

## OSIRIS Rex Sample Return and Preliminary Results

The enthusiasm after the successfully returned sample capsule of the OSIRIS REx (Origins, Spectral Interpretation, Resource Identification and Security – Regolith Explorer) satellite was quickly dampened by NASA’s sobering statement:

“After multiple attempts at removal, the team discovered two of the 35 fasteners on the TAGSAM (Touch-and-Go Sample Acquisition Mechanism) recovery capsule could not be removed with the current tools approved for use in the OSIRIS-REx glovebox.”[1]

The recovered capsule has been secured in a specialized sealed glovebox for opening because a constant flow of nitrogen ensures the sample is not contaminated by Earth’s present chemistry.

As a result, the methods available to NASA to access the sample are somewhat limited.

### *Sample Collection*

The image above shows the OSIRIS REx spacecraft with extended TAGSAM and the sample collection head at the very end of the arm descending on the massive asteroid body like a thirsty mosquito (artist’s conception).

After more than four years of flight, on Oct. 20, 2020, OSIRIS REx unfurled its robotic arm, and in a first for NASA, briefly touched an asteroid - Bennu, to collect dust and pebbles from the surface for delivery to Earth in 2023.

At 1:50 p.m. EDT that day, OSIRIS-REx fired its thrusters to nudge itself out of orbit around Bennu. It extended the shoulder, then elbow, then wrist of its 11- foot (3.35-meter) sampling arm, known as the TAGSAM, and transited across Bennu while descending about a half-mile (805 meters) toward the surface. After a four-hour descent, at an altitude of approximately 410 feet (125 meters), the spacecraft executed the “Checkpoint” burn, the first of two maneuvers to allow it to precisely target the sample collection site, known as “Nightingale” in the Hokioi crater.

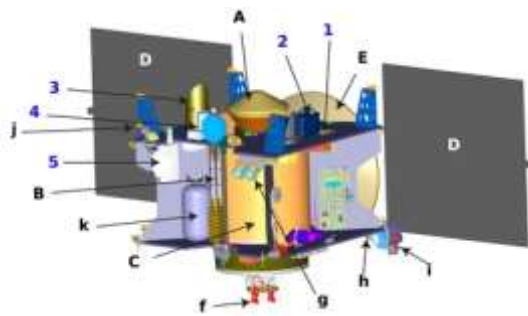
Ten minutes later, the spacecraft fired its thrusters for the second “Matchpoint” burn to slow its descent and match the asteroid’s rotation at the time of contact. It then continued a treacherous, eleven-minute coast past a boulder the size of a two-story building, nicknamed “Mount Doom,” to touch down in a clear spot in a crater on Bennu’s northern hemisphere. The size of a small parking lot, the site “Nightingale” site is one of the few relatively clear spots on this unexpectedly boulder covered space rock. Real-time data indicated the TAGSAM *successfully contacted the surface and fired a burst of nitrogen gas*. The gas stirred up dust and rocks on Bennu’s surface, some of which were captured in the TAGSAM *sample collection head*. This collection head then was placed into the opened return capsule and sealed shot to be returned to Earth (see also youTube animation, Ref. [3]).

The spacecraft carried out the sample collection sequence autonomously, with pre-programmed instructions from the ground control team – a navigational masterpiece of touch-and-go maneuvering! Lockheed Martin Space provided flight operations, built the spacecraft and developed TAGSAM.

With the successful return flight of the Bennu samples to Earth the OSIRIS REx mission continues: About 20 minutes after the OSIRIS-REx spacecraft released its sample return capsule to enter the atmosphere and drop down to the designated landing zone at the Department of Defense’s Utah Test and Training Range via parachute, the spacecraft fired its engines to set off on a new mission to explore asteroid Apophis under a new name: OSIRIS-APEX (OSIRIS–Apophis Explorer). OSIRIS-



APEX will reach Apophis in 6 years, in 2029, just after the asteroid makes its closest approach to Earth. [4]

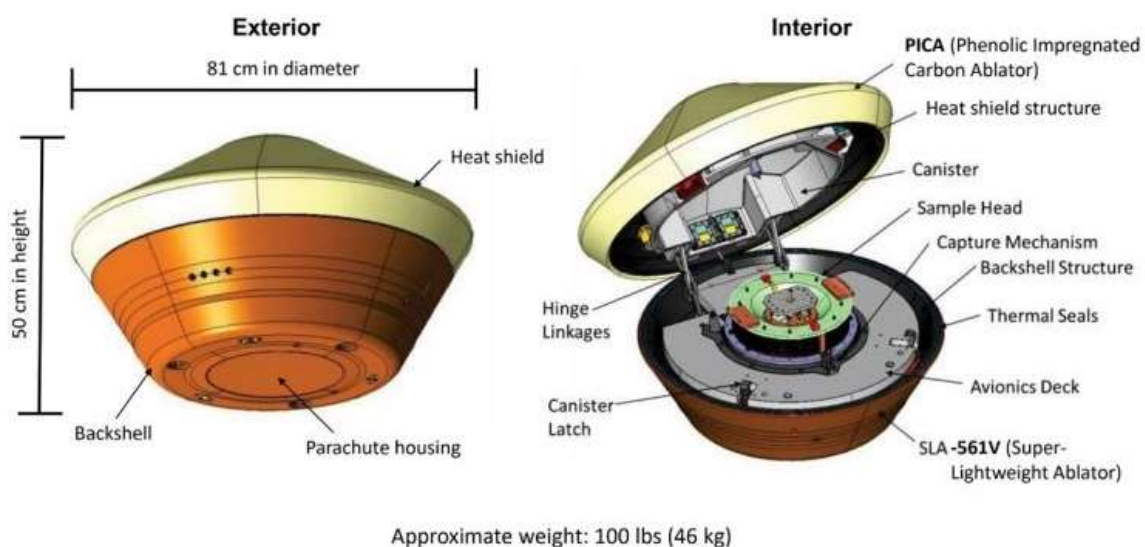


### *OSIRIS REx Spacecraft*

*A Return Capsule, B TAGSAM with Sample Collection Head (light blue), C Spacecraft Body, D Solar Modules, E Parabolantenna, f Propulsion, g Starsensors, h Antenna, j Antenna, k Heliumtank;*

*Science Instruments: 1 Lidar , 2 OLA, 3 OCAMS, 4 OTES, 5 OVIRS [4]*

### *Return Capsule with Sample Collection Head inside [4]*



### *Preliminary Results*

As mentioned above, NASA has been struggling to open the canister containing rocks and dust collected from Bennu ever since the container landed on Earth. As of the writing of this report (Jan. 2024) the space agency now anticipates that the asteroid sample canister will be opened sometime in the next couple of months, as engineers fashion new tools to help crank it open while still preserving the pristine rocks.

However, the team did manage to collect some material from outside the TAGSAM sample collection head. When the aluminum lid to the sample capsule was first removed, team members found black dust and debris on the avionics deck of the canister. They also removed some of the material from inside the canister with tweezers or a scoop while holding down the TAGSAM head's mylar flap.

Scientists performed an early analysis of the asteroid sample and found an abundance of carbon and water molecules, supporting the theory that the building blocks of life may have made their way to Earth via asteroids. [5]

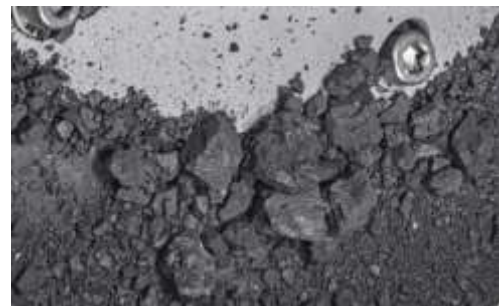
“The OSIRIS-REx sample is the biggest carbon-rich asteroid sample ever delivered to Earth and will help scientists investigate the origins of life on our own planet for generations to come,” said NASA Administrator Bill Nelson. “Almost everything we do at NASA seeks to answer questions about who we are and where we come from. NASA missions like OSIRIS-REx will improve our understanding of asteroids that could threaten Earth while giving us a glimpse into what lies beyond. The sample has

made it back to Earth, but there is still so much science to come – science like we’ve never seen before.” [5]

The plan is for the curation team at NASA’s Johnson Space Center to extract and weigh the entire sample material, create an inventory of what’s inside, and distribute pieces of Bennu to an international sample analysis team of more than 200 members from more than 35 globally distributed institutions.

The samples will be distributed as follows:

- The JSC curation team will have access to about 25% of the returned sample to achieve the mission’s science goals.
- 4% of the total returned sample will be delivered to the CSA (the Canadian Space Agency), which contributed the OSIRIS-REx Laser Altimeter (OLA) instrument aboard the spacecraft, and which supports the Canadian co-investigators on the OSIRIS-REx science team.
- 0.5% of the total returned sample will be delivered to JAXA (Japan Aerospace Exploration Agency) as part of a partnership between the two space agencies that includes NASA support for the Hayabusa2 mission and the exchange of scientists and samples between the two missions.
- A portion of the Johnson-curated material will be sent to a secure backup facility in White Sands, New Mexico, similar to the procedure followed for the Apollo Moon rocks.
- The remainder of the sample will be publicly available for analysis by request by scientists around the world and curated such that a large fraction will be stored and available to future generations of researchers. [4]



*Returned capsule after heat shield opening with debris from asteroid Bennu on the outside of the OSIRIS-REx sample collector head Screenshot: NASA TV and [1]*

## References

- [1] <https://blogs.nasa.gov/osiris-rex/2023/10/#:~:text=After%20multiple%20attempts%20at%20removal,in%20the%20OSIRIS%20REx%20lovebox.>
- [2] image return capsule : screenshot from press kit [4]
- [3] Animation Sample acquisition Youtube [https://www.google.com/search?q=touch-and-go+sample+acquisition+mechanism+\(tagsam\)+osiris-rex&oq=Touch-and-Go+Sample+Acquisition+Mechanism&gs\\_lcrp=EgZjaHJvbWUqBwgDEAAyAQyBwgAEAAyAQyBwgBEAAyAQyBwgCEAAyAQyBwgDEAAyAQyBwgATSAQg3ODYwajBqN6gCALACAA&sourceid=chrome&ie=UTF-8#fpstate=ive&vld=cid:c3f2efa6,vid:NjIGYHJ2560,st:0](https://www.google.com/search?q=touch-and-go+sample+acquisition+mechanism+(tagsam)+osiris-rex&oq=Touch-and-Go+Sample+Acquisition+Mechanism&gs_lcrp=EgZjaHJvbWUqBwgDEAAyAQyBwgAEAAyAQyBwgBEAAyAQyBwgCEAAyAQyBwgDEAAyAQyBwgATSAQg3ODYwajBqN6gCALACAA&sourceid=chrome&ie=UTF-8#fpstate=ive&vld=cid:c3f2efa6,vid:NjIGYHJ2560,st:0)
- [4] <https://science.nasa.gov/wp-content/uploads/2023/09/osirisrexpkit-2023.pdf>
- [5] <https://www.nasa.gov/news-release/nasas-bennu-asteroid-sample-contains-carbon-water/>