

Asteroid Bennu



(NASA / GSFC / UA / Mike Nolan-Arecibo Observatory/
Bob Gaskell-Planetary Science Institute)

Simulated cratering and topography are overlaid on radar imagery of asteroid Bennu — one of the next asteroids to be visited up close by NASA's OSIRIS-REx mission. Click image for more information from University of Arizona News.

Asteroids Up Close

The importance of spacecraft missions in the quest to understand **asteroids** is highlighted in a recent review paper by Thomas Burbine (Mount Holyoke College, Massachusetts). Burbine discusses achievements in understanding the chemistries and mineralogies of asteroids since the launch of NASA's NEAR-Shoemaker robotic spacecraft in 1996, the first mission dedicated to asteroid exploration. As two new robotic asteroid-sample-return missions are underway (NASA's OSIRIS-REx and JAXA's Hayabusa2), Burbine's review paper and a review by Derek Sears earlier this year (see the January 2016 **PSRD CosmoSparks: [Comprehending Asteroids](#)**) provide timely recaps of why asteroids are so important to our understanding of the building blocks of our Solar System.

Burbine reviews these mission highlights:

- NEAR-Shoemaker (NASA mission) flew by (253) Mathilde, a C-complex asteroid. It orbited and landed on (433) Eros, an S-type asteroid, and used an X-ray spectrometer to determine elemental ratios, which were consistent with a body that did not melt globally. Most likely meteorite matches for Eros are surface-altered ordinary **chondrites** or primitive **achondrites**. For more see **PSRD** article: **[The Composition of Asteroid 433 Eros](#)**.
- Hayabusa (JAXA mission) was a touch-and-go mission to (25143) Itokawa, an S-complex asteroid. It carried a multiband imager, near-infrared spectrometer, laser altimeter, LIDAR, X-ray spectrometer, and a sample capsule. Grains returned to Earth for analysis confirmed Itokawa has an LL ordinary chondrite composition affected by **space weathering**. For more see **PSRD** article: **[Samples from Asteroid Itokawa](#)**.
- Dawn (NASA mission) orbited (4) Vesta and is orbiting dwarf planet (1) Ceres. Data from the visual and infrared spectrometer and gamma ray and neutron detector confirmed Howardite-Eucrite-Diogenite (**HED**) composition for Vesta. For more see **PSRD** article: **[Water in Asteroid 4 Vesta](#)**. Materials, including water and clays, on Ceres are under investigation; for more see last month's **PSRD CosmoSparks** report: **[Science Journal—Results using Dawn Image and Spectral Data from Dwarf planet Ceres](#)**.
- Hayabusa2 (JAXA mission) launched December 3, 2014 and is in transit to encounter (162173) Ryugu, a C-complex near-Earth-asteroid, in mid-2018. With a similar instrument suite (covering a broader spectral range) as Hayabusa, this new mission has a lander and three small rovers. Hayabusa2 also has a sampler system for returning samples to Earth in 2020.
- OSIRIS-REx (NASA's Origins, Spectral Interpretation, Resource Identification, Security and Regolith Explorer) launched September 8, 2016 and is in transit to encounter (101955) Bennu, a C-complex near-Earth-asteroid, in 2018. It has a touch-and-go sampler system for returning samples to Earth in 2023. The mission will also study the **Yarkovsky effect** to better understand how the asteroid's orbit evolves.

Interrogating asteroids from spacecraft flybys and orbits, returning samples from asteroid Itokawa, and the

anticipated return of samples from two more asteroids all build on the achievements of Earth-based and Earth-orbiting telescopic spectroscopy and meteorite sample analyses. Through the stunning success of pairing remote sensing data with laboratory analyses of actual samples, meteorites and asteroid pieces collected in situ and returned to Earth, we are truly beginning to understand asteroids up close.

See Reference:

- Burbine, T. H. (2016) Advances in Determining Asteroid Chemistries and Mineralogies, *Chemie der Erde*, v. 76, p. 181-195, doi: 10.1016/j.chemer.2015.09.003. [[abstract](#)]

Also:

- [PSRD archive of asteroid articles.](#)
- [JAXA's Hayabusa2 Mission.](#)
- [NASA's OSIRIS-REx Mission.](#)

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October 2016

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