Probing our origins

A composite image of asteroid Bennu ejecting particles from its surface (images taken by the NavCam 1 imager onboard NASA's OSIRIS-REx spacecraft on 19 January 2019. *(Image credit: NASA/Goddard/ University of Arizona/ Lockheed Martin)*

Formed from primitive material during the early stages of planetary formation, Sara Russell discusses how samples from carbonaceous asteroids could hold clues to the origins of our solar system

TWO MISSIONS, Hayabusa2, run by the Japanese state space agency, JAXA, and NASA's OSIRIS-REx mission, have successfully collected samples from carbonaceous asteroids in near-Earth orbits, as Sara Russell from the Natural History Museum explains.

First peek

"The aim of the Hayabusa2 mission is to use the rocky material collected from the asteroid Ryugu, which formed at the start of our solar system, to learn about our origins."

Launched in 2014, Hayabusa2 arrived at Ryugu in 2018 and surveyed the surface for a year and a half before collecting samples.

"Hayabusa2 placed a lander and tiny rovers on the surface of Ryugu to explore in more detail. The regolith was then collected in two ways. First, the spacecraft fired a projectile that disrupted the surface and funnelled the grains into a collector. Then, a surface impactor exposed the subsurface and collected a sample. The spacecraft returned to Earth in December 2020, dropping its cargo onto the Australian desert.

"The material is already being analysed. A first peek reveals that the sample is very, very black in colour, similar to some carbonaceous chondrite meteorites, which are the most primitive materials known to humankind, but perhaps even darker!"

Homeward bound

NASA's OSIRIS-REx mission launched in September 2016 and touched down on the carbonaceous asteroid Bennu in December 2018.

"Samples were collected from Bennu's surface by blasting nitrogen at the regolith, which caused pebbles and dust to rise up and be caught in the collection mechanism. The process worked well—the sample capsule seems to be stuffed full of material. The spacecraft is now on its way home."

Although the sample won't arrive on Earth until September 2023, the OSIRIS-REx mission is already providing new insights.

"One exciting and unexpected outcome is that Bennu is 'active' – every few days we observe a fountain of particles spewing from its surface. The exact cause is not quite understood, but it hints that Bennu may be very volatile-rich and in some ways comet-like.

"The rocks returned from Bennu will help us to understand what the solar system was originally made from, what its environment was like, and how asteroids form and evolve. Bennu likely contains organic material and water, and asteroids like this may have brought these life-essential ingredients to the early Earth."

There are meteorites on Earth (such as carbonaceous chondrites) that are potentially similar to Bennu, but collecting an uncontaminated sample from the asteroid surface provides broader geological context.

"It's like fieldwork for meteoriticists!"

Frozen snapshot

Other planned missions to planetary bodies and asteroids also aim to help us better understand the solar system.

"Launching in 2029, the JAXA MMX mission will visit Mars' largest moon, Phobos, and collect material from the surface to bring back to Earth. The origin of Phobos and its sister moon Deimos is a bit of a mystery; they either formed in a giant impact to the surface of Mars, or they may be captured asteroids."

Meanwhile, Sara is busy characterising a meteorite that fell in the Cotswold town of Winchcombe on 28 February 2021.

"Not only is it the first recovered fall in the UK for the last 30 years, but it is a rare carbonaceous chondrite that may have originated in the outer reaches of our solar system in its very early history, providing a frozen snapshot of this era."

SARA RUSSELL
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