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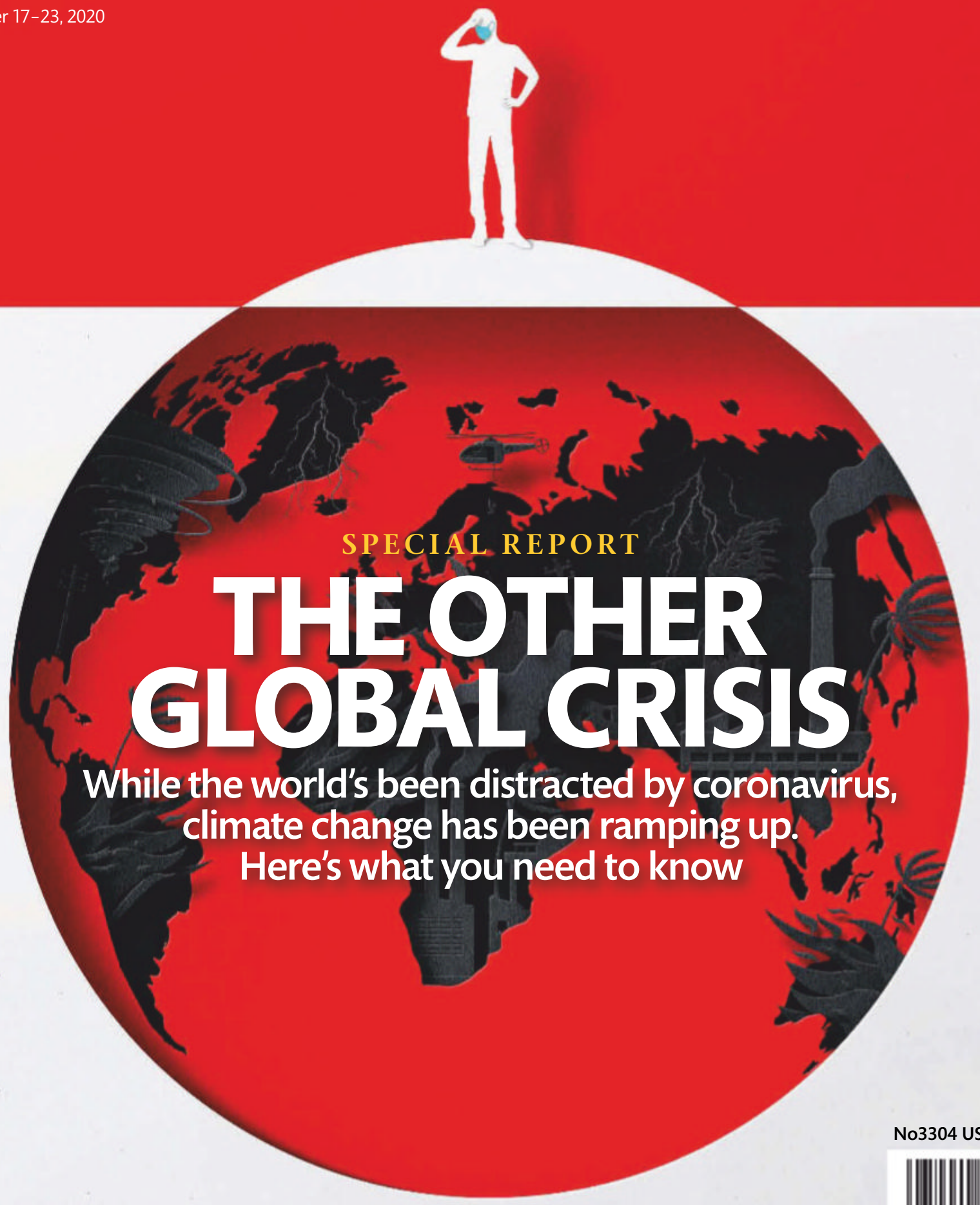

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Space exploration

An asteroid's watery past

The parent body of the asteroid Bennu probably had flowing water on its surface

Leah Crane

THE asteroid Bennu is a strange little place, but data from NASA's OSIRIS-REx mission is starting to unravel its mysteries. The spacecraft, which has been orbiting Bennu since December 2018, is gearing up to take a sample from the asteroid's surface later this month. In preparation, it has gathered a smorgasbord of information, including hints that Bennu's parent asteroid may have had flowing water.

Bennu is a rubble pile, formed when something smashed into a larger asteroid billions of years ago and the bits coalesced into many smaller asteroids. By studying Bennu, which is about 500 metres wide, we can learn more about this parent asteroid, which was probably a few hundred kilometres across.

When OSIRIS-REx reached Bennu, it spotted something strange: some of its boulders had bright veins up to 150 centimetres long and 14 centimetres thick. These are too large to have formed on Bennu itself, says Hannah Kaplan at NASA's Goddard Space Flight Center in Maryland, so they were probably portions of larger cracks on Bennu's parent that were up to several kilometres long.

"They suggest that there was fluid flowing on fairly large scales on Bennu's parent asteroid," says Kaplan. That is because the veins are made of carbonates, a type of compound that generally forms due to interactions between water and rocks (*Science*, doi.org/fctb).

Over 98 per cent of Bennu's surface seems to be coated in carbonates and organic molecules, complex carbon-bearing compounds seen as precursors to life. Yet despite probably having both water and organic molecules, Bennu's parent was unlikely to be teeming with life.

"You're in the vacuum of space, there's no atmosphere, you're looking at a lot of irradiation, it's cold – you wouldn't want to sit on the surface," says Kaplan. "It's not a favourable environment per se, but it does have a lot of the factors that make a place technically habitable."

One of the main goals of OSIRIS-REx is to investigate the carbon on Bennu because Earth was probably built from rocks similar to it, and these may have brought the ingredients for life here. "These same types of organics may have been delivered to early Earth and may have been the start of some of the organic chemistry that led to life as we know it," says Kaplan.

55%

Some boulders on Bennu are made of this much empty space

There are also differences across the surface of Bennu that are hard to explain. It is covered in boulders, but the largest ones are mostly in its southern hemisphere. The boulders themselves are strange too, with some being so porous that empty space appears to comprise up to 55 per cent of them, more than any meteorite we have ever recovered.

There seem to be two populations of rocks: porous, darker-coloured ones and denser, lighter-coloured ones that often have carbonate veins. These differences aren't obvious to the human eye – the surface would seem to be a fairly uniform dark-grey to us – but they could be critical in helping us figure out how Bennu formed. They may have come from two different areas in Bennu's parent body, with the denser rocks coming from deeper underground.

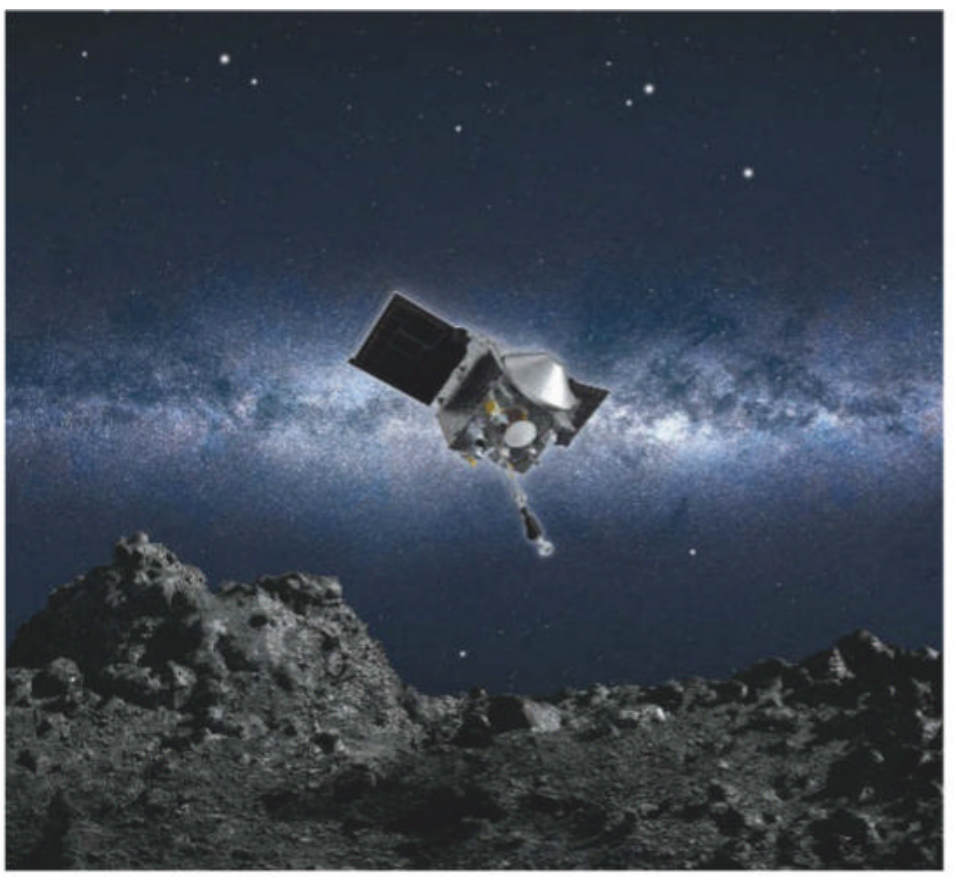
That wouldn't answer all of Bennu's mysteries, though, because some relate to the asteroid's evolution after it was chipped off its parent. "The way Bennu's colour changes over time is quite a bit different than what we have seen on other planetary surfaces like the moon or other asteroids that we've visited," says Daniella DellaGiustina at the University of Arizona.

Ageing an asteroid

Astronomers can date different areas of Bennu by comparing fresher regions with more weathered ones, revealing how they change over time. Rocks on Bennu seem to become more blue, whereas those on other space rocks tend to become more red. This may be because those carbonate-filled rocks interact with the solar wind and micrometeorites differently to rocks without carbonates, says DellaGiustina.

On 20 October, OSIRIS-REx will take a small sample from Bennu's surface before heading back towards Earth. When the sample gets here in 2023, researchers will hopefully be able to answer many of these questions. "All the characterisation work we've done for Bennu basically puts this return sample into context," says Benjamin Rozitis at the Open University in the UK. If we can study the sample thoroughly and understand how it relates to the different rocks on Bennu, that makes it easier to compare with other asteroids and small bodies.

"We can't do a sample return from every interesting place in the solar system, but by studying Bennu globally and trying to understand it as a small world, we get a much better sense of how Bennu relates to other objects in our solar system that we might never be able to sample," says DellaGiustina.



NASA/GODDARD/UNIVERSITY OF ARIZONA

OSIRIS-REx will take a sample from asteroid Bennu later this month