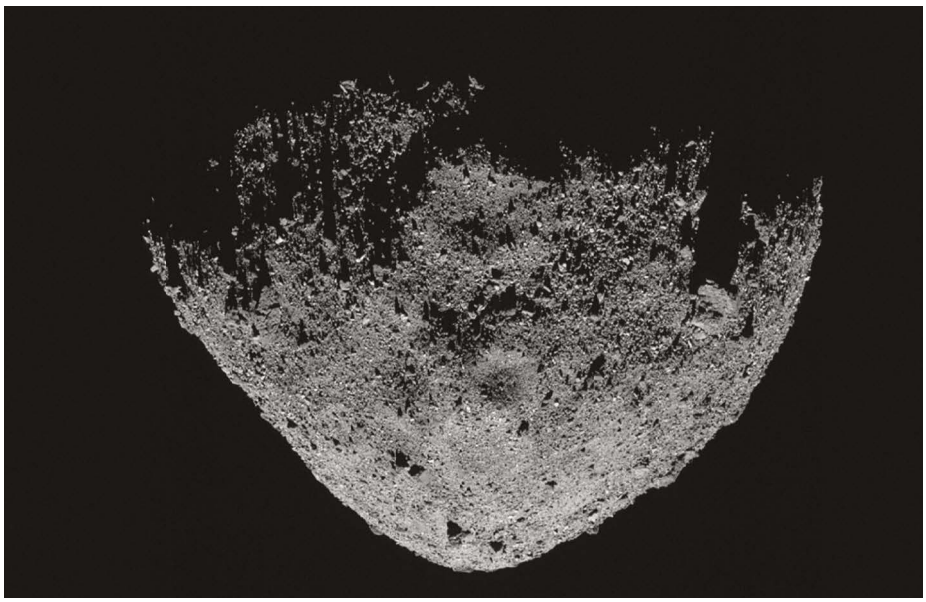


NASA/GODDARD/UNIV. ARIZONA

Scientists suspect that the asteroid Bennu was once geologically active.

NASA ATTEMPTS TO 'FIST BUMP' AN ASTEROID

OSIRIS-REx spacecraft will scoop up rocks that could reveal the Solar System's secrets.

By Alexandra Witze

NASA is on track to grab its first-ever taste of an asteroid. On 20 October, some 334 million kilometres from Earth, the agency's OSIRIS-REx spacecraft was due to approach a diamond-shaped asteroid named Bennu, with the aim of touching its surface for a few seconds — long enough to hoover up a collection of dust and pebbles. As *Nature* went to press, the manoeuvre had not yet been completed. If successful, the spacecraft will fly its samples back to Earth, where scientists can probe them for clues to the history of the Solar System.

The journey to Bennu's surface is not easy. The spacecraft has to navigate its way past a towering boulder nicknamed Mount Doom, then on to a sampling area no larger than a few car-parking spaces. "We may not be successful on our first attempt," said Dante Lauretta, the mission's principal investigator and a planetary scientist at the University of Arizona in Tucson. But if it does work, he said, "I hope the world looks at this as a piece of good news — something we can be proud of with all the insanity that's going on this year."

Launched in 2016, the US$800-million OSIRIS-REx is NASA's first asteroid-sampling mission. It follows two missions from the Japan Aerospace Exploration Agency (JAXA) that have scooped dust off the surface of asteroids — including some retrieved last year that is currently on its way back to Earth for analysis. Before JAXA's missions, scientists learnt about asteroids' contents mainly by studying meteorites that had fallen to Earth — and those can be contaminated as they travel through the atmosphere and hit the planet. Scooping a sample directly off an asteroid offers a pristine glimpse at rocks left over from the formation of the Solar System more than 4.5 billion years ago. Asteroids such as Bennu each have a story to tell about how it formed and evolved over time.

But first, OSIRIS-REx has to pull off the sampling. When Lauretta and his colleagues picked Bennu as its target, they thought the 500-metre-wide asteroid would be relatively smooth and easy to land on. But after OSIRIS-REx arrived and began orbiting Bennu in 2018, the craft got a closer look and found large, dangerous boulders[1].

Mission engineers developed an automated system to guide the spacecraft down to the surface. It collects images as the spacecraft descends and compares them with previously taken images of the same target region. OSIRIS-REx can then track whether it is safely on its preselected path. If not, it can autonomously abort and fly away from the asteroid, waiting for a second chance to descend.

Its target is a 16-metre-wide crater named Nightingale, which offers a relatively smooth surface for a landing. If you could stand in the middle of Nightingale, you would feel pebbles and fine-grained sand beneath your feet, says Erica Jawin, a planetary scientist at the Smithsonian National Museum of Natural History in Washington DC, who has studied Bennu's geology[2].

OSIRIS-REx is due to descend towards Nightingale with its 3.3-metre-long robotic arm outstretched (see 'Grab and go'). On touching the asteroid's surface, it is programmed to release a puff of nitrogen gas that kicks up small grains in a cloud of asteroid debris. A sampling device aims to hoover some of those particles up and store them.

The process, lasting 10–15 seconds, is more of a 'fist bump' than a landing. As soon as the spacecraft finishes hoovering, it backs away to a safe distance, and scientists assess how much material it collected. NASA wants at least 60 grams of rocks and dust — but close to that amount will be good enough. "If it's 58 grams, we're stowing and coming home," says Lauretta.

If the spacecraft collects 40 grams or less, then scientists are likely to return it to a second location on Bennu, called Osprey, to grab some more. (It cannot sample Nightingale for a second time, because the original nitrogen puff will have pushed small rocks on the surface to uncertain locations, making a 'double dip' hazardous, Lauretta says.) Sampling at Osprey would probably happen in January; whatever happens, the spacecraft is due to leave Bennu in March, and will eventually land on Earth with its precious cargo in 2023.

Asteroid anatomy

Bennu has been through a lot in its lifetime. It formed between around 100 million and one billion years ago, when it broke away from a larger 'parent' body during a cosmic collision in the Solar System's asteroid belt. But Bennu has retained traces of its parent. While orbiting the asteroid, OSIRIS-REx detected that some of the boulders on Bennu are shot through with veins of ancient, carbon-rich material known as carbonate. The carbonate probably formed when ice melted and trickled through the parent body, causing watery reactions inside its rocks.

"I was surprised" at seeing these veins, says Hannah Kaplan, a planetary scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, and lead author of the *Science* paper[3] that announced the discovery. They measure centimetres wide and can stretch more than a metre long — much bigger than carbonate veins seen in some meteorites. According to Lauretta, the large veins suggest that Bennu's parent body once had a massive system of hot

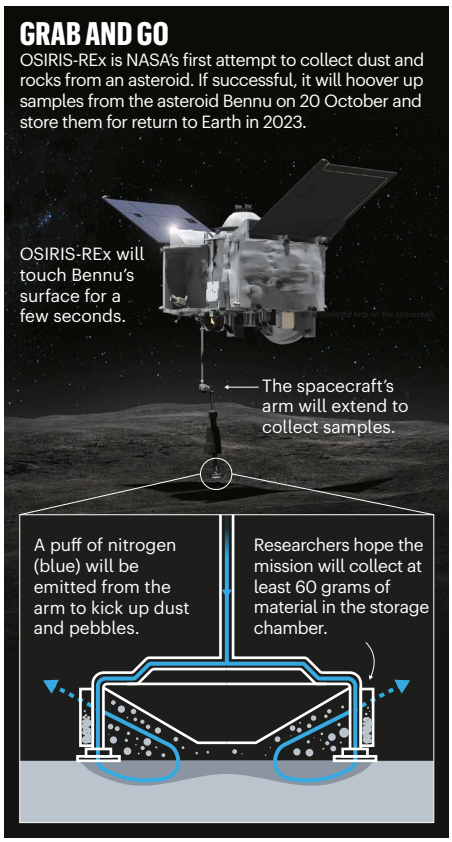
water flowing through it — meaning that it had lots of active geology. Some fragments of these carbonates might be picked up by OSIRIS-REx.

Researchers plan to compare the Bennu samples with the ones currently on their way back to Earth from Ryugu, the larger asteroid that JAXA's Hayabusa2 spacecraft visited last year. "I feel like a spoiled child getting to cut two delicious cakes at my birthday," says Queenie Hoi Shan Chan, a planetary scientist at Royal Holloway, University of London, in Egham, UK, who works on Hayabusa2. Ryugu seems to have less water-rich material on its surface than does Bennu; by comparing the samples, researchers will be able to better understand how common watery processes are on asteroids, says Chan.

Scientists plan to scour Bennu's rocks for clues about how to protect Earth from asteroids. Bennu orbits dangerously near Earth, and has a small chance of smashing into the planet sometime in the twenty-second century. By closely examining the consistency of Bennu's rocks, scientists could propose ways to deflect or break apart threatening near-Earth asteroids.

"Any sample from Bennu is going to be amazingly useful," says Jawin. "It probably won't care too much that we were there and stole some of its rocks."

1. Lauretta, D. S. *et al. Nature* **568**, 55–60 (2019).
2. Jawin, E. R. *et al. J. Geophys. Res. Planets* **125**, e2020JE006475 (2020).
3. Kaplan, H. H. *et al. Science* https://doi.org/10.1126/science.abc3557 (2020).



SOURCE: NASA

THE UNSUNG HEROES OF NOBEL-WINNING HEPATITIS C DISCOVERY

A tight-knit team of scientists worked hard to identify the deadly virus. Only one was awarded a Nobel.

By Heidi Ledford

Virologist Qui-Lim Choo spent much of the 1980s working from 8 a.m. until 11 p.m., 7 days a week. The work was frustrating: he and two colleagues were hunting for a deadly virus that was contaminating blood supplies, and the search had stalled. Every day that passed without a way to test for the virus meant that more people would become infected.

It was also a period of late nights and missed family dinners for his collaborator, George Kuo. But both say that the time was among the best of their lives. "It was a difficult time and a lot of work," Choo says. "But very happy." Ultimately, the search was successful and the team identified the hepatitis C virus (HCV). The finding led to a way to screen blood for the virus, and a drug regimen that cures most infected people.

On 5 October this year, Choo's supervisor on the project, Michael Houghton, was awarded a share of the Nobel Prize in Physiology or Medicine for the identification of HCV. Choo and Kuo were not among the three recipients, who also included Charles Rice at the Rockefeller University in New York City and Harvey Alter, formerly at the US National Institutes of Health in Bethesda, Maryland. Houghton has long campaigned for his two colleagues to be recognized for their work on HCV. "It spoiled a little bit the whole discovery as soon as the awards came into it," Houghton says.

Screening sequences

Houghton launched his hunt for the virus in 1982, at a biotechnology company called the Chiron Corporation in Emeryville, California. At the time, one in every three blood transfusions given in the United States was tainted with the virus we now know as hepatitis C. Left untreated, the virus can damage the liver and cause cancer. Without having determined what was infecting those who received blood transfusions, scientists referred to the disease by what it wasn't: 'non-A, non-B hepatitis'.

That was before there was an easy way to amplify DNA. The idea of sequencing a new virus within weeks of its emergence — as happened for the coronavirus SARS-CoV-2 earlier this year — was unthinkable. Houghton began screening for viral nucleic acids using samples from infected and uninfected chimpanzees.

Choo joined Houghton's lab in 1984, and the two became friends. The search for the contaminant was hard work, and for years the team came up empty-handed, despite screening tens of millions of genetic sequences.

In the lab next door to Houghton's, Kuo, who had joined Chiron in 1981, was running a project studying a protein called tumour necrosis factor. One day, seeing Choo's frustration, Kuo offered some advice: the team needed to change tack. Kuo suggested harvesting fragments of RNA from infected samples, and expressing them in bacteria to amplify their abundance. The researchers could then screen these 'libraries' using antibodies from the blood of infected people.

The trio worked around the clock. Houghton prepared libraries from serum taken from infected people, spinning the sample in an ultracentrifuge to harvest the DNA and RNA in a gluey pellet at the bottom of the test tube. One day, his preparation seemed to have gone wrong. "I got this really weird, oily nucleic acid extract," he says. A research assistant advised him to throw it down the sink, but he used it anyway. Shortly afterwards, Choo struck gold: in the library made from Houghton's oily extract, he found a snippet of nucleic acid that seemed to come from the virus. Using that snippet, the team was able to fish out adjacent sequences from the viral genome, and ultimately piece it together.

Kuo used the information to design a test that could screen blood for the infection, and the discovery also paved the way for a treatment. In 2014, the US Food and Drug Administration approved a drug regimen that cured the infection in more than 90% of people.

Several prestigious awards have recognized the various scientists behind the discovery of hepatitis C. Many have honoured Houghton, and he convinced some, but not all, to recognize Choo and Kuo, too.

When news of the Nobel prize broke, Choo says that he was "very happy". "It's my baby; I'm so very proud," he adds. "How can I not be proud?" Kuo says he did feel disappointed that the prize could be awarded to only three people. But he adds that awards were never the goal. "I was motivated by a dream that I could make a difference in helping people worldwide," he says.