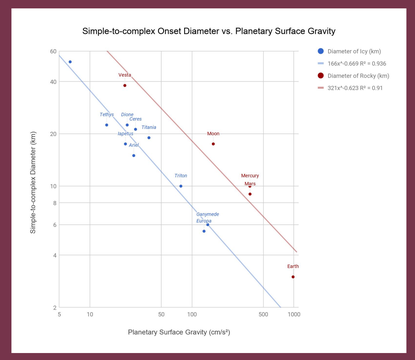

Fig 2. Logarithmic plot showing rocky body and icy body trendlines in onset diameter vs planetary surface gravity.

- Onset diameter is the cutoff diameter between simple and complex craters
  - Below onset diameter = simple crater
  - Above onset diameter = complex crater
- Onset diameter between a simple and complex crater correlates to the body's surface gravity.
- Because the graph is logarithmic, there is a negative power relation between the two variables.
- Rocky bodies fall on a higher trendline than icy bodies.

JMARS

- Geospatial Information System
- New Horizons data - approximately 35% of Charon surface
- Global Mosaic - most detailed view of Charon
- Long-Range Reconnaissance Imager (LORRI)
- Multispectral Visible Imaging Camera (MVIC)
- 300m/pixel resolution

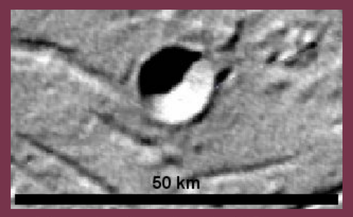

Fig 3. Simple crater on Charon with diameter of 11.7 km. Centered at 201.18E, 3.766.

Fig 4. Complex crater on Charon with diameter of 32 km. Centered at 215.094E, 20.922.

Methods

- Consult the coordinate database provided by Stuart Robbins to locate craters on Charon.
- Find crater using JMARS, measure diameter, and visually determine whether it is simple or complex.
- Determine onset diameter ratio by using the following methods:
  - 50% transition- After sorted in 2.5km diameter ranges, when there is a greater number of complex than simple craters in a range.
  - Geometric mean- Geometric mean of crater diameters from the largest simple to the smallest complex.
  - 5th Percentile- Of all complex craters, the 5th percentile diameter.

Results

Craters Analyzed	Simple Craters	Complex Craters	Ambiguous Craters
677	411	117	149
Diameter Ranges	1.0-15.6 km	8.6-230.0 km	-----

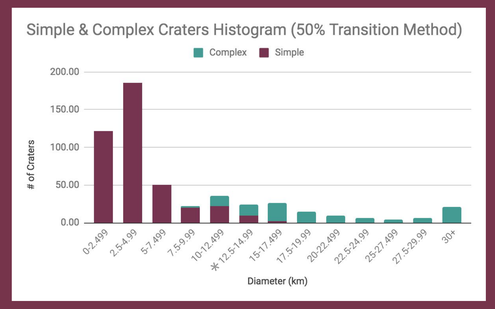

Fig 5. Histogram showing the number of simple and complex craters in each 2.5km bin. The 12.5-14.99 km is the first bin with more complex than simple craters.

Onset Diameter Using Three Methods	
50% transition	12.5 km*
Geometric mean	11.9 km
5th percentile	11.5 km

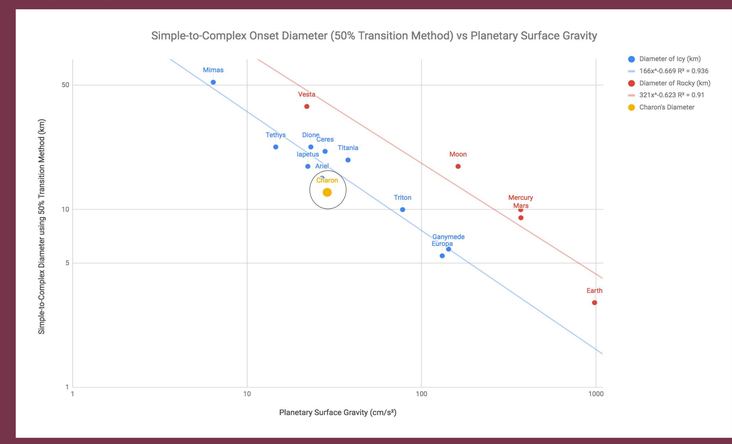

Fig 6. Plot of onset diameter (50% transition method) vs surface gravity including Charon, denoted by circle.

Conclusion

- Charon has a surface gravity of 28.8 cm/s² and an onset diameter of 12.5 km, placing it below the trendline for icy bodies.
- Charon follows the icy bodies trend, suggesting that the composition of Charon is predominantly icy.

References

Baker, David M.h., et al. "The Transition from Complex Crater to Peak-Ring Basin on the Moon: New Observations from the Lunar Orbiter Laser Altimeter (LOLA) Instrument." *Icarus*, vol. 214, no. 2, 2011, pp. 377–393.

Christensen, P.R.; Engle, E.; Anwar, S.; Dickenshied, S.; Noss, D.; Gorelick, N.; Weiss-Malik, M.; *JMARS – A Planetary GIS*, http://adsabs.harvard.edu/abs/2009AGUFMIN22A..06C.

Robbins, Stuart M.h., et al. "Craters of the Pluto-Charon system" *Icarus*, vol. 287, no. 2, 2016, pp. 187–206.

Figure 1. *Impact Craters in the Solar System*, www.lpi.usra.edu/science/kiefer/Education/SSRG2-Craters/craterstructure.html.