OSIRIS-REx
ASTEROID SAMPLE RETURN MISSION

Preliminary Assessment of Bennu's Impact Crater Population, and First Interpretations

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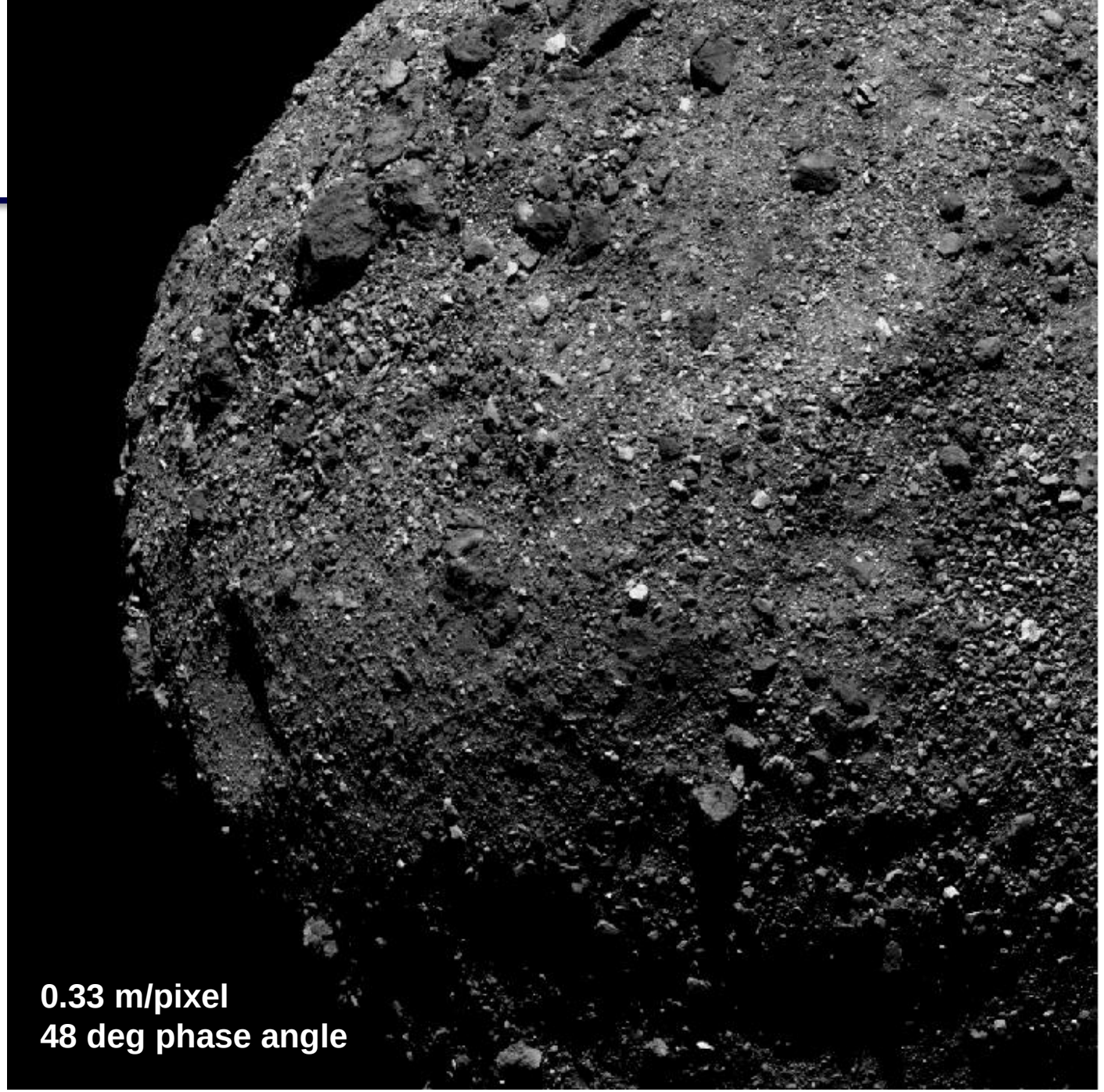
Bennu Has Impact Craters!

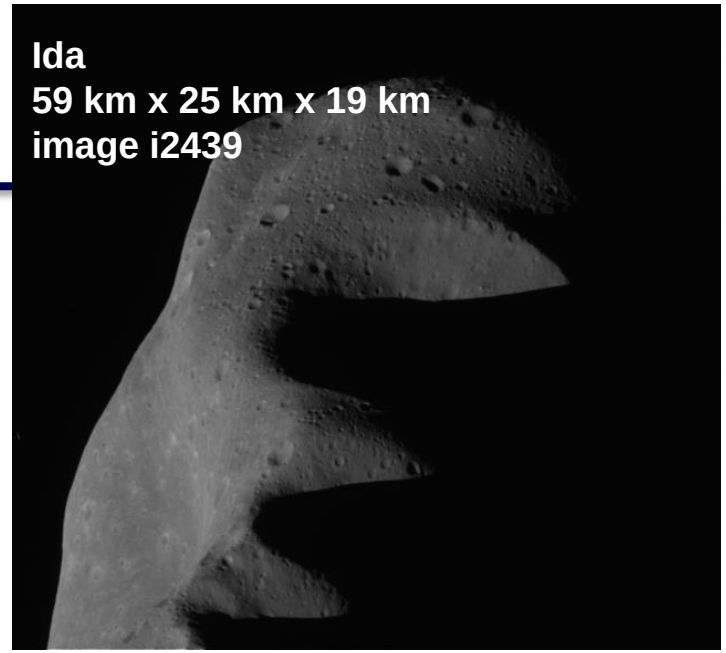
- Tens of candidate crater features identified
- Diameters between ~5 m and possibly over ~200 m
- Range of morphologies present



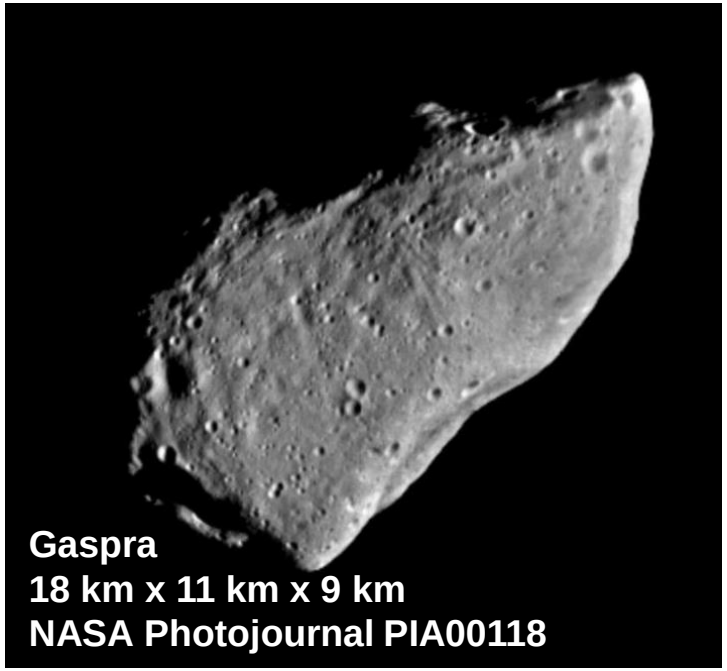
Reminder: Craters on Larger Asteroids

- The first asteroids visited by spacecraft are larger than Bennu
- In many cases these objects bear craters that resemble morphologies seen on larger bodies
  - “clean” bowl shapes
  - Raised rims
- Ida and Gaspra shapes have large facets, which some interpreted as craters
  - Overall shape of the body affects the formation and evolution of crater cavity

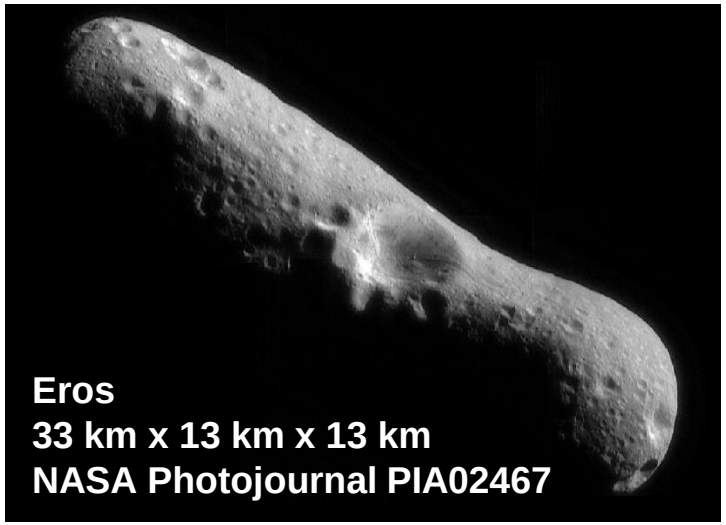
Mathilde
66 km x 48 km x 44 km
NASA Photojournal PIA02477



Ida
59 km x 25 km x 19 km
image i2439



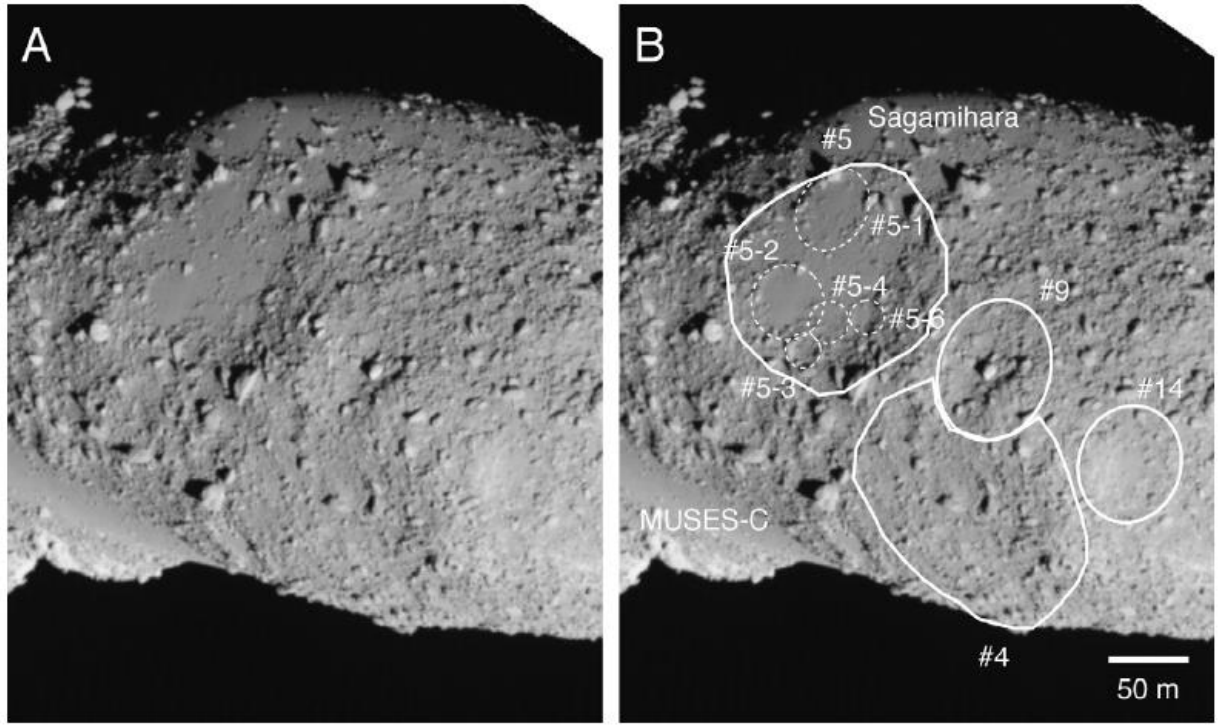
Gaspra
18 km x 11 km x 9 km
NASA Photojournal PIA00118



Eros
33 km x 13 km x 13 km
NASA Photojournal PIA02467

Craters on Itokawa

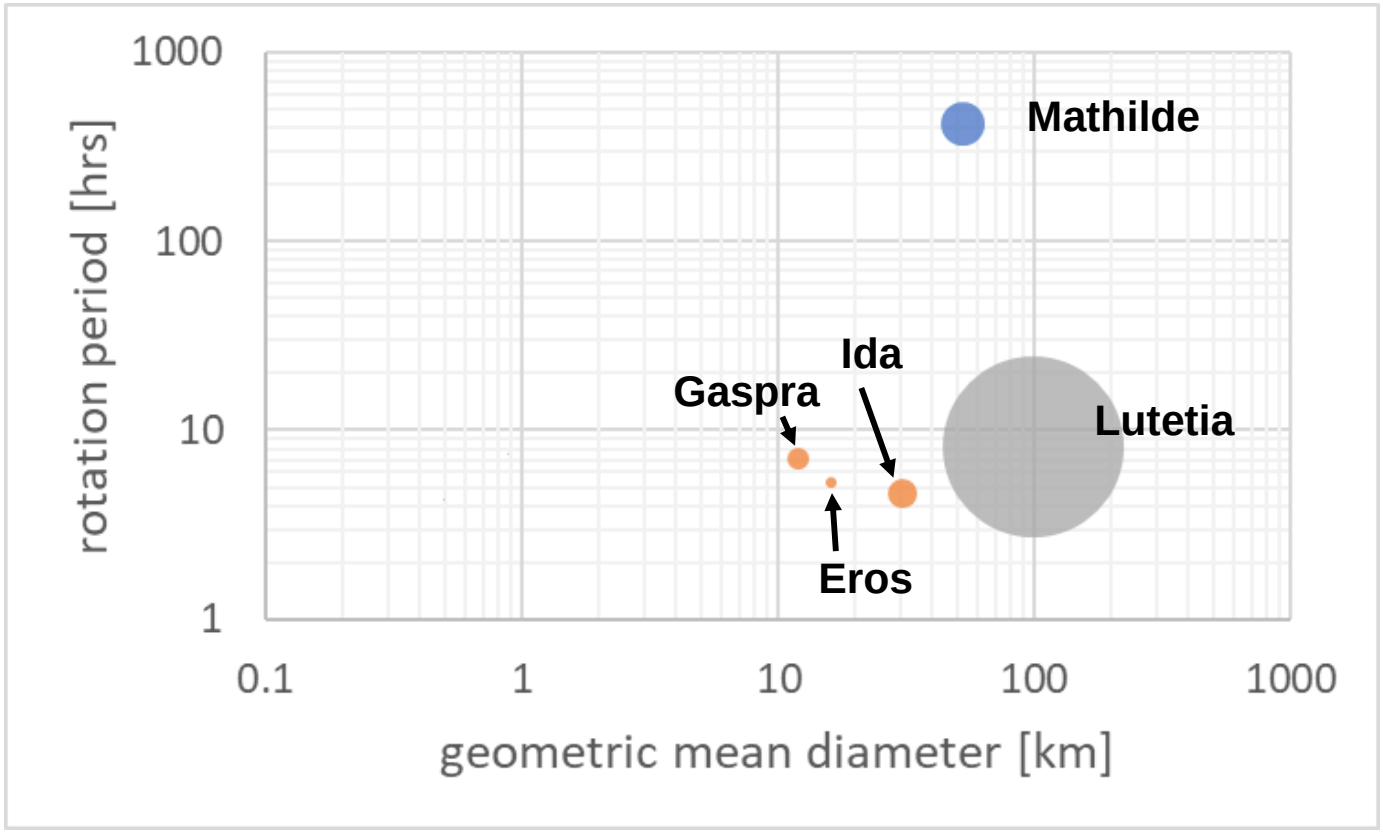
- Itokawa was the first sub-km asteroid visited by spacecraft
- Surface texture largely dominated by boulders
- Even in “smooth” Muses-C region, highest-resolution images reveal gravel-like surface
- Craters expressed different morphology than seen on large planetary bodies, and larger asteroids
  - Subdued topography, crater rims subtle or absent



Hirata et al. (2009)

Dimension, Rotation, and Mass

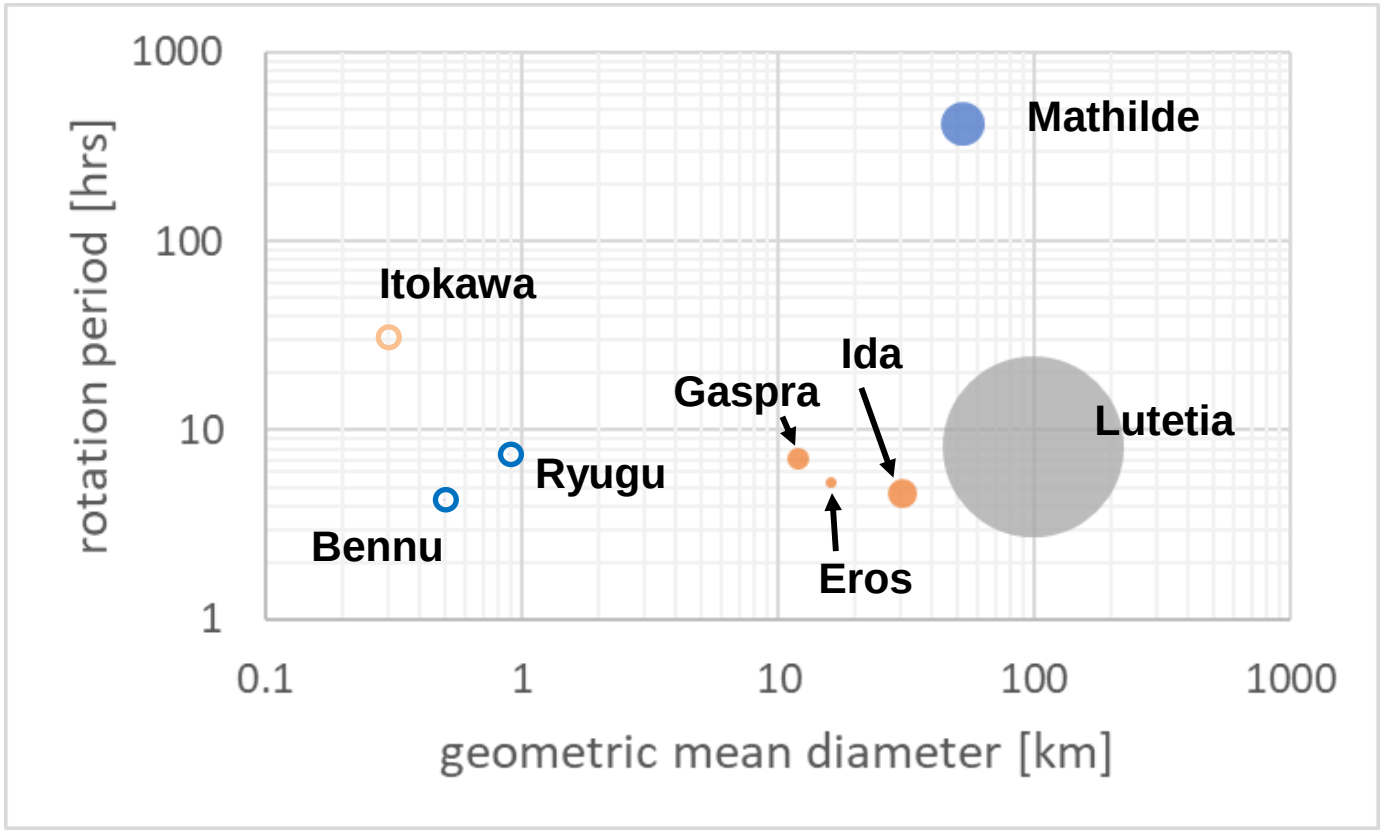
- C-complex
- S-type
- M-type



size of circle is proportional to mass

Dimension, Rotation, and Mass

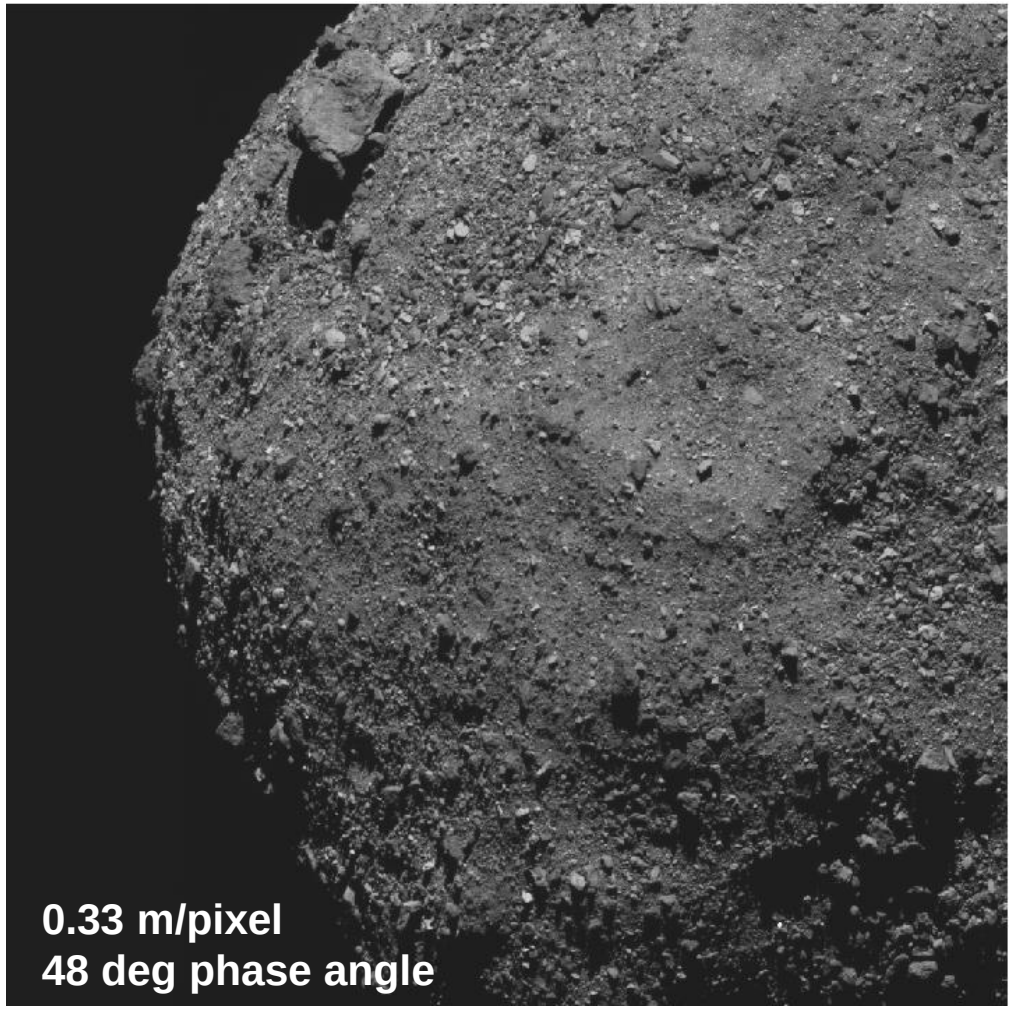
- **C-complex**
- **S-type**
- **M-type**

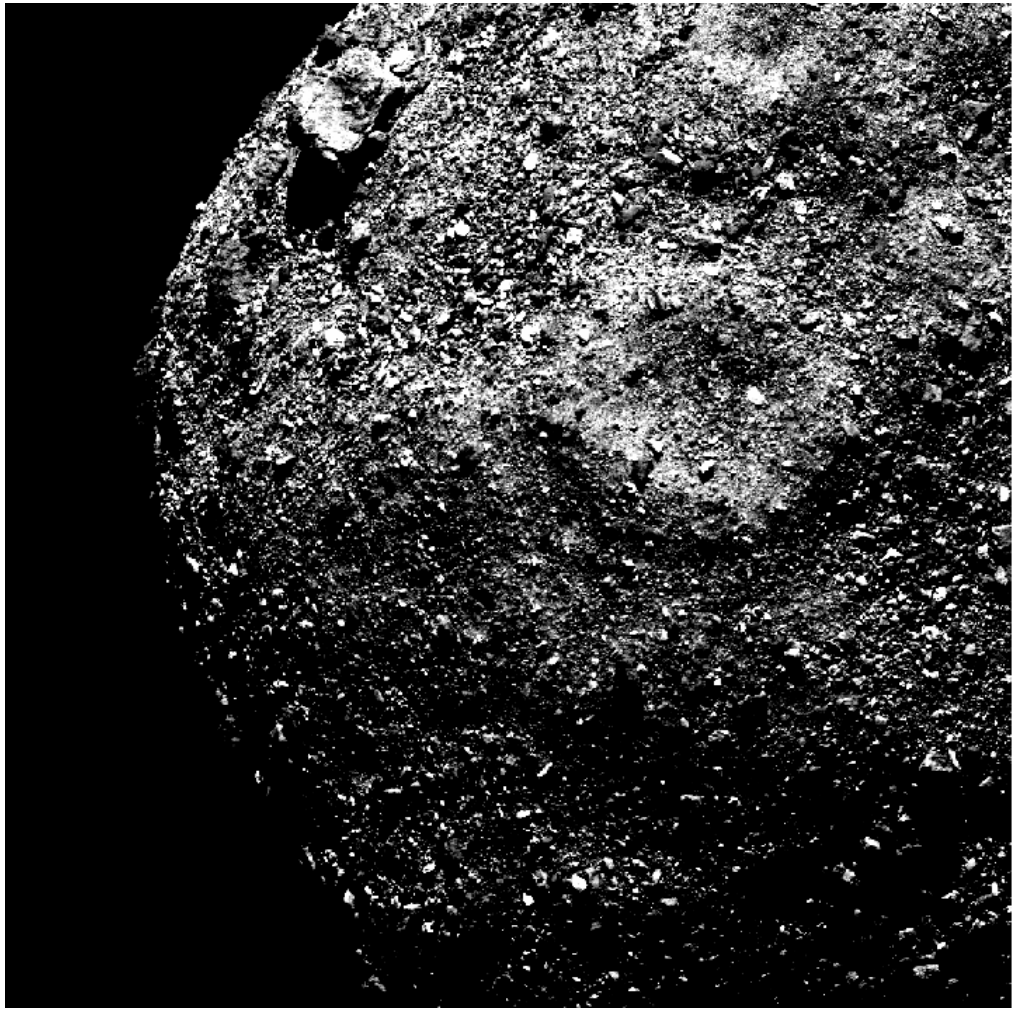


Bennu is:
- 1st B-class visited
- And a unique combination of size, mass, and rotation rate

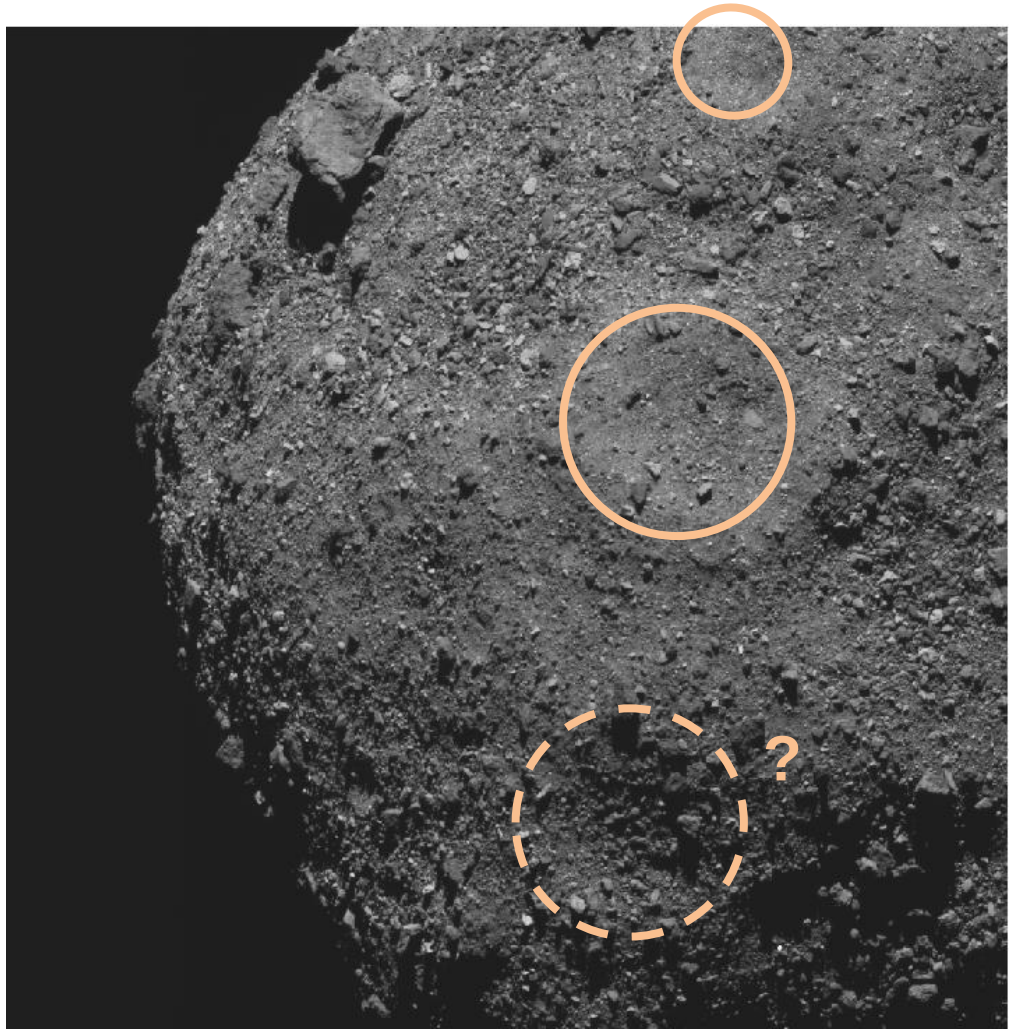
size of circle is proportional to mass
Itokawa, Ryugu and Bennu circles not to scale!

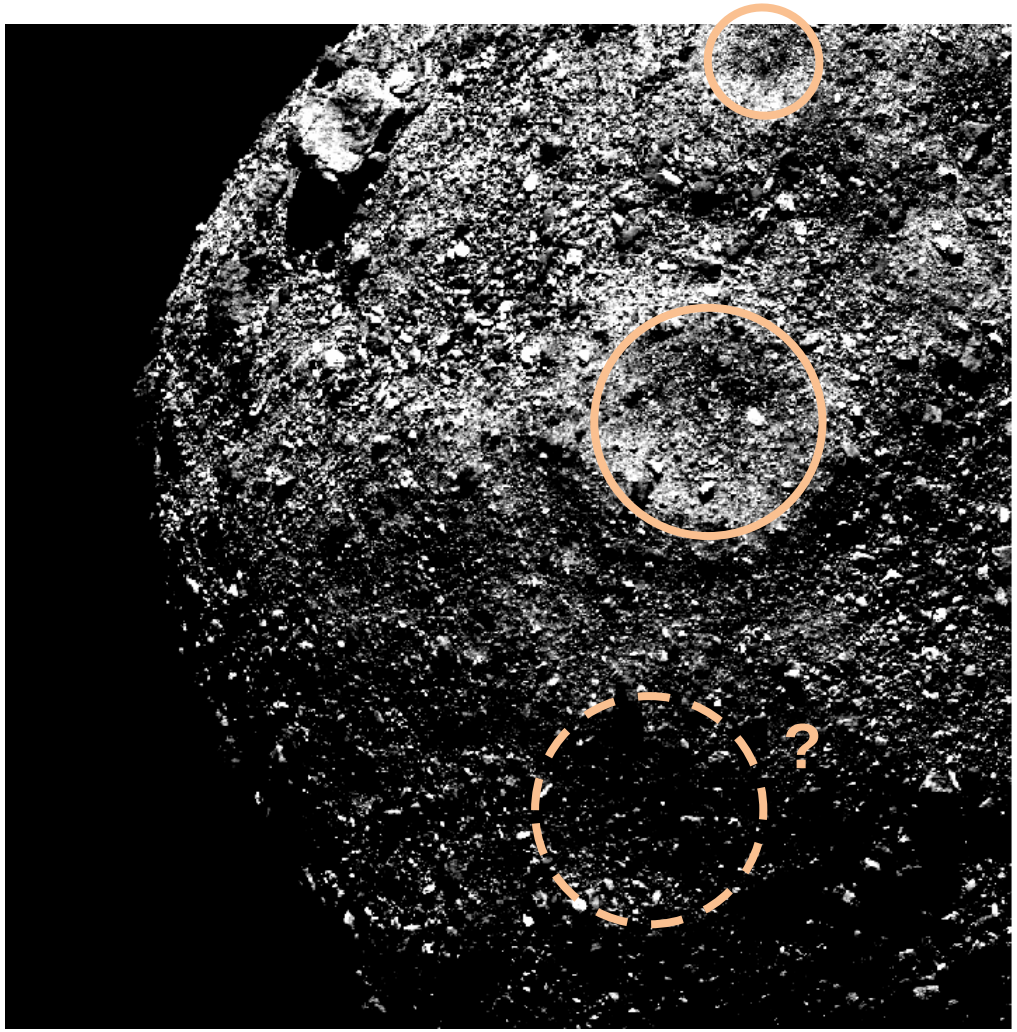
Finding Craters





Finding Craters

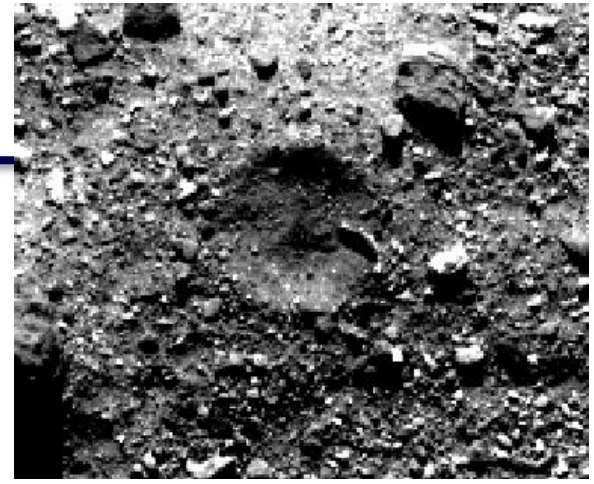




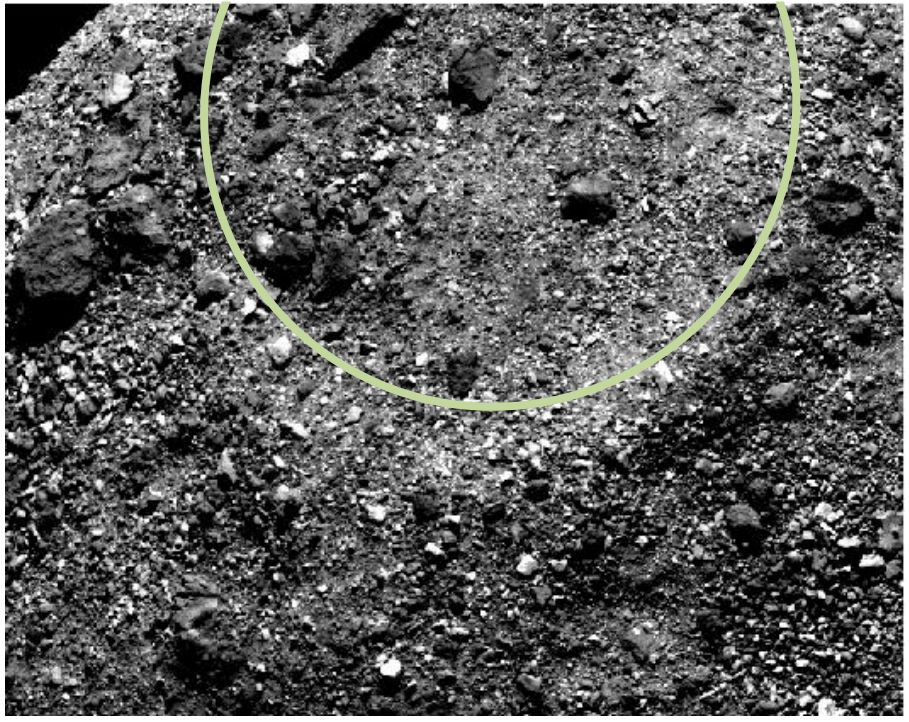
Diverse Craters on Bennu: A First Look

- Morphology is a mix of “obvious” craters, and crater-like features
  - Feature identification sensitive to viewing geometry and lighting
- Some craters include raised rims (previous slide)
  - Higher-resolution image data and topographic data from the OSIRIS-REx Laser Altimeter (OLA) will resolve ambiguous cases
- Some craters have relatively boulder-free floors, and some have boulder-rich floors

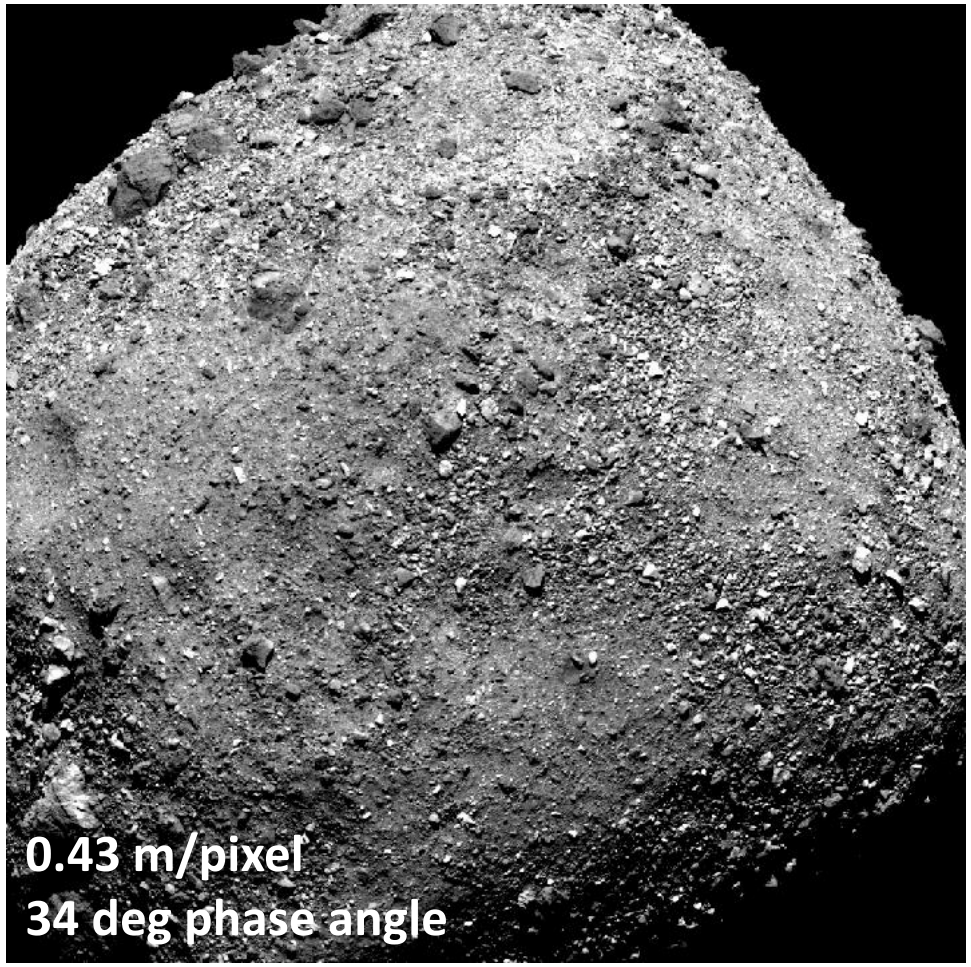
~20 m diameter crater, smooth floor



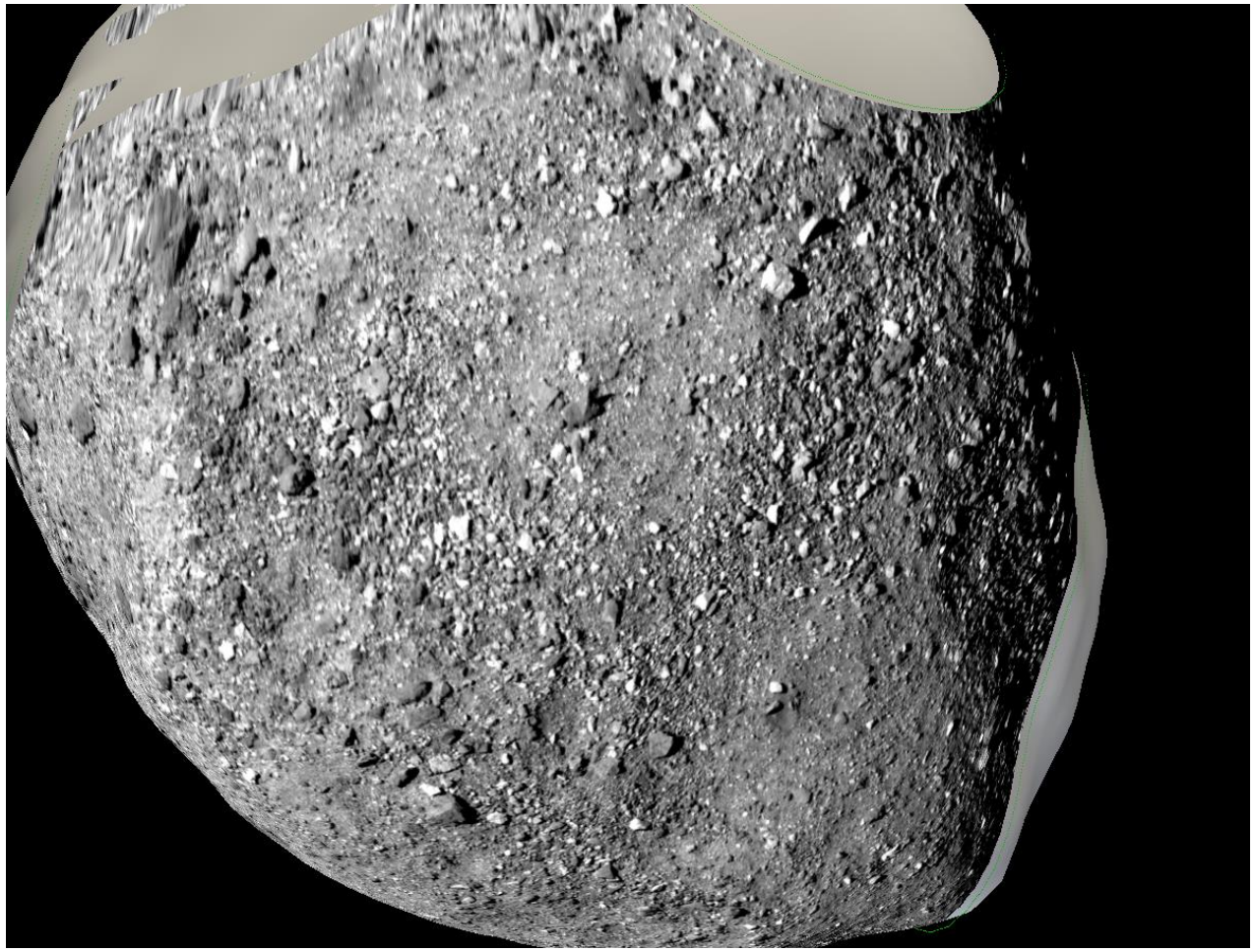
~150 m diameter crater



(Maybe) The Largest Crater on Bennu



Raw image



Projected on shape model

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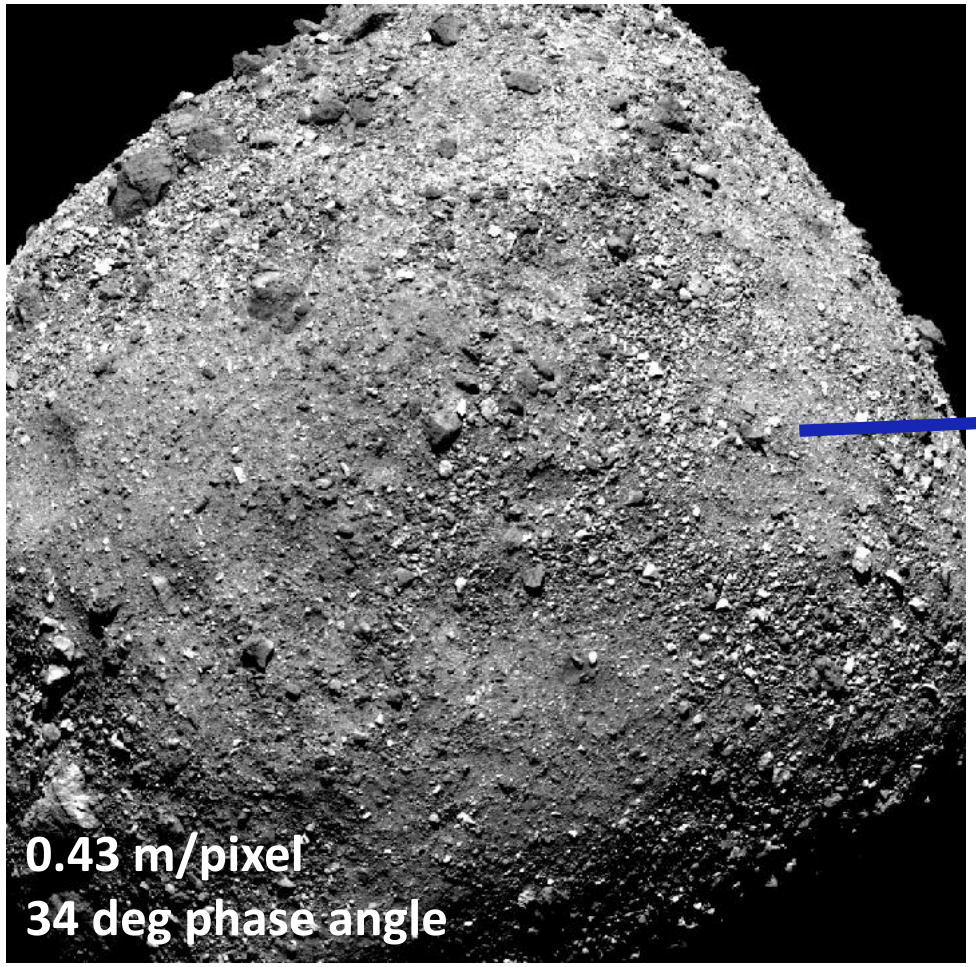

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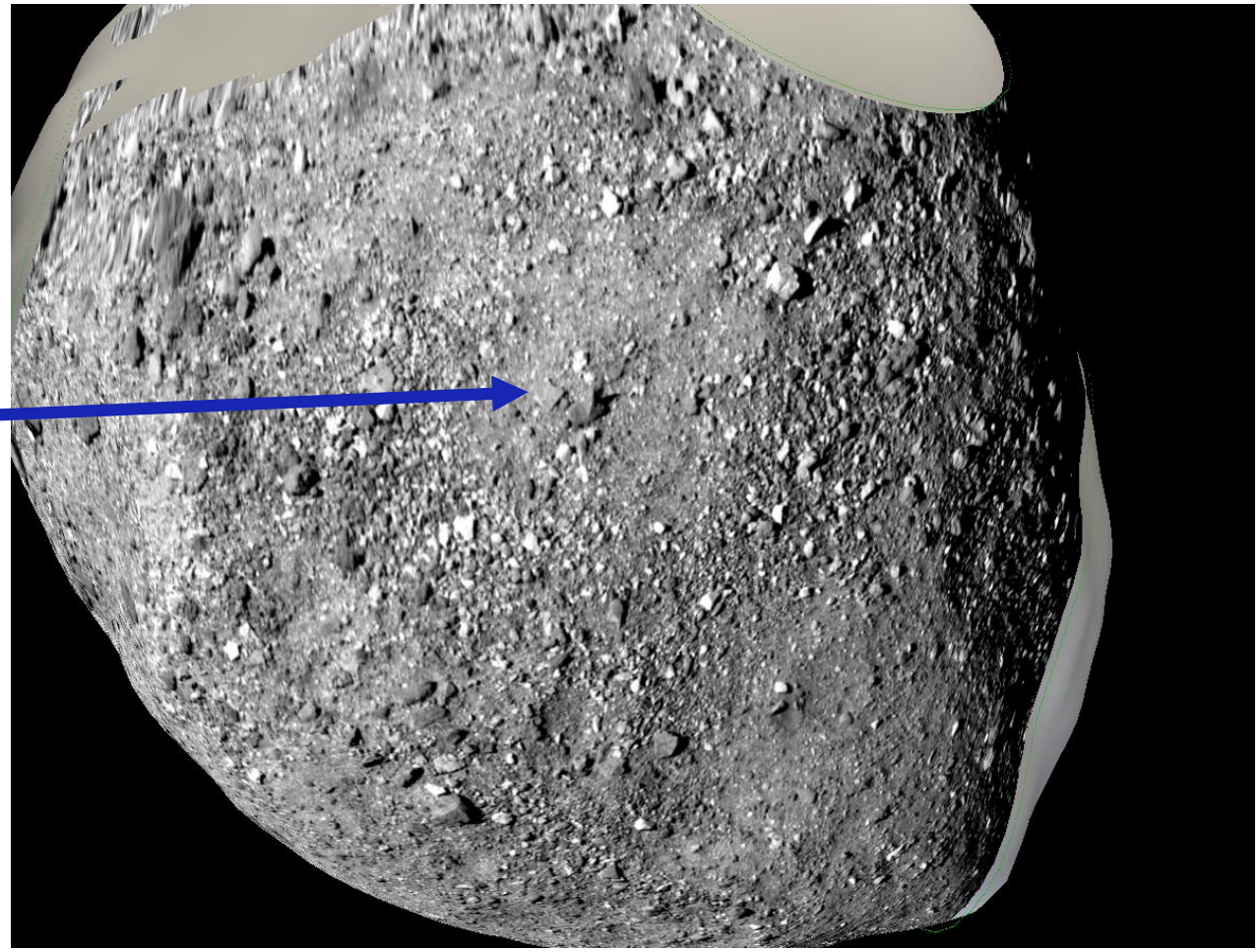

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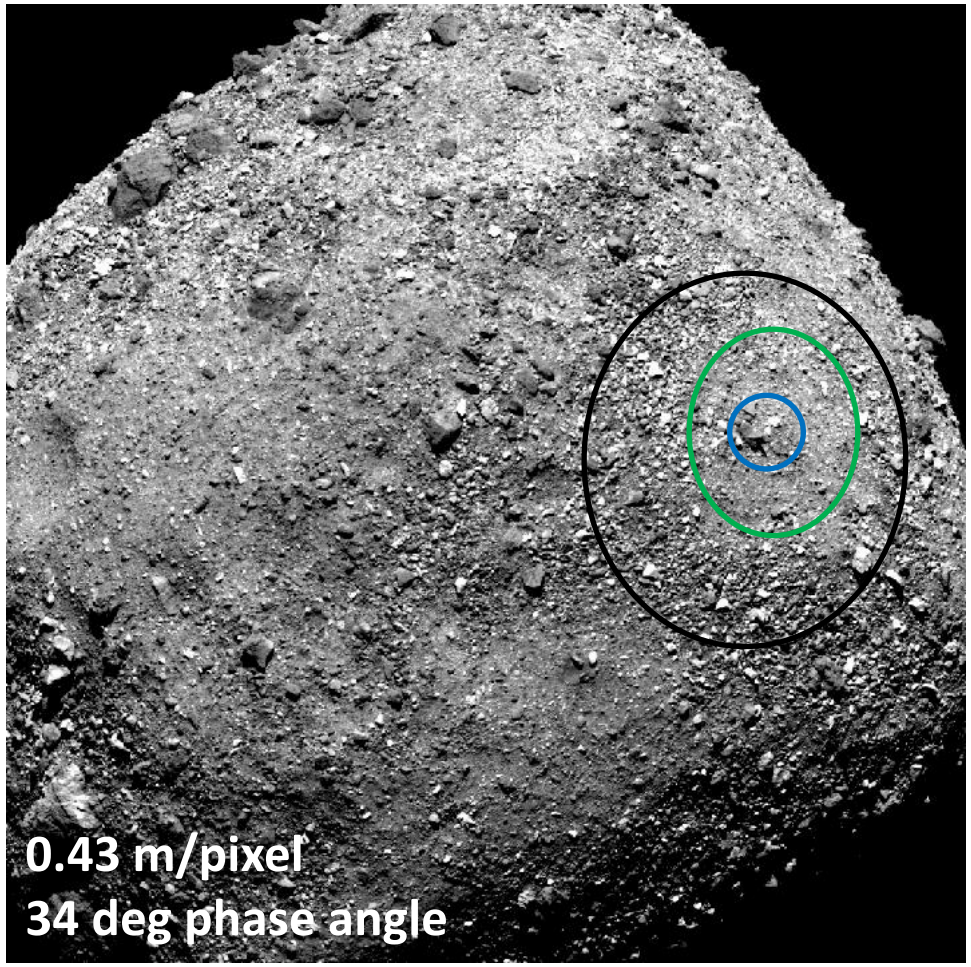

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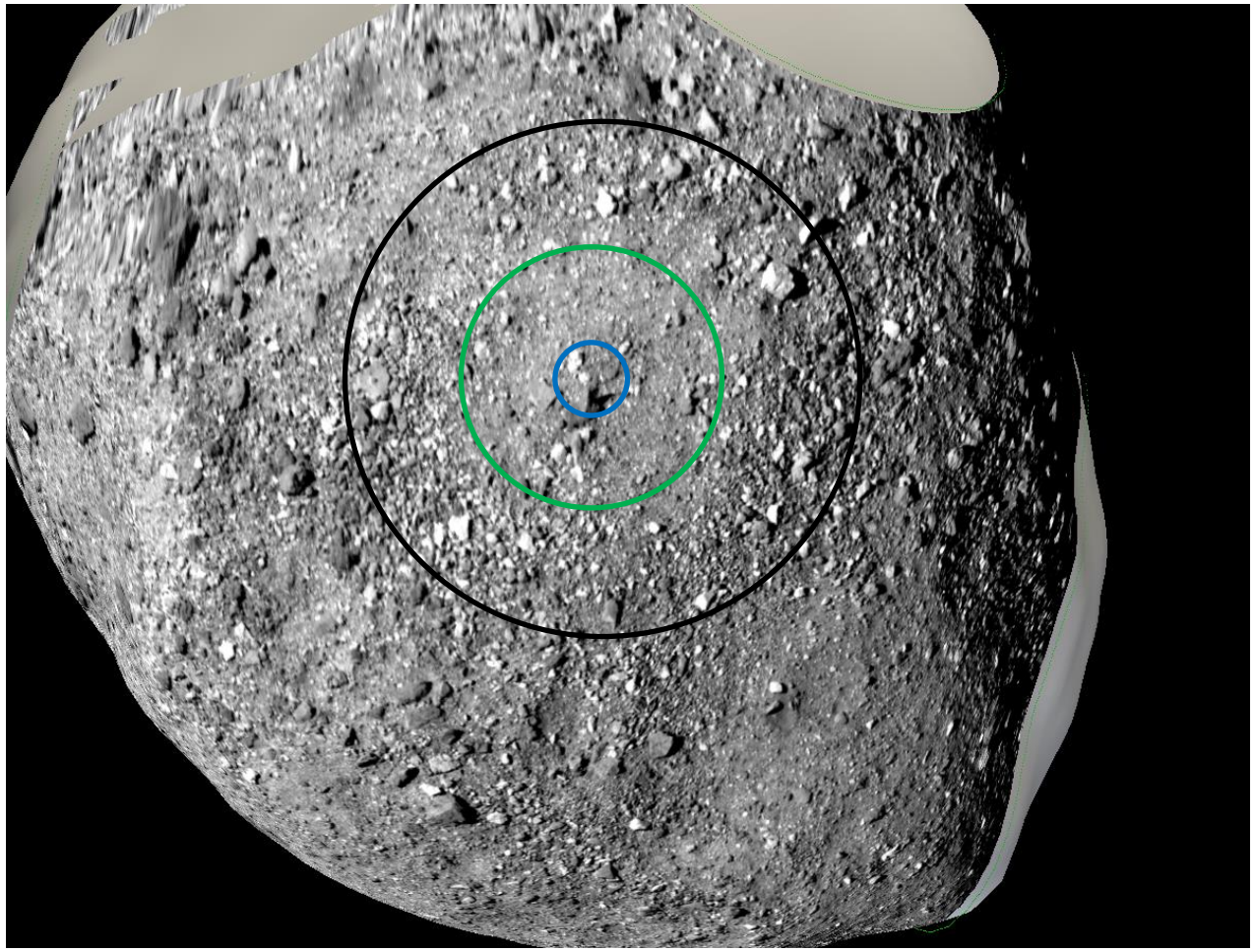


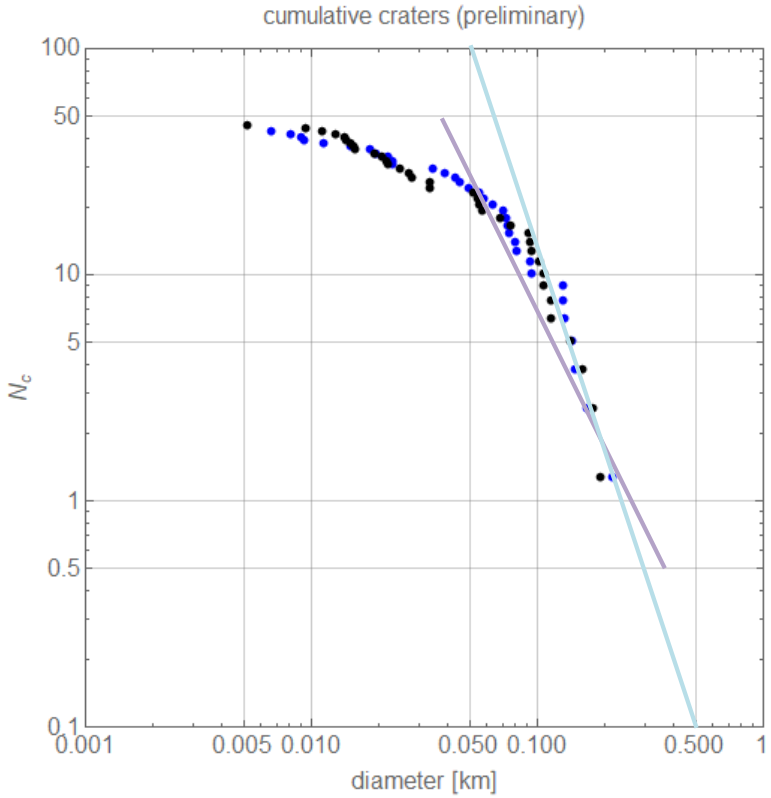
Projected on shape model

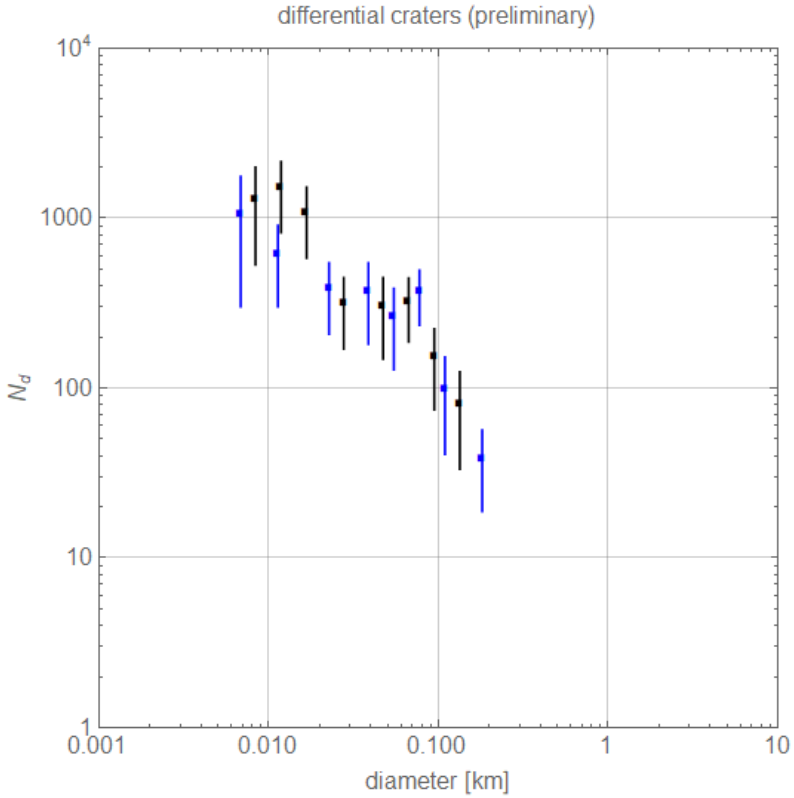
Preliminary Crater Size-Frequency Distribution

-2 cumulative power-law

-3 cumulative power-law

Blue and black points are two versions of global candidate crater measurements.

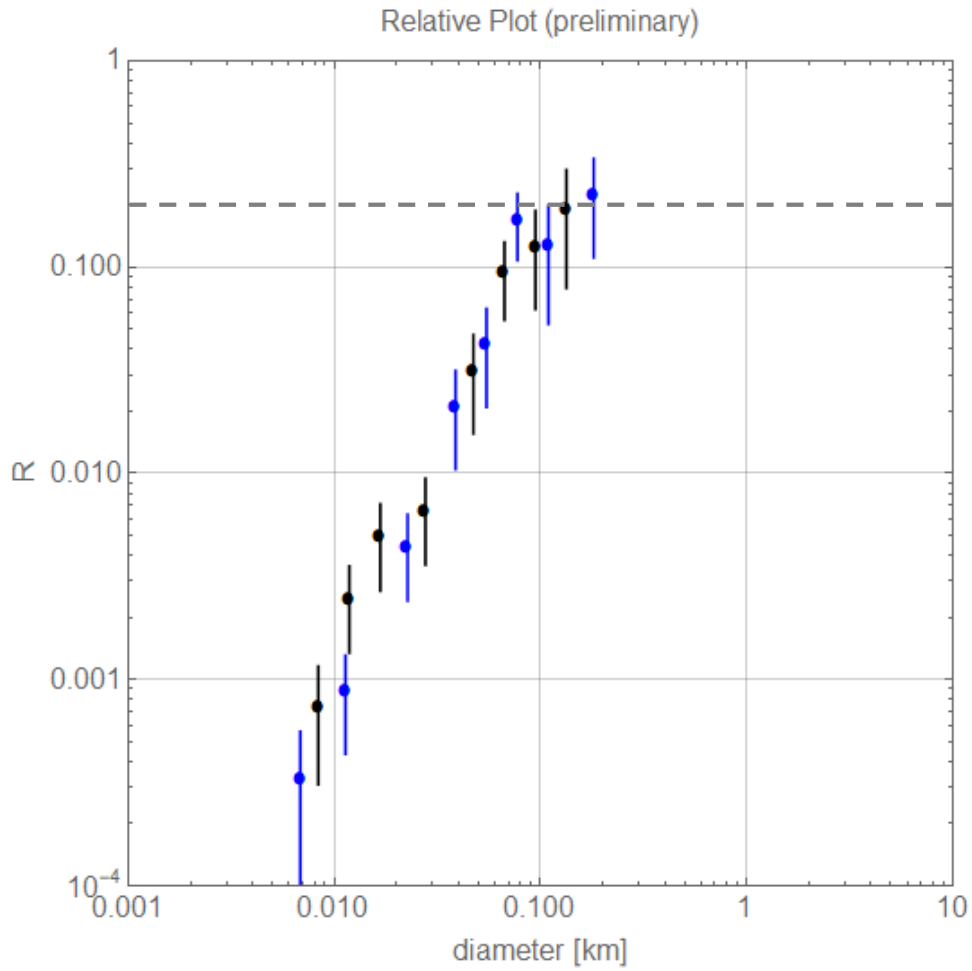




- Measurements made on images with pixel scale < 1 m/pix
- The largest craters have a cumulative power-law index close to -3
- There is a transition to a more shallow slope between 50 m to 100 m, well above completeness limit (caveated by challenge of identifying features on a small body)

Preliminary Crater Size-Frequency Distribution

- Relative (R) plot to the right
  - Normalizes the differential plot to D^{-3} (a differential D^{-3} slope plots as flat line)
- Dashed line at R = 0.2 is a typical value of crater saturation on other planetary surfaces
  - At the very largest diameters, Bennu could be close to crater saturation

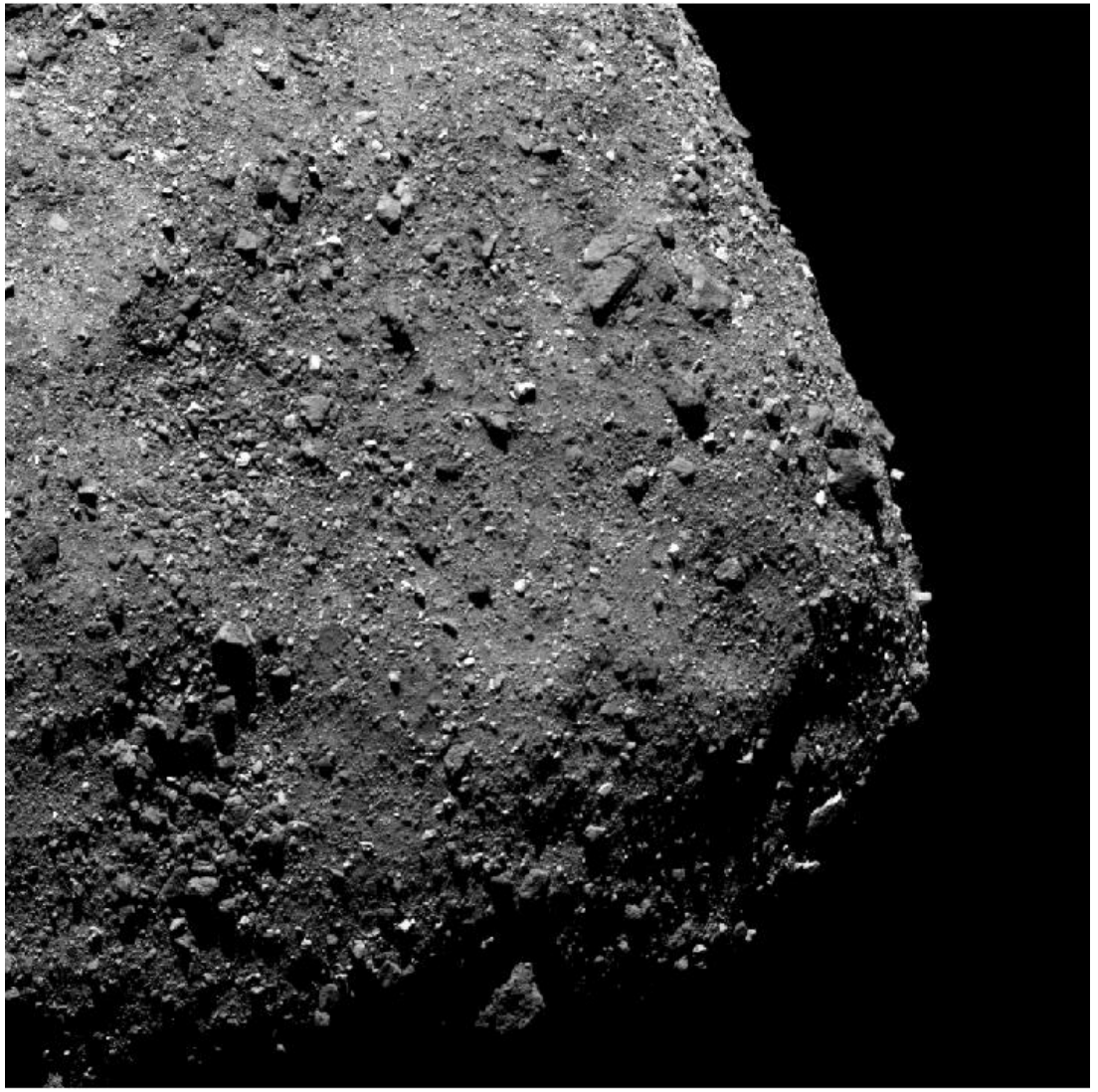


Preliminary Interpretations

- The shape and spatial density of the crater population has rich potential to illuminate Bennu's ***recent*** and ***past*** history
- **Recent history**: the under-abundance of smaller craters suggests active erosional processes that operate faster than the crater production function
  - Because bigger impacts generally occur less-frequently than small impacts, seismic shaking from impacts may not be the sole process removing small craters
- **Past history**: the abundance of large craters suggests the global shape of Bennu may be relatively old

Summary

- With approach image data, we identified tens of multiple candidate impact craters
- Largest possible impact feature is near 200 m diameter – preliminary result, subject to refinement
- Under-abundance of small craters is likely real
- Lots of work to go with incoming data, stay tuned!



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