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Craters on (101955) Bennu's boulders

Bennu's near-Earth lifetime of 1.75 million years inferred from craters on its boulders

AAS DPS 402.01 & Ballouz et al. (2020), *Nature*

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Ron Ballouz*

Lunar and Planetary Lab, University of Arizona, Tucson, AZ

K.J. Walsh

Southwest Research Institute, Boulder, CO

O.S. Barnouin

Johns Hopkins University Applied Physics Lab, Laurel, MD

D.N. DellaGiustina

Lunar and Planetary Lab, University of Arizona, Tucson, AZ

M. Al Asad

University of British Columbia, Vancouver, BC, Canada

E.R. Jawin

Smithsonian Institution National Museum of Natural History, Washington, DC

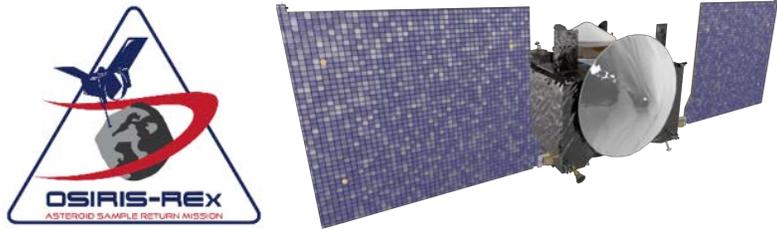
M.G. Daly

York University, Toronto, ON, Canada

the OSIRIS-REx team

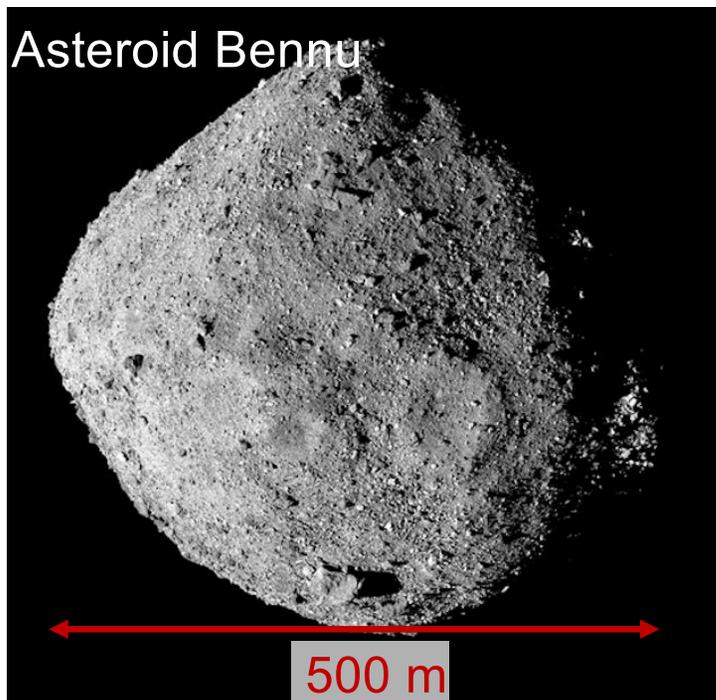
*email: rballouz@orex.lpl.arizona.edu

Background: the OSIRIS-REx mission

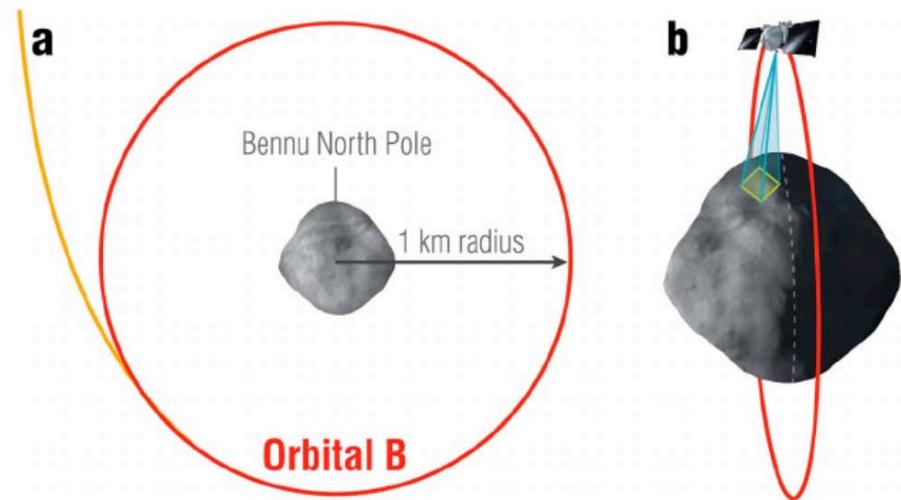


Close survey of the asteroid:
Images with pixel scales of 1 cm/pixel

OSIRIS-REx Laser Altimeter (OLA):
LIDAR instrument that measured the shape of the
surface at a precision of a few cm



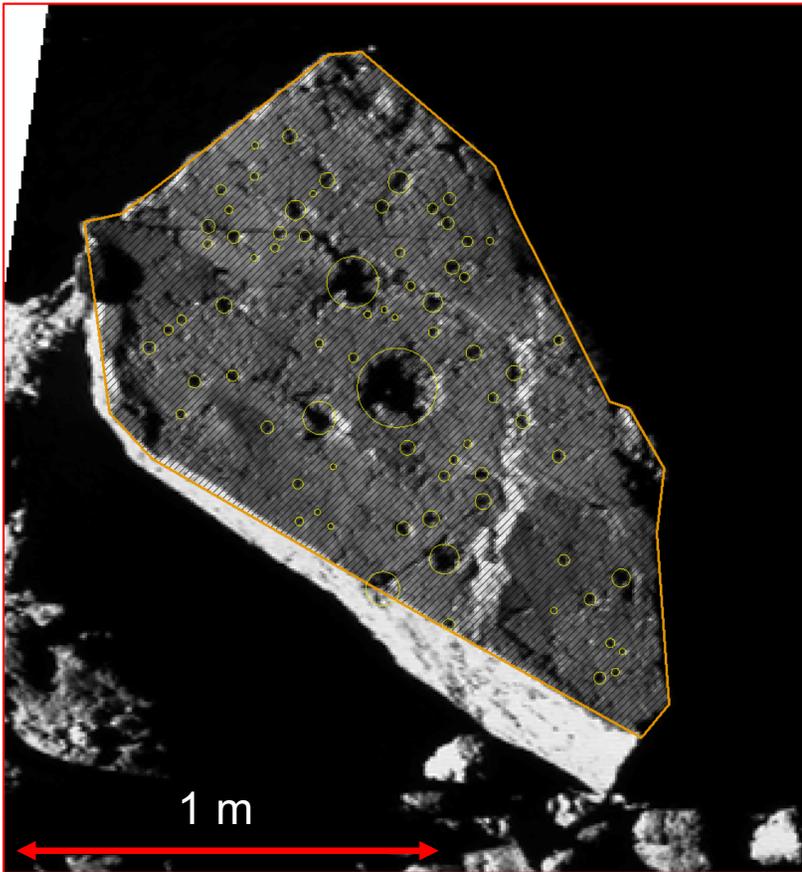
OCAMS/OSIRIS-REx/UA/NASA



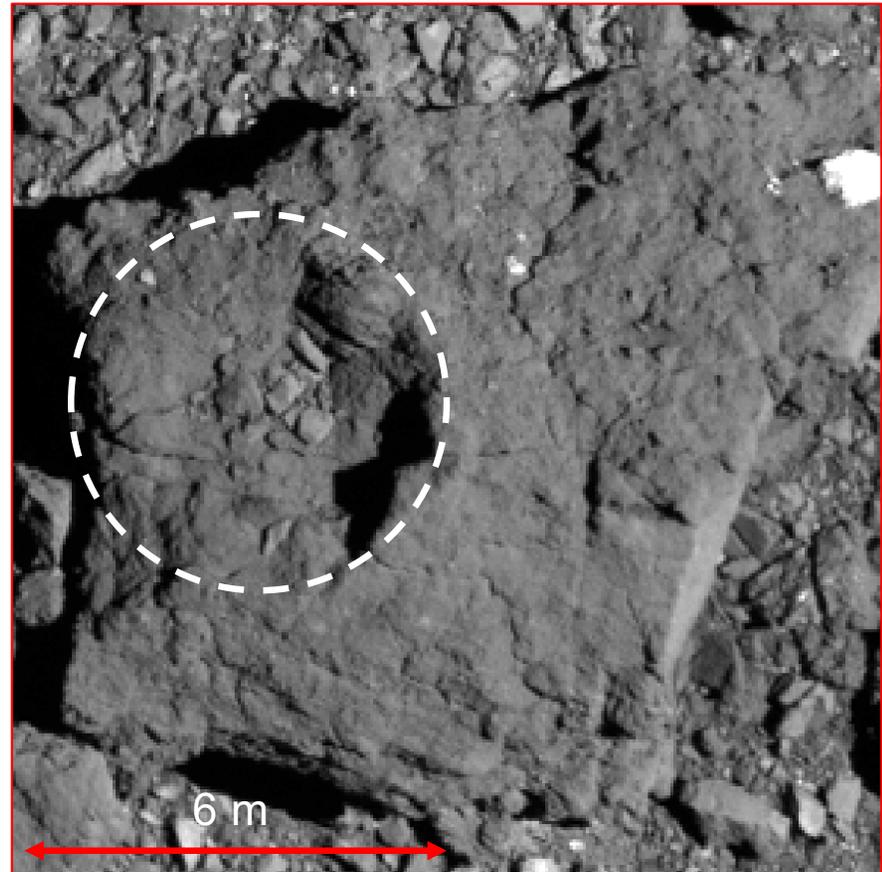
DellaGiustina et al. (2018)

Results: Observations of Craters on Bennu's Boulders:

created by impacts from meteoroids



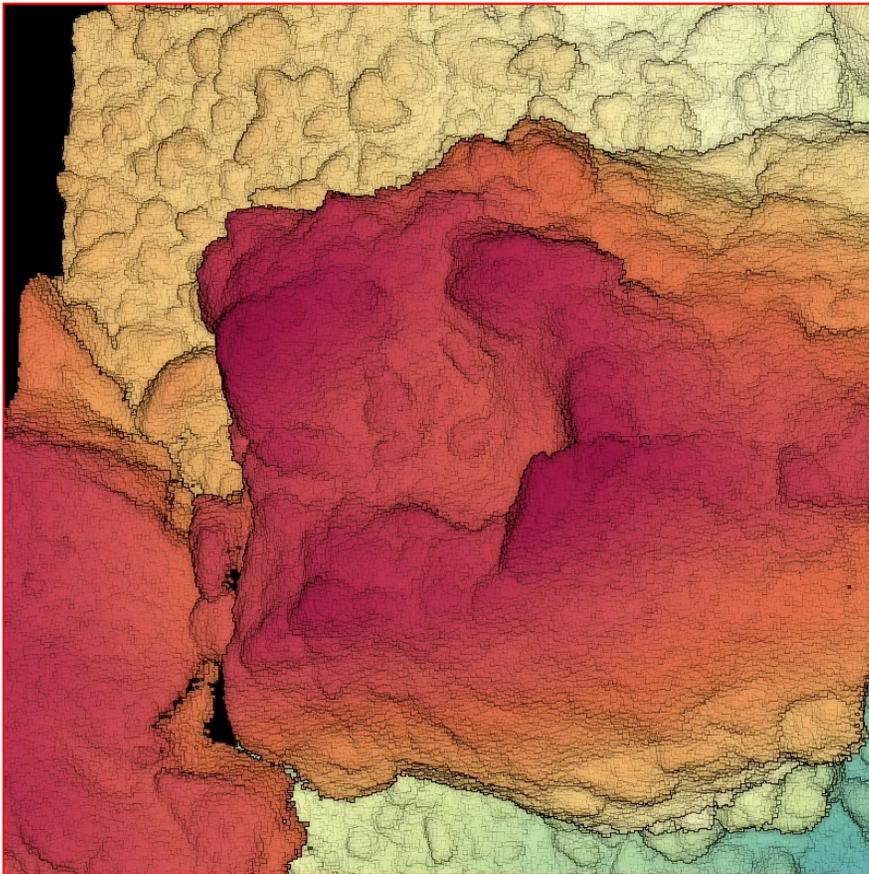
Craters in this image range in size between 3 cm up to 30 cm.



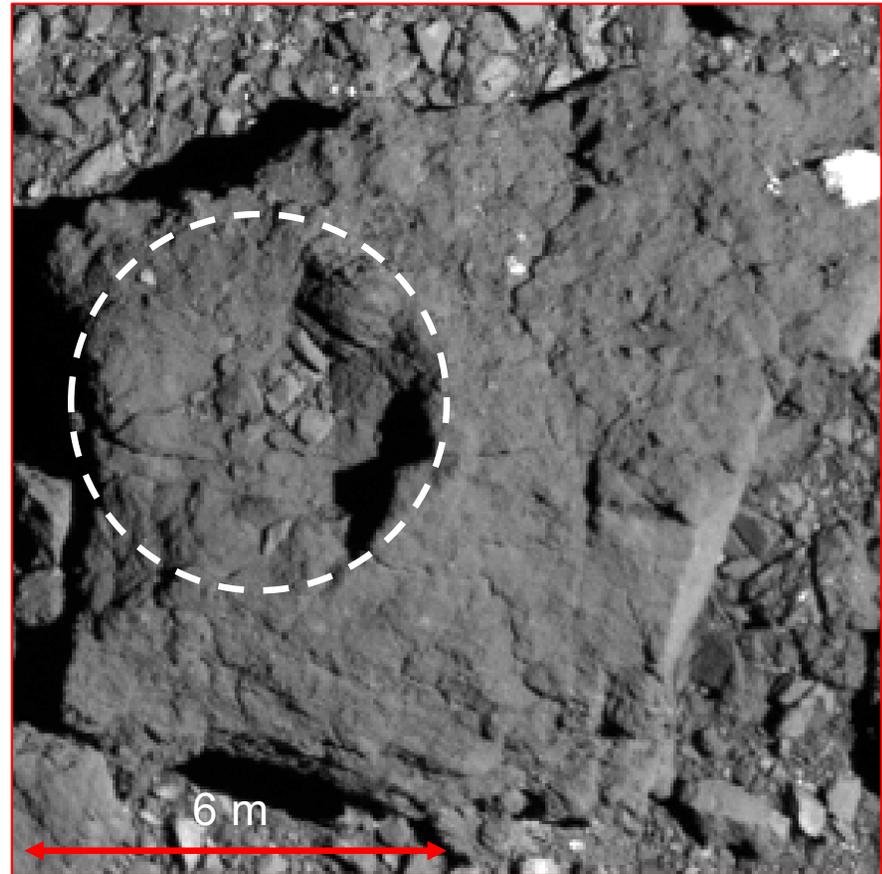
The crater highlighted is 5m wide

OCAMS/OSIRIS-REx/UA/NASA

Results: Observations of Craters on Bennu's Boulders: created by impacts from meteoroids



OLA LIDAR data of the same boulder to the right (5 cm resolution shape model)



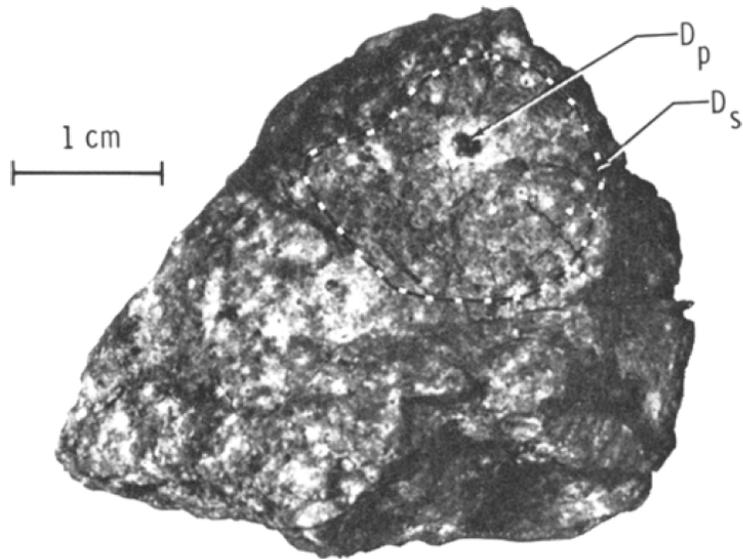
The crater highlighted is 5m wide

OCAMS/OSIRIS-REx/UA/NASA

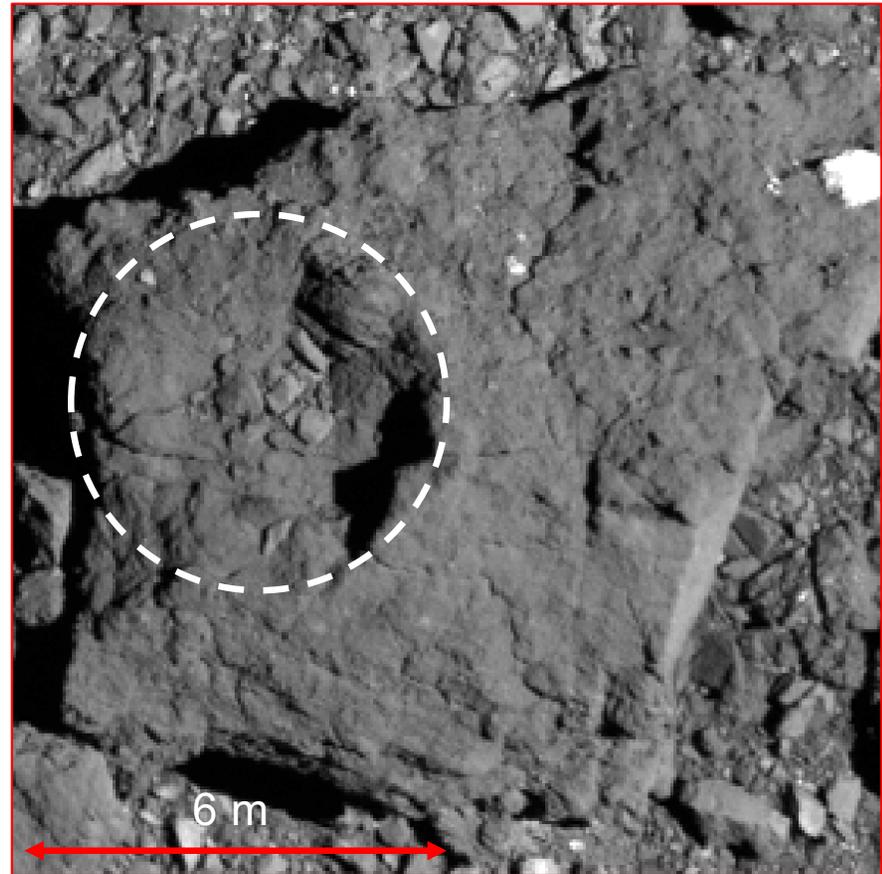
Results: Observations of Craters on Bennu's Boulders:

created by impacts from meteoroids

Craters on solid rock from an extra-terrestrial body were last measured on Apollo samples:



Hörz et al. (1975)



The crater highlighted is 5m wide

OCAMS/OSIRIS-REx/UA/NASA

Results: The Strength of Solid Boulders

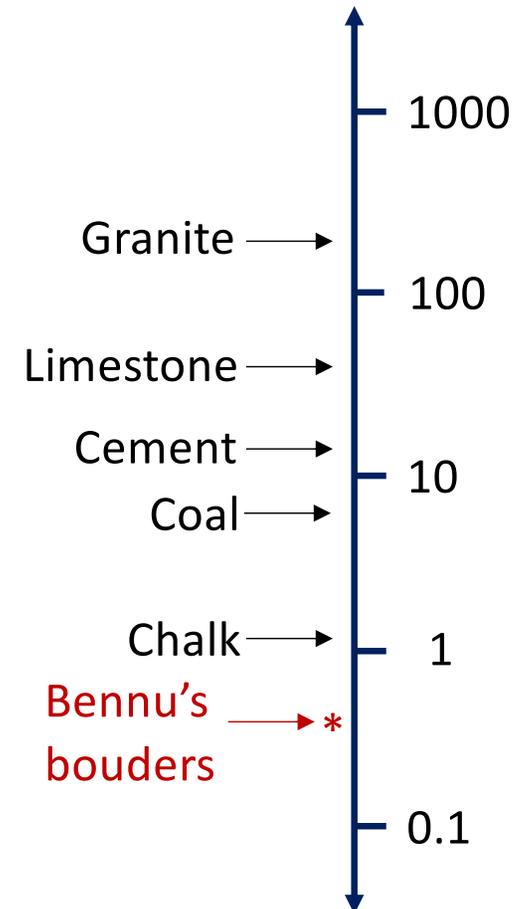
Craters can tell us about the properties of both the target and the projectile:

1. Develop a technique to quantify the strength of solid objects using craters.

Bennu's 1-m boulders have a compressive strength of ~ 0.5 MegaPascals (MPa)*.

2. Use the boulders as witness plates to understand Bennu's history.

Compressive Strength (MPa)



Results: Bennu's lifetime as a near-Earth Asteroid

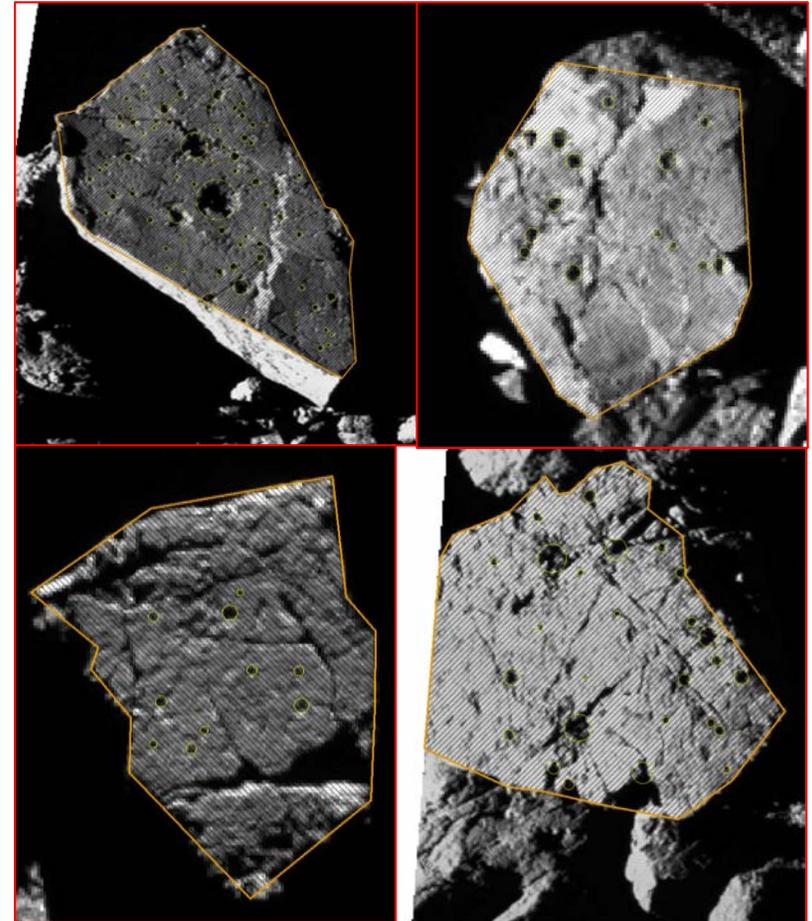
Craters can tell us about the properties of both the target and the projectile:

1. Develop a technique to quantify the strength of solid objects using craters.

Bennu's 1-m boulders have a compressive strength of ~ 0.5 MegaPascals (MPa)*.

2. Use the boulders as witness plates to understand Bennu's history.

Bennu's boulders have been exposed to impacts for 1.75 ± 0.75 Million years.



OCAMS/OSIRIS-REx/UA/NASA

Implications: The Strength of Solid Asteroids

1. Bennu's 1-m boulders have a compressive strength of ~ 0.5 MegaPascals (MPa).

“A catalog that is 90% complete for [Potentially Hazardous Objects] larger than 140 meters, which corresponds to characterizing 90% of the impact risk of sub-global effects” – Near-Earth Object Science Definition Team



Chelyabinsk meteor fireball (20 m)



Otohime Boulder on Ryugu (160 m)
Sugita et al. (2019)

Implications: The lifetime of near-Earth Asteroids

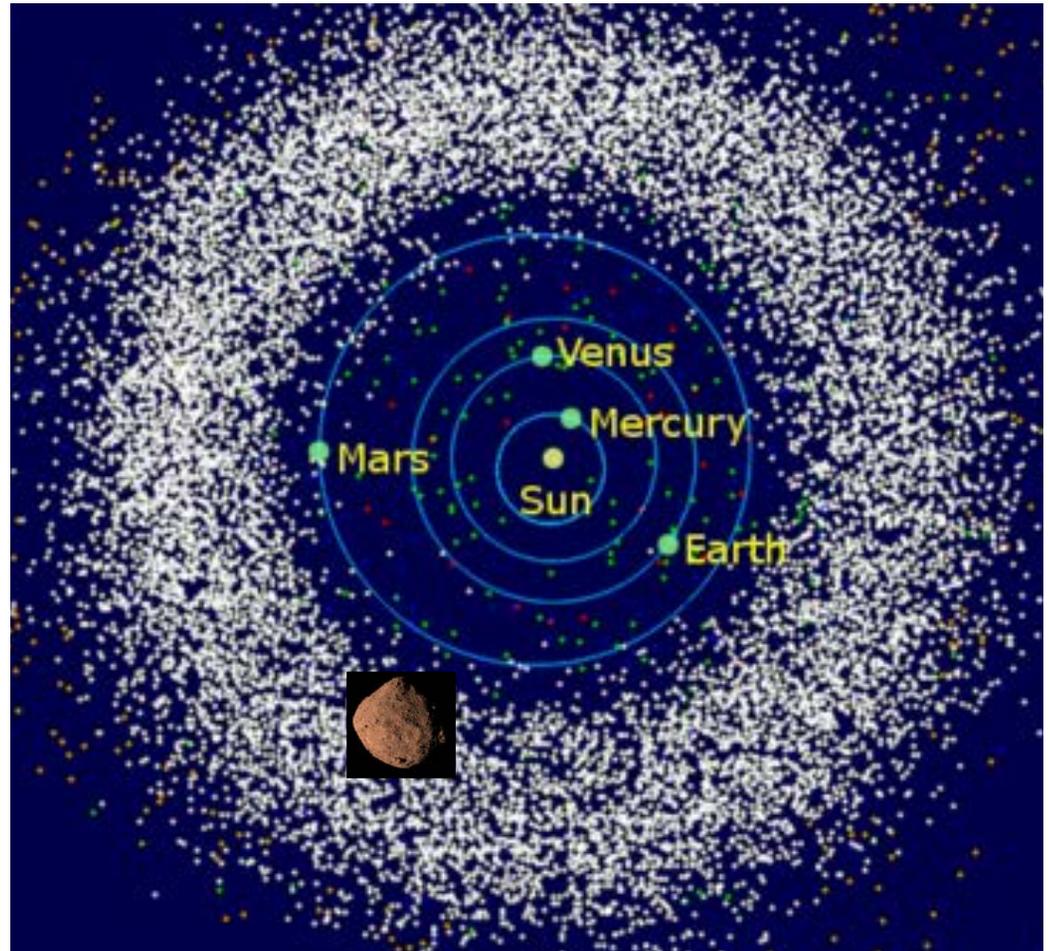
2. Bennu's boulders have been exposed to impacts for 1.75 ± 0.75 Million years

This tracks Bennu's lifetime as a near-Earth asteroid:

Validates decades of theoretical studies that show the short lifetimes of near-Earth asteroids (NEAs), compared to the age of the Solar System.

*email: rballouz@orex.lpl.arizona.edu

mobile: +1 203 673 9068



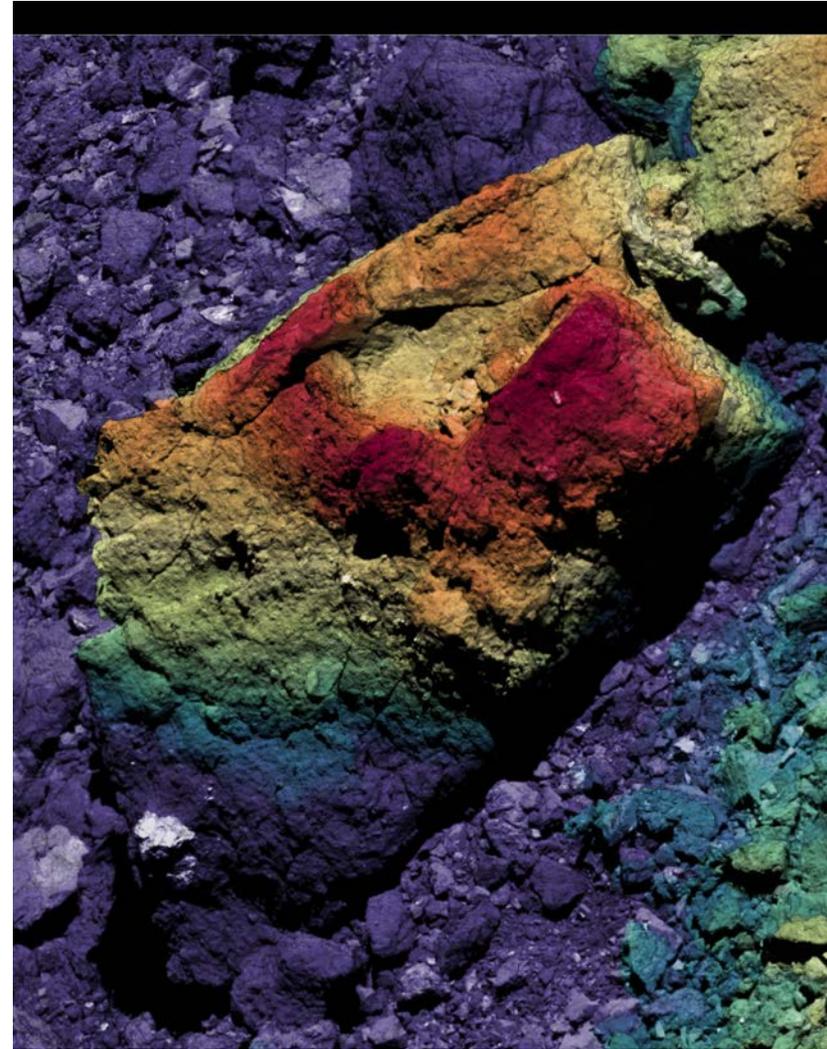
NASA/JPL

Summary

- Report on the discovery of craters on asteroid Bennu's boulders.
- Develop a technique to quantify the strength of solid objects using remote observations of craters on their surfaces.
- Use the boulders as witness plates to estimate Bennu's lifetime in Near-Earth space.
- Please see Ballouz et al. (2020), *Nature*, for a more detailed description of this work.

- This material is based upon work supported by NASA under contract NNM10AA11C issued through the New Frontiers Program.
- We are grateful to the entire OSIRIS-REx Team for making the encounter with Bennu possible.

*email: rballouz@orex.lpl.arizona.edu



OCAMS & OLA data of crater on boulder, OSIRIS-REx/UA/NASA