OSIRIS-REx
ASTEROID SAMPLE RETURN MISSION

Science Highlights from the OSIRIS-REx Mission and Predictions for the Returned Sample

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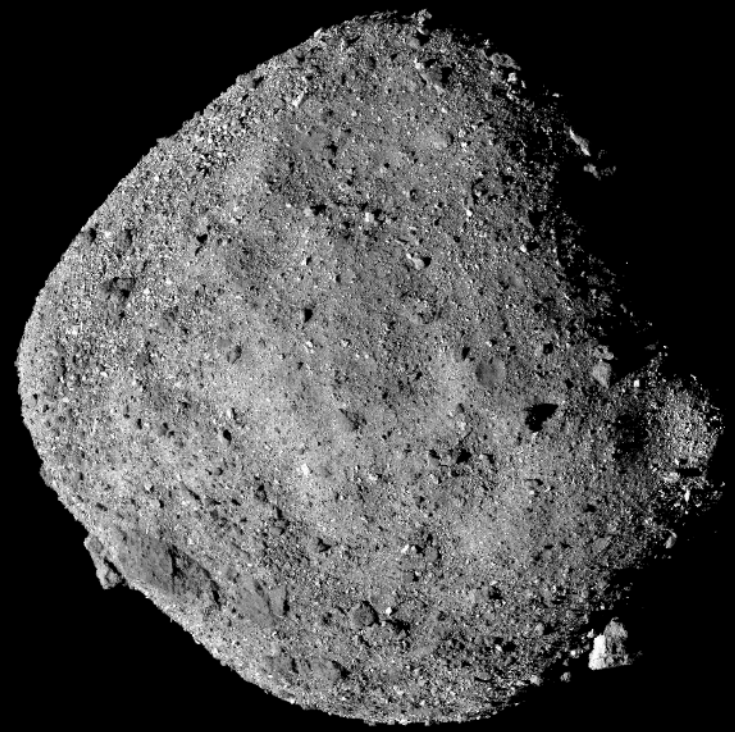
The OSIRIS-REx Mission Objectives

- Origins, Spectral Interpretation, Resource Identification, Security - Regolith Explorer

- *Primitive asteroids are a time capsule that are the best record of what was happening in our Solar System 4.567 billion years ago*

- OSIRIS-REx's key science objectives:
  - Return and analyze a sample of pristine, carbonaceous, early Solar System material from Bennu's surface
    - 60 g (about 30 sugar packets)
  - Map the asteroid's composition and geology
  - Measure the factors that change potentially hazardous asteroid orbits over time
  - Compare observations at the asteroid to ground-based observations

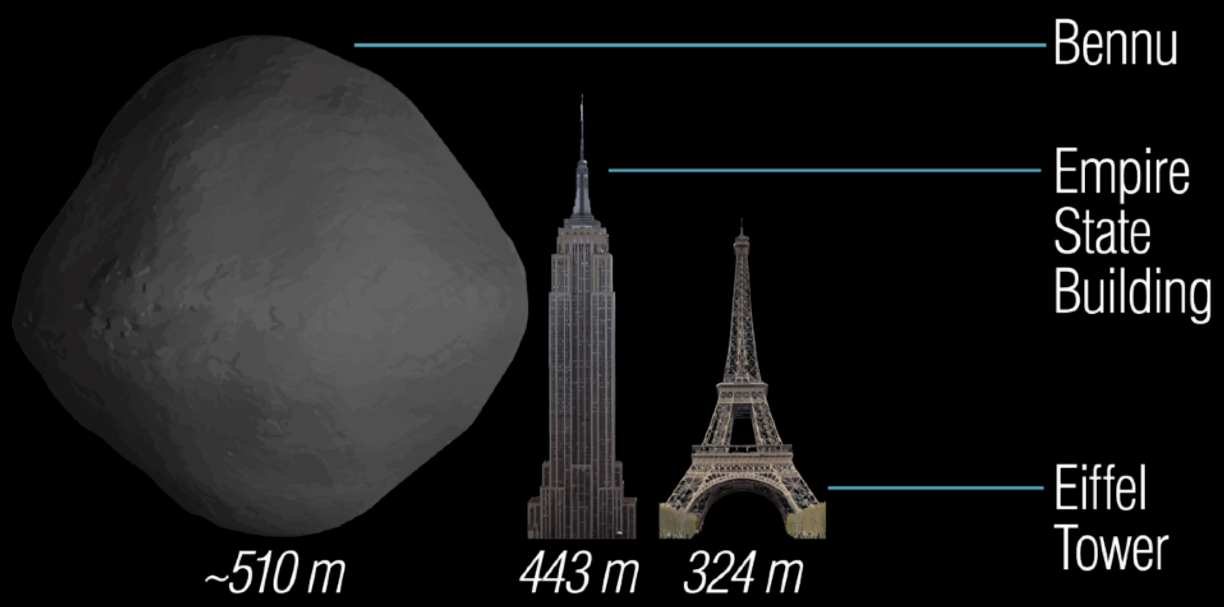


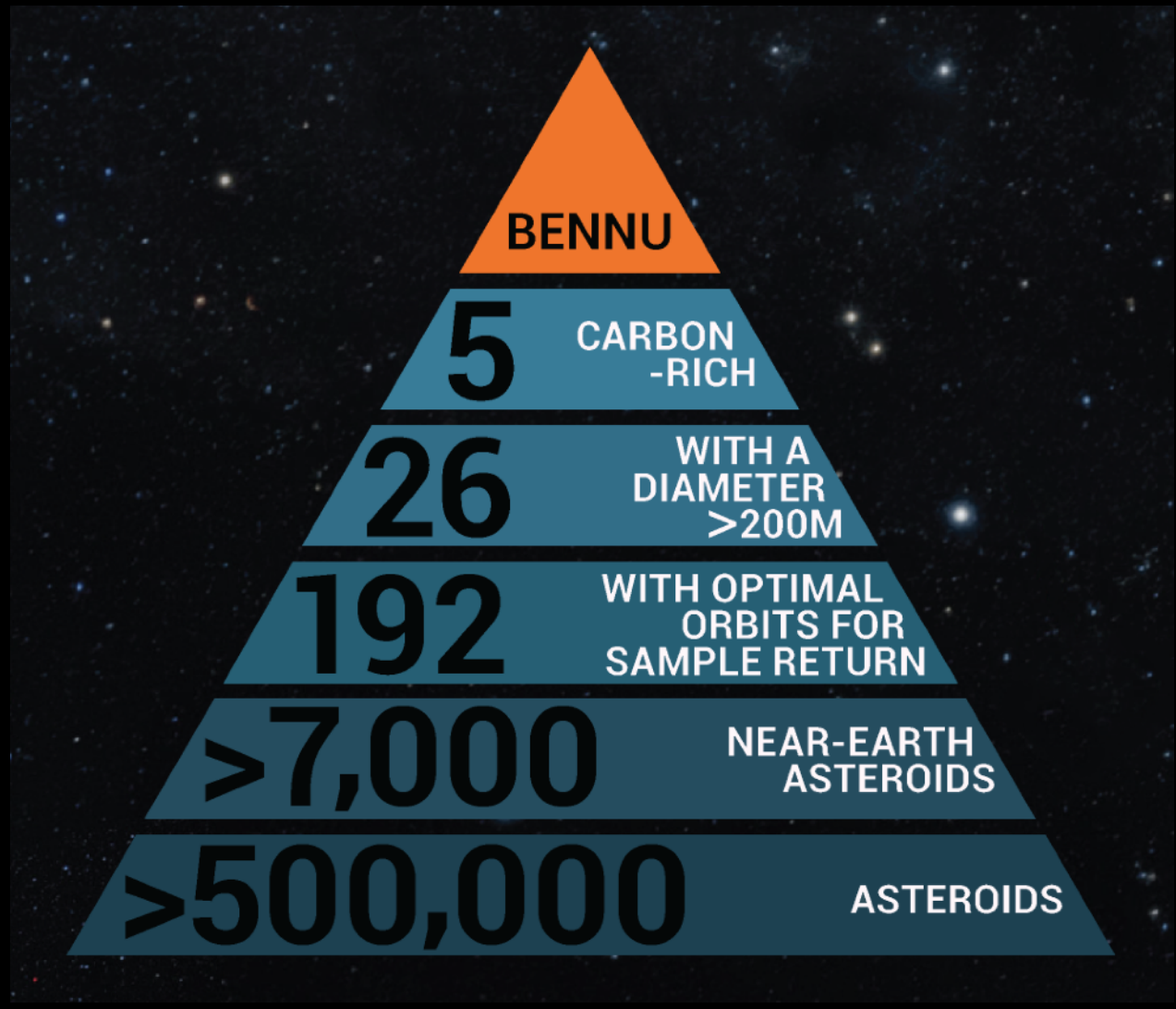
Carbonaceous Chondrites

- A type of carbon-enriched, stony meteorite whose parent body was never melted
- Formed in the solar nebula by sedimentary processes and contain chondrules (solidified droplets of silicate magma)
- The most primitive meteorites, although some have been altered by water and/or heat and come from a number of different parent bodies
- Variously comprised of silicate, oxide, carbonate, and sulfide minerals plus organic compounds
  - Up to 22% by weight of water in some groups (CI, CM)
- *Why aren't meteorites good enough?*

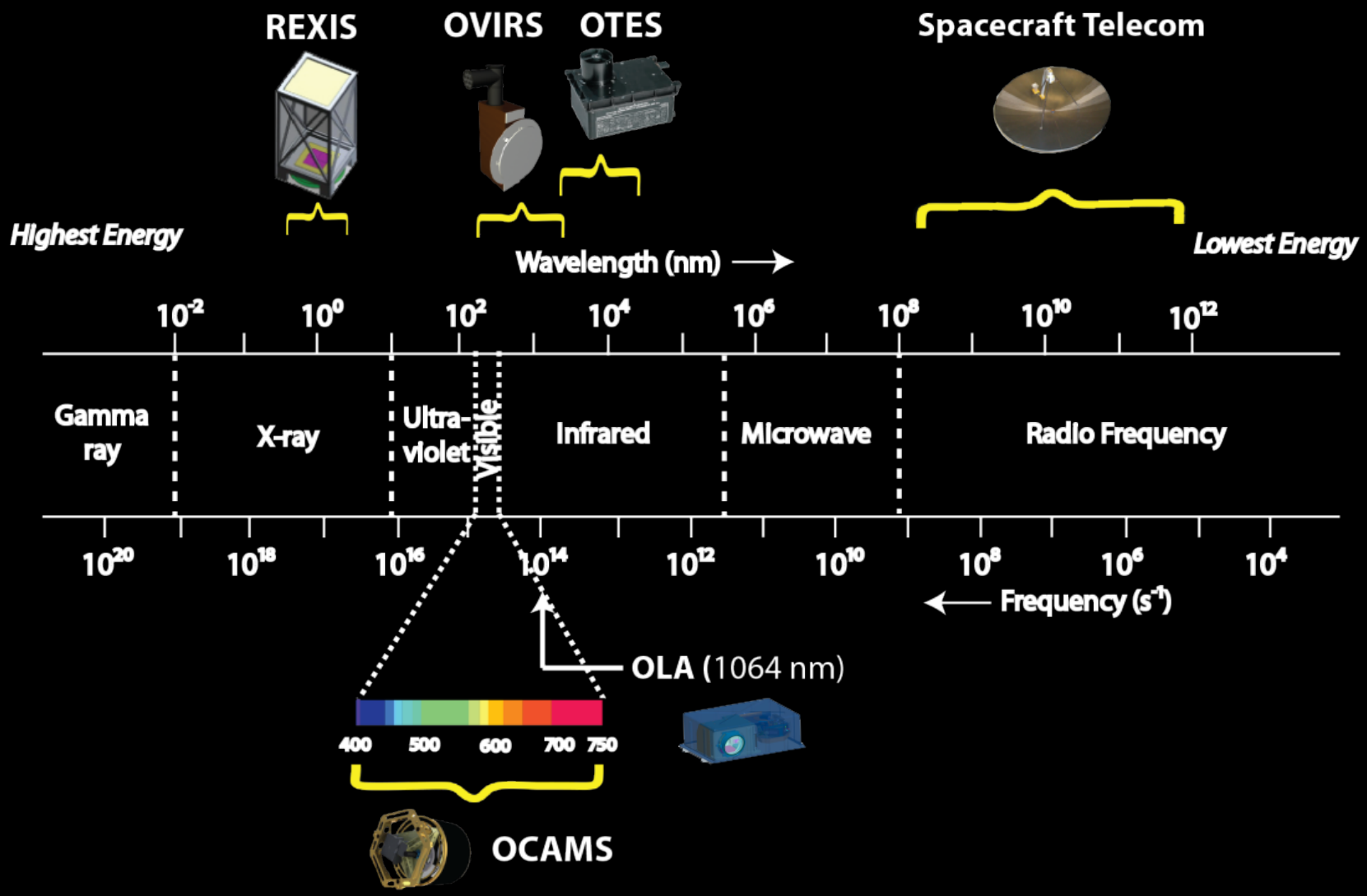
Orgueil (CI1)

Asteroid Bennu



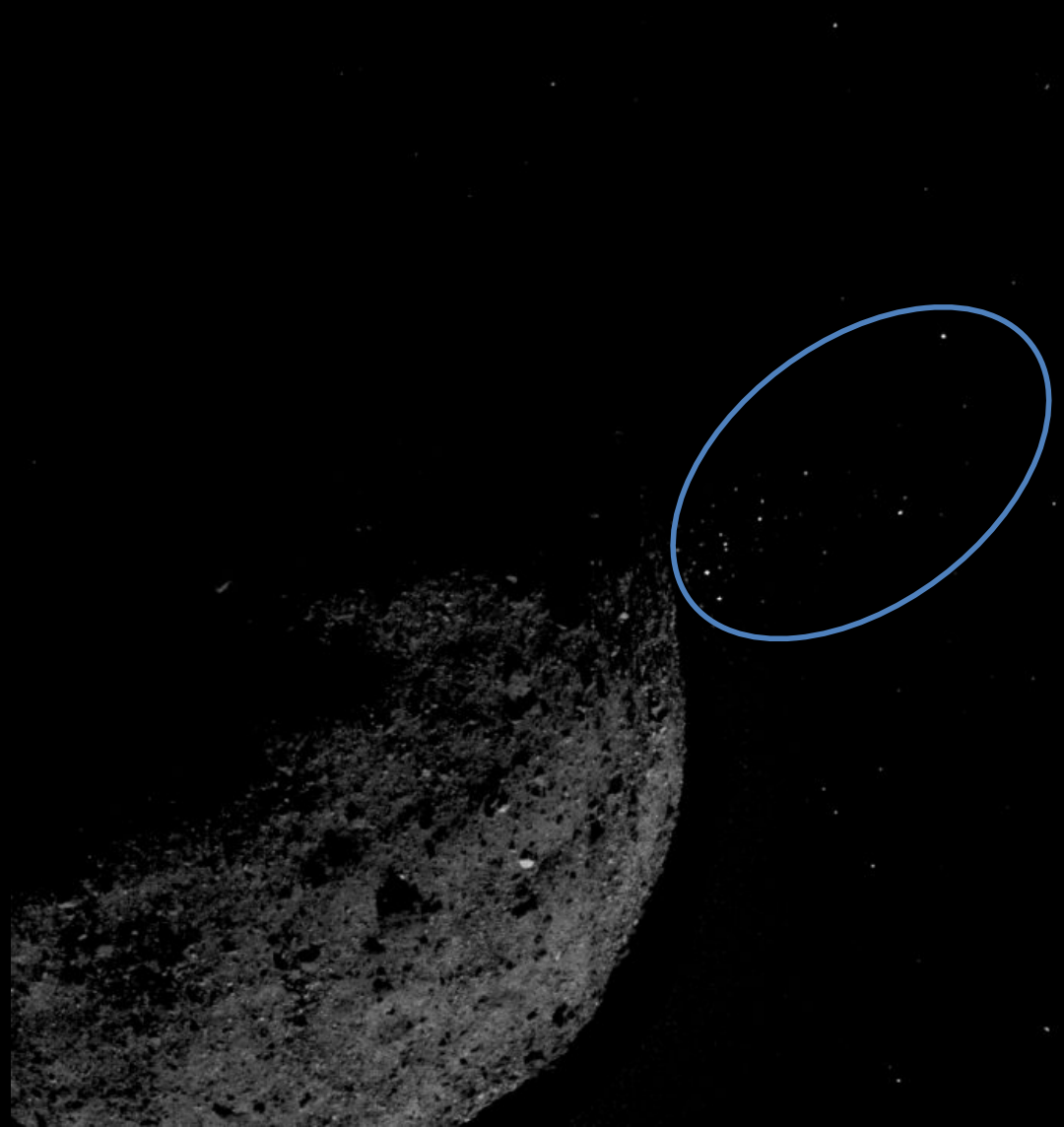


The OSIRIS-REx instruments

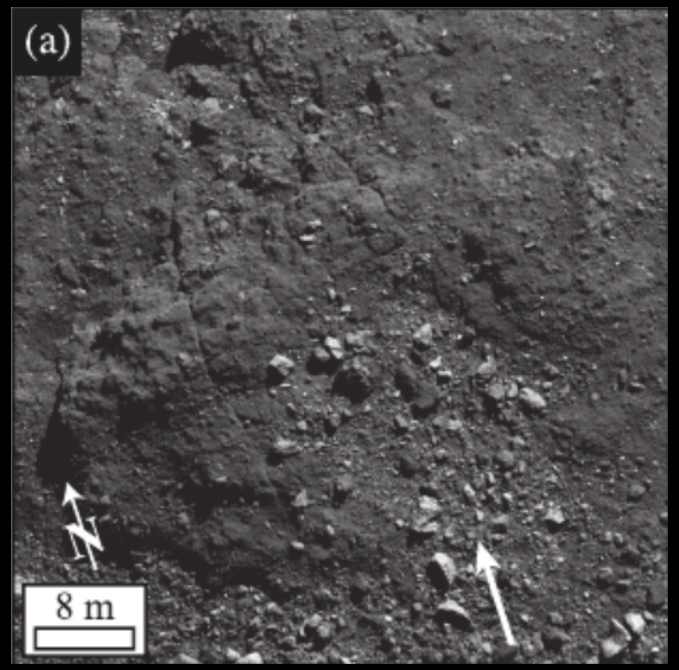


Discoveries - Bennu is Ejecting Particles

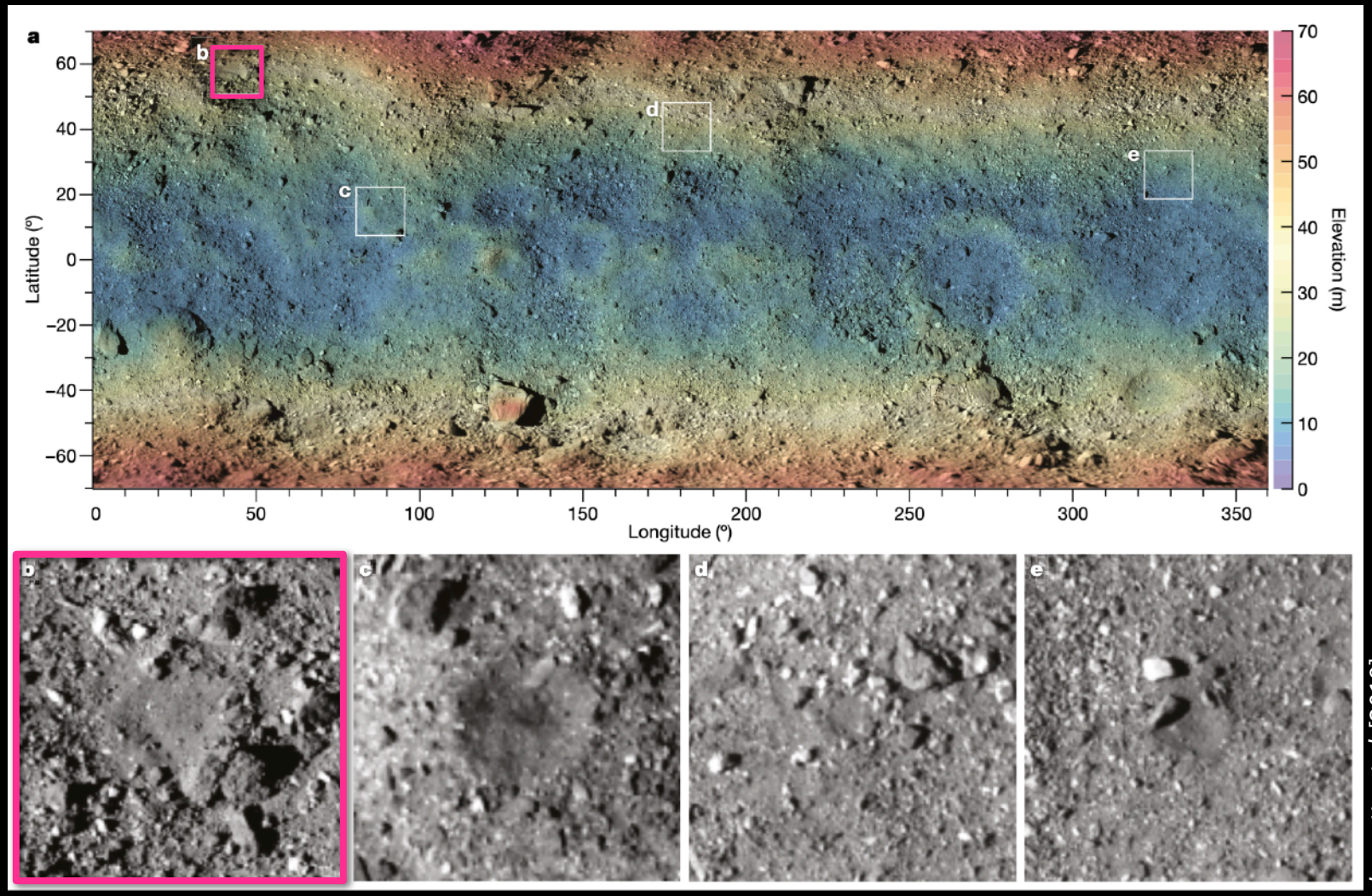
- We think of most asteroids as dead rocks, but Bennu proved us wrong
  - 1-10 cm rocks are regularly ejected
  - Could be due to thermal fracturing, release of water in minerals, meteoroid impacts
  - Larger mass loss ejections have been observed previously, but not on small scales like this
  - We have an unexpected front-row seat to a process that is partially responsible for how asteroids evolve and are ultimately destroyed



Discoveries - Bennu is Old and Dynamic



Jawin et al. [2020]

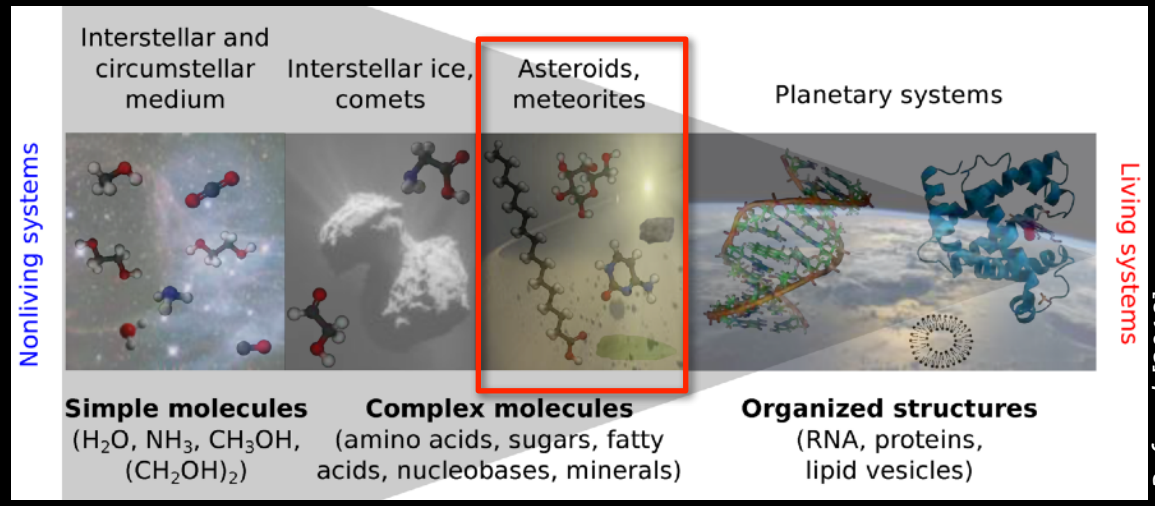


Lauretta et al. [2019]

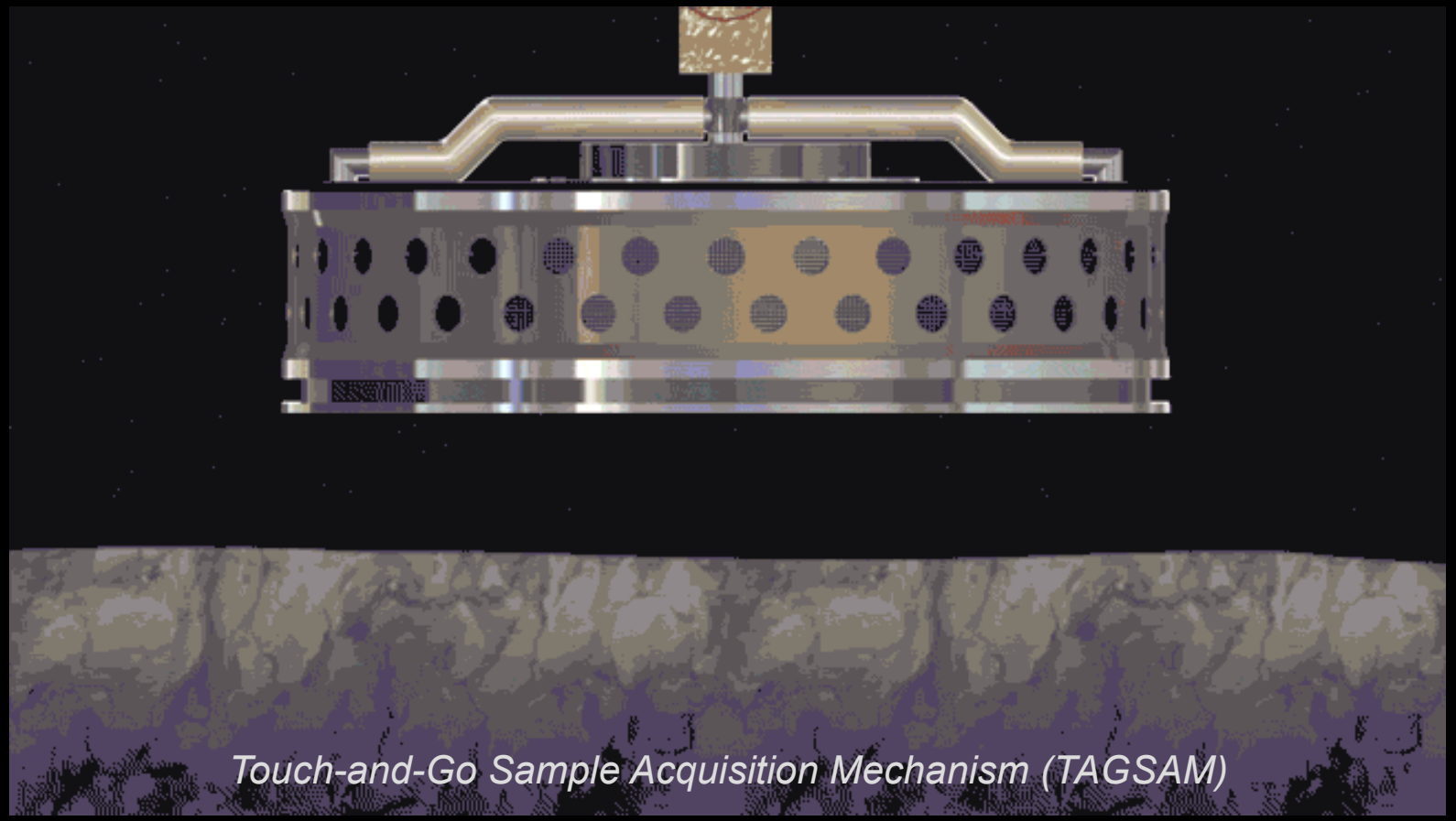
Nightingale crater - TAG site

Discoveries - Bennu's Watery, Organic-Rich Past

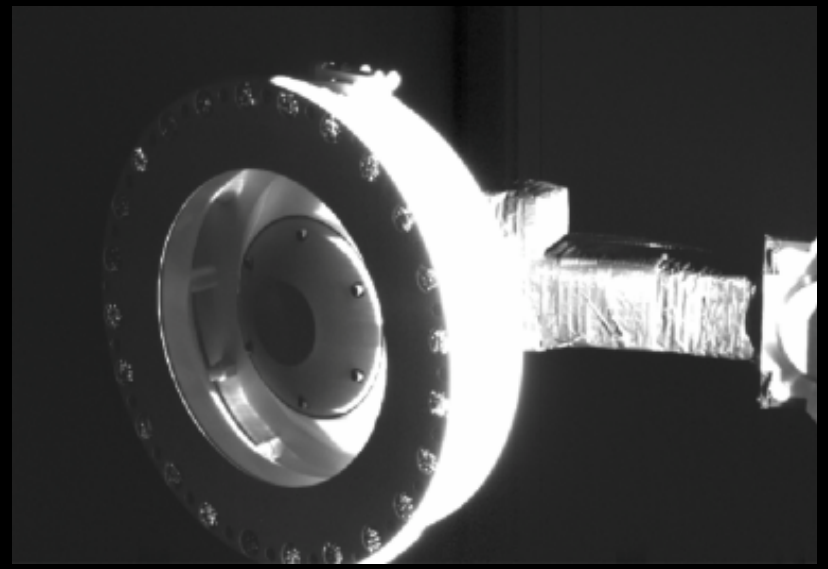
- Bennu's composition is diverse, but uniformly distributed at the scale of s/c observations
- Bennu is made up primarily of minerals that form in the presence of water
  - The returned sample will allow us study these minerals in detail, some of which preserve this ancient water
- We also see pre-biotic organic compounds
  - Information about the early inventory of organic molecules in the Solar System that ultimately contributed to the development of life on Earth

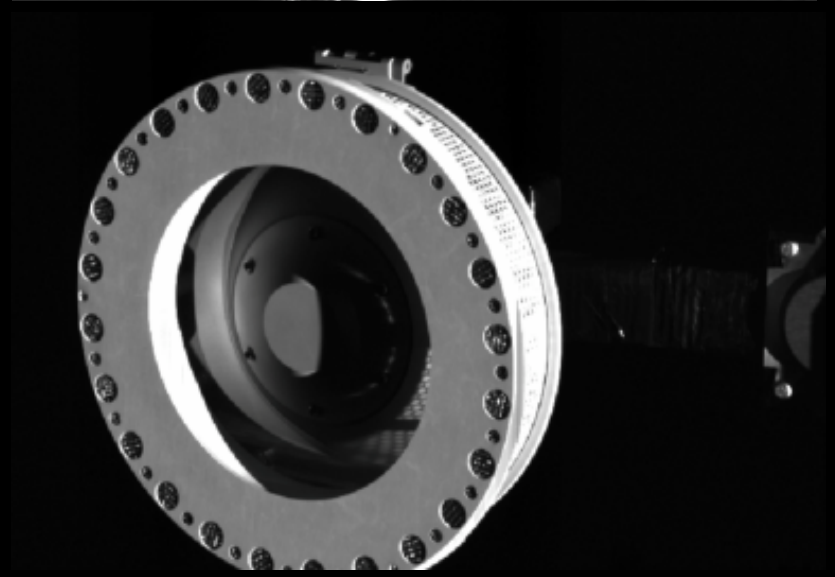


Touch and Go

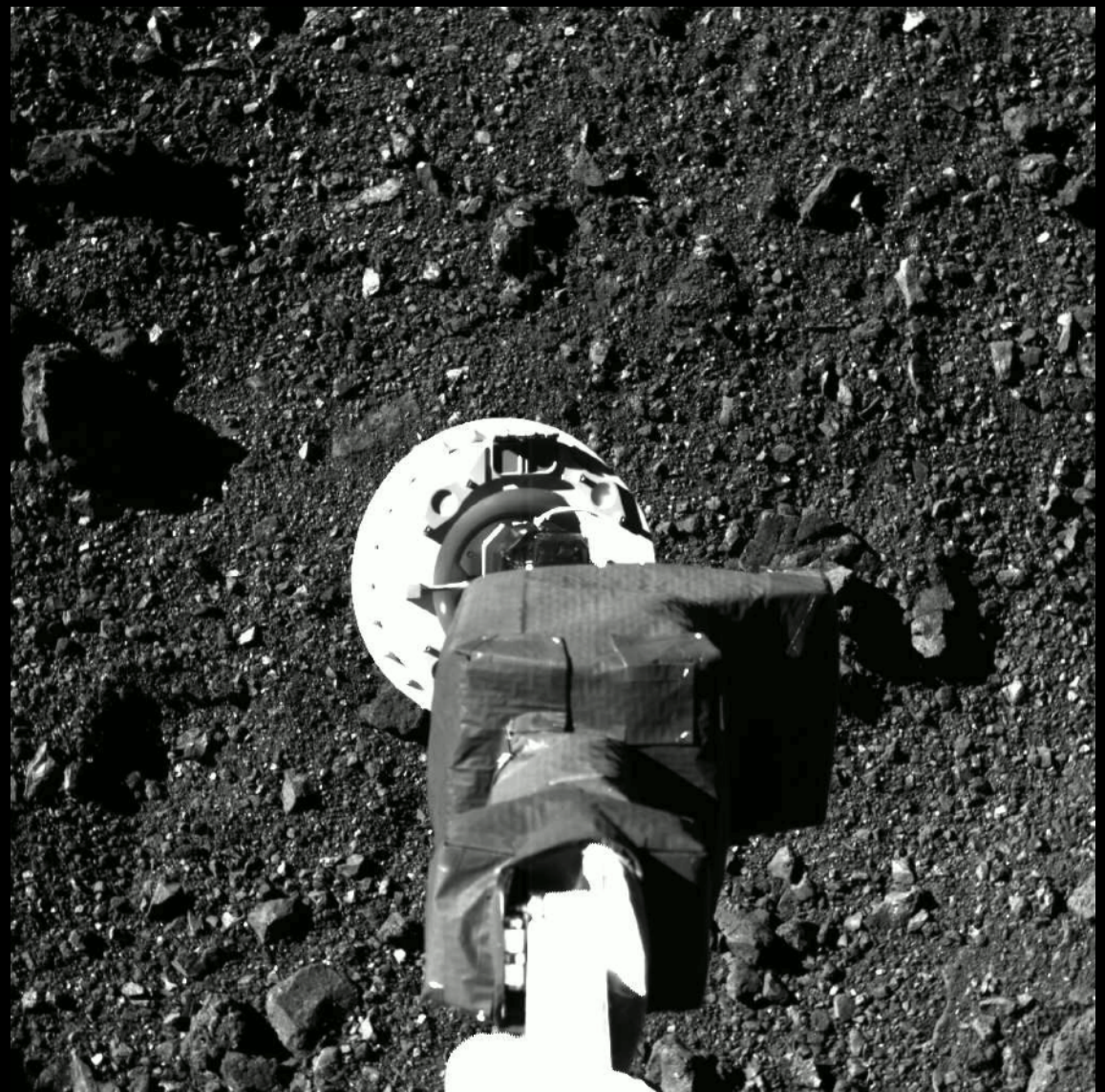


Touch-and-Go Sample Acquisition Mechanism (TAGSAM)

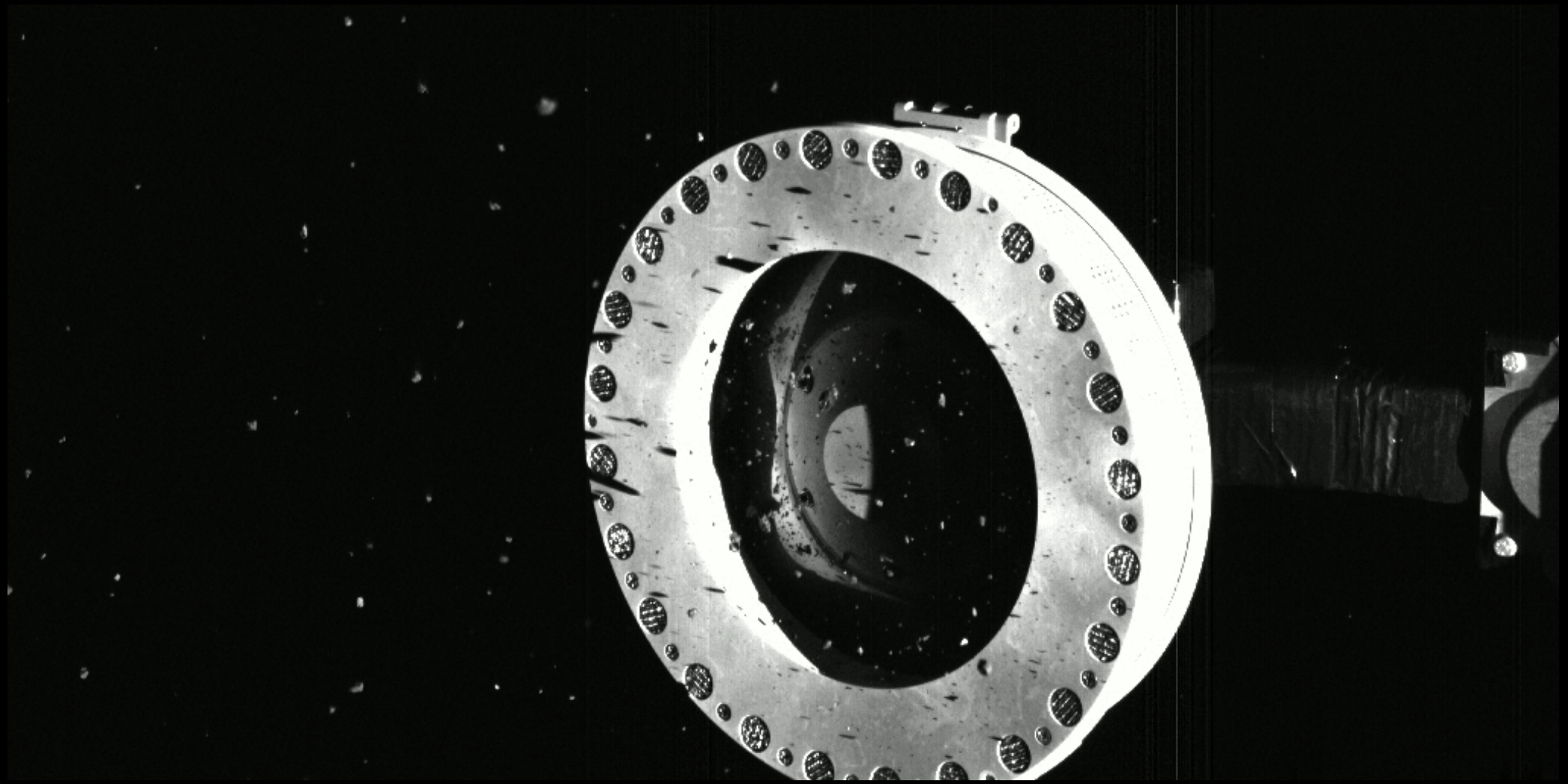




TAG at Nightingale



Now Stow!



Predictions for the Returned Sample

- We expect to get a LOT of material, potentially hundreds of grams
- There is spectral evidence for the presence of both solid/coarse materials as well as fine particulates (<~100 µm) and we expect to sample a range of particle sizes
  - Morphologies range from "flaky" to more coherent; expect low densities
- The sample should be dominated volumetrically by hydrous silicates with less than ~10 vol% anhydrous silicates
- Magnetite, carbonate, and organics should be present
- Based on spectral differences and physical properties, Bennu's surface materials may differ in composition from typical carbonaceous chondrites

DellaGiustina et al., 2020

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