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DIGEST

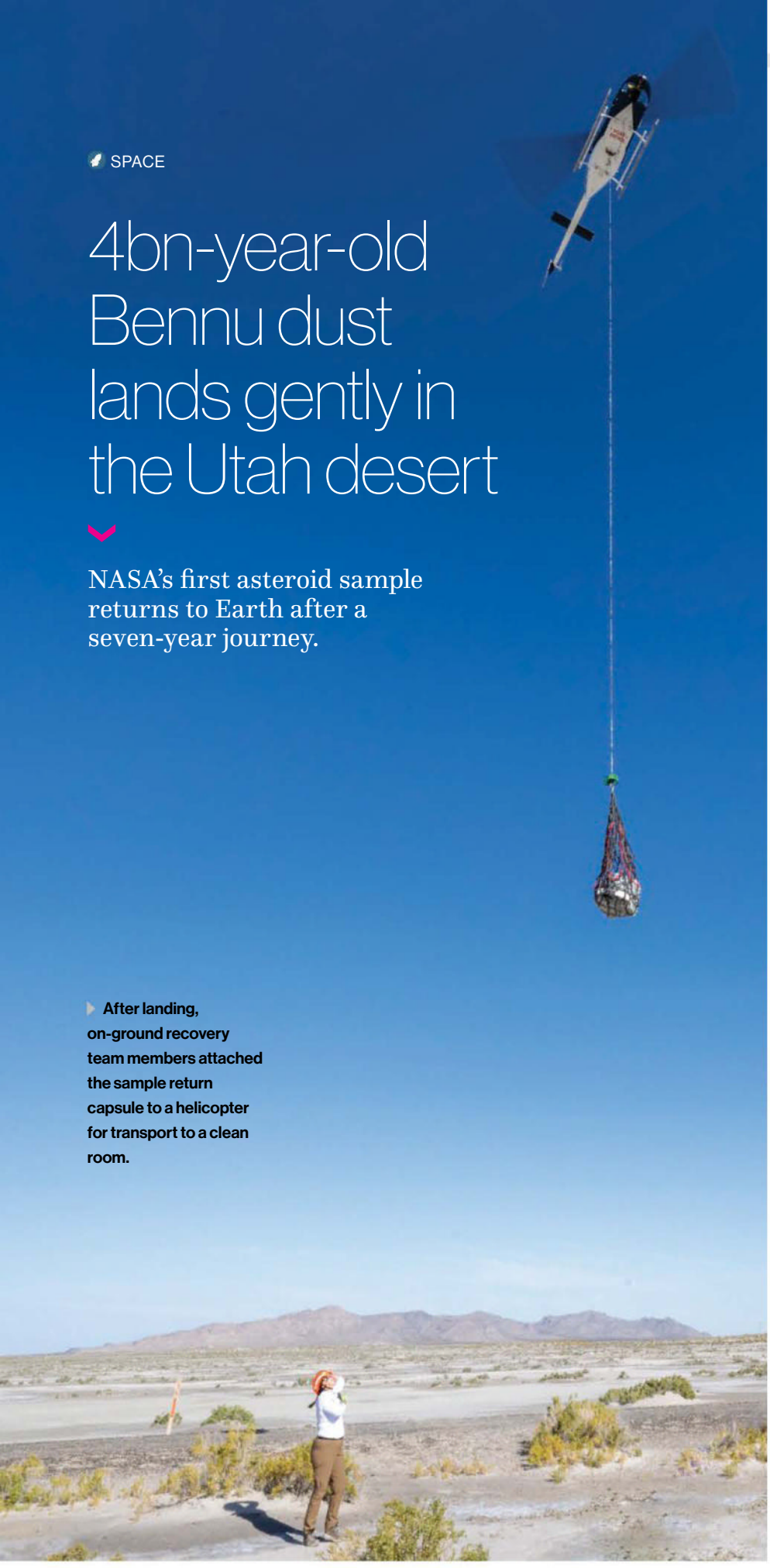
On Sunday 24 September, 2023, the sample return capsule of NASA's OSIRIS-REx mission touched down in the Utah desert. Inside: part of an asteroid.

KEEGAN BARBER / NASA

SPACE

4bn-year-old Bennu dust lands gently in the Utah desert

NASA's first asteroid sample returns to Earth after a seven-year journey.



After landing, on-ground recovery team members attached the sample return capsule to a helicopter for transport to a clean room.

KEEGAN BARBER / NASA

IT MIGHT have been a scene from a sci-fi movie. Helicopters converging on an object fallen from outer space into a stark, desert landscape. People in gas masks cautiously approaching, checking to see if it's safe.

But science fiction it wasn't. This was the long-awaited return of NASA's OSIRIS-REx mission. Launched in 2016, the spacecraft rendezvoused with asteroid 101955 Bennu in 2018, delicately scooped out material from one of the few flat spots it could find, then headed back to Earth to deliver its cargo to waiting scientists.

The object that landed in the desert was a 45kg capsule released by OSIRIS-REx as it sped by Earth at 45,000km/h, already on its way to its next destination: a hoped-for rendezvous in 2029 with another asteroid, 99942 Apophis.

But the capsule was by far the most important part of the mission. This precious payload entered the atmosphere like a fiery meteor, deployed its parachute and gently plopped onto the mud flats of America's Utah Test and Training Range slightly before 9am local time on 24 September. It landed about 8km east of its target landing zone – a predicted deviation based on weather forecasts of landing-day atmospheric density and wind speed.

"I was really excited," says Mike Moreau, NASA's deputy project manager for the mission. "[The forecasters] told me exactly where it was going to land, and that's where it ended up."

The capsule came down light as a feather, barely denting the soft desert surface, perfectly upright waiting to be collected ... and right near a road that provided a convenient helicopter landing zone. "Boy did we stick that landing," says Dante Lauretta, the mission's principal investigator. "It didn't roll, didn't bounce, it just made a tiny little divot in the Utah soil."

The only glitch was that the first parachute, a small drogue designed to pull out the main chute, may have been slow to fully deploy. But it worked, and – more importantly – so did the main chute.

When Lauretta heard the main chute had deployed, he says, "I literally broke into tears because that was the moment I knew we made it home."

After the capsule hit the dirt, on-ground recovery team members approached with caution. The Utah Test and Training Range is an active military base – plus, the capsule had recently entered the atmosphere at a very high velocity; the heat shield would have hit a peak temperature in the vicinity of 2,800°C (5,000°F). The capsule also contained a battery that might have ruptured and released toxic gases

As it was, it all went swimmingly. Nobody was blown up, burned or poisoned. Within minutes a member of the team had given the thumbs up and removed his gas mask, and an hour after that, a helicopter carried the capsule to a clean room where it was flushed with nitrogen to drive out Earth air and soon disassembled to retrieve the sample container deep inside it.

The container was then transferred to the Johnson Space Center in Houston and opened. So far, 70.3 grams of Bennu material have been removed, with much more to come as scientists carefully delve into the bulk of the sample. While this isn't the first asteroid sample to be returned to Earth (JAXA's Hayabusa beat NASA to it), it is already the largest.

Portions of the sample will be parcelled out to a wide range of scientists. "We have over 200 researchers using 60 different analytical techniques to interrogate this material," Lauretta says. But much of it will be saved for study in years and decades to come, with methods undreamed of today.

"Those are going to be a treasure for scientific analysis for years and years to come, to our kids and our grandkids, and people that haven't even been born yet," says Lori Glaze, Director of NASA's Planetary Science Division.

The mission is part of a larger NASA project to study asteroids and other small bodies throughout the Solar System, looking for clues to how our Solar System formed – clues that Glaze describes as relating to various chapters of "our origin story".

In the case of the Bennu, she says, "scientists believe that [it] is representative of the Solar System's oldest material, forged in large, dying stars and supernova explosions" – that is, our origins all the way down to the atomic level.

SPACE

"Bonus sample" in OSIRIS-REx canister

THOUGH THE heart of the OSIRIS-REx sample return canister, called the TAGSAM, has not yet been opened, its exterior contained an unexpected gift.

Scientists found extra asteroid material sitting on the lid – it escaped when other rocks blocked the flap that was supposed to seal the inner container shut. With 70.3 grams weighed, the bonus sample alone is vastly greater than the 5.4 grams returned from asteroid Ryugu three years ago by Hayabusa2.

While the painstaking process of retrieving the main sample continues, the material tested so far proved to contain abundant water in the form of hydrated clay minerals, along with sulphur and magnetites. Excitingly, the sample was also 4.7% carbon by weight.

According to OSIRIS-REx sample analyst Daniel Glavin, "we picked the right asteroid. And not only that, we picked the right sample. This stuff is an astrobiologist's dream."

The water was locked inside a clay mineral called serpentine. The Earth is habitable because of its oceans, lakes and rivers, says principal investigator Dante Lauretta, which exist because "minerals like the ones we're seeing from Bennu landed on Earth 4 billion to 4.5 billion years ago. So, we're seeing the way that water got incorporated into the solid material and then ultimately into planets – not just Earth but probably Venus and Mars as well."

Carbon is also essential for all life on Earth. Scientists want to determine whether asteroids like Bennu could have not only delivered water for our oceans but also seeded the Earth with prebiotic chemicals – the building blocks of life.

The next step is to crush bits of the sample and extract the organics for examination by analytical chemists.

"We'll be making what we call Bennu tea and extracting these compounds," Glavin says. "Stay tuned."

Sample retrieval is slow, as scientists work in a purpose-built clean room.

KEEGAN BARBER/NASA