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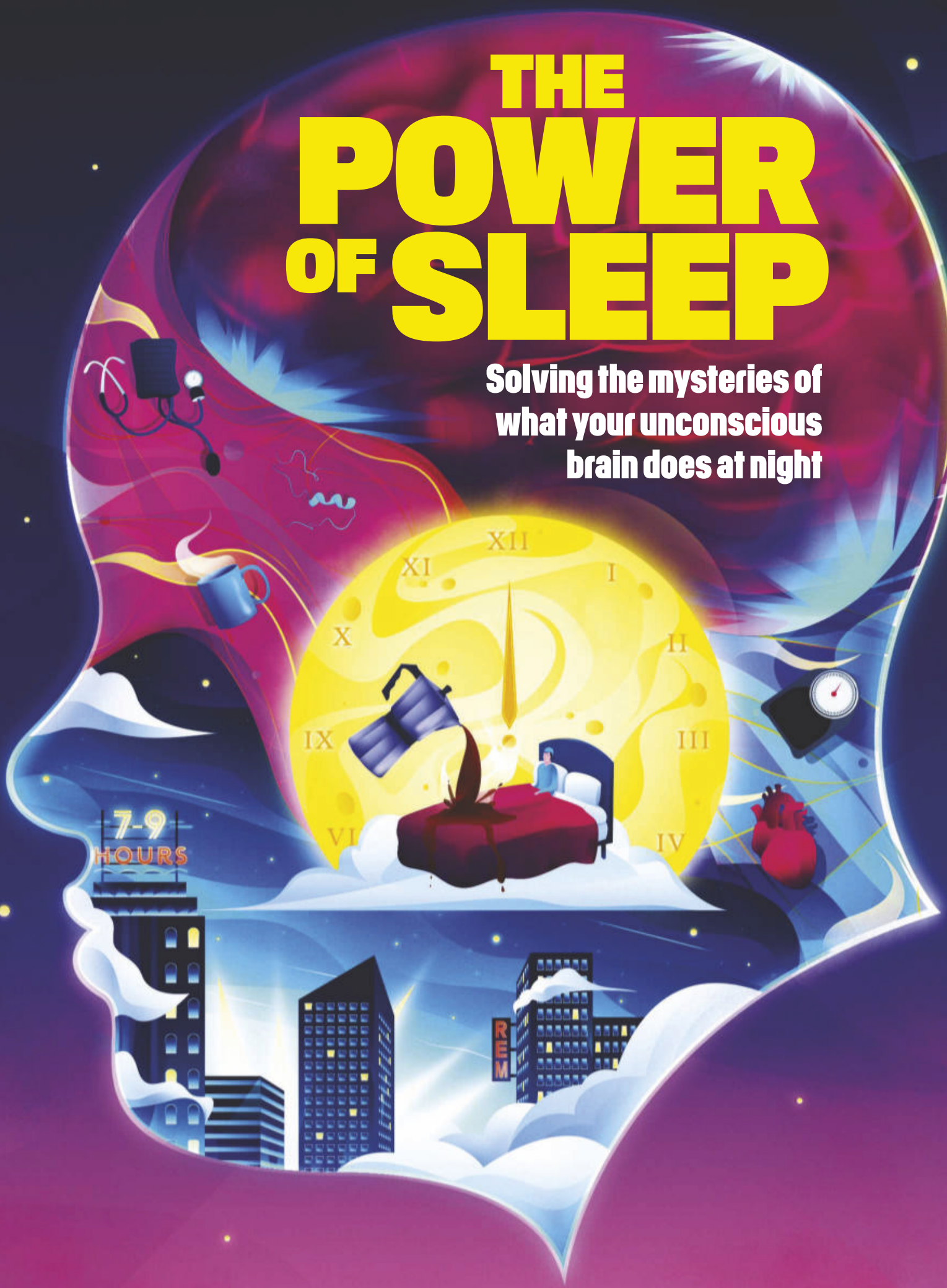


## THE POWER OF SLEEP

**Solving the mysteries of what your unconscious brain does at night**

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ZOOLOGY

# Octopuses have sleep stages like humans – and may even dream

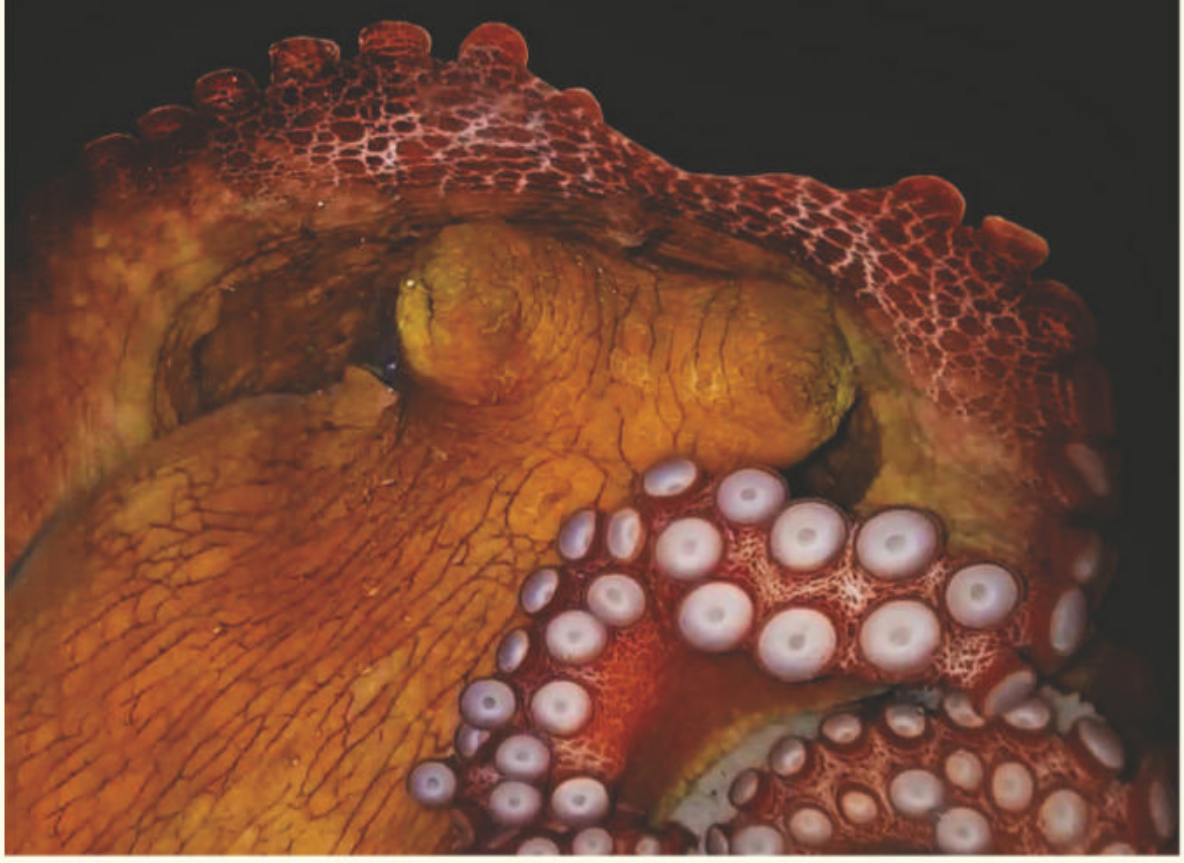
True, you may never see an octopus slip into some pyjamas or snuggle under a duvet, but research has discovered that the cephalopods closely mirror human sleep stages while snoozing.

A new study from Brazil's University of Rio Grande do Norte has revealed that the eight-limbed creatures have two major alternating sleep states: an 'active sleep' stage and a 'quiet sleep' stage. When observing octopuses sleeping in a lab setting, researchers found that during 'quiet sleep', the animals were motionless, with their pupils contracted. However, during 'active sleep', they changed their skin colour and texture, and – akin to humans during rapid eye movement (REM) sleep – moved their eyes and experienced muscle twitches. Although it could not be confirmed, these findings indicate that octopuses may be able to dream in their sleep.

"Our results suggest that during 'active sleep' the octopus might experience a state analogous to REM sleep, which is the state during which humans dream the most," said lead researcher Sylvia Medeiros. "If octopuses indeed dream, it is unlikely that they experience complex symbolic plots like we do. 'Active sleep' in the octopus has a very short duration – typically from a few seconds to one minute. If during this state there is any dreaming going on, it should be more like small video clips, or even gifs."

Whether octopuses dream or not, the study raises major questions about the nature of sleep. As humans and octopuses evolved almost independently (their lineages diverged around 500 million years ago), the similarity between the sleep stages asks why both exhibit this behaviour.

"If in fact two different sleep states evolved twice independently in vertebrates and invertebrates, what are the essential evolutionary pressures shaping this physiological process? The independent evolution in cephalopods of an 'active sleep' analogous to vertebrate REM sleep may reflect an emerging property common to centralised nervous systems that reach a certain complexity," Medeiros said.



SYLVIA L S MADEIROS ILLUSTRATION: ACUTE GRAPHICS

MARS

# Scientists have measured the core of Mars, and found something unexpected

For the first time, scientists have directly measured the core of another planet. NASA's InSight mission on Mars has discovered the Red Planet's core is bigger than expected.

Instruments on the craft have listened to seismic energy deep within the planet, and have suggested a core measurement of between 1,810km and 1,860km in diameter, roughly half the size of Earth's core. It's larger than some predictions, which means the Martian core is less dense than previous estimates, probably due to the presence of lighter elements such as oxygen.

The measurements, which were taken with a seismometer, have not yet been published, but were reported at a virtual gathering of the Lunar and Planetary Science Conference.

"A seismometer is like a very sensitive ear pressed against the ground, listening for energetic events in the interior of a planet. On Earth, these are usually earthquakes. InSight has detected hundreds of seismic events in the first Martian year of its mission," said Divya Persaud, a planetary scientist at UCL, who was not involved in the research. "On Earth, when an earthquake releases a lot of energy, these waves of energy travel quickly throughout the interior of the planet and bounce off different materials, like magma, or the boundaries between layers of different types of rock. They also slow down in some materials or speed up in others."

By measuring the strength of these signals, and how they interact with material underground, scientists can detect the internal structure of the planet. The InSight team used the same technique on Mars.

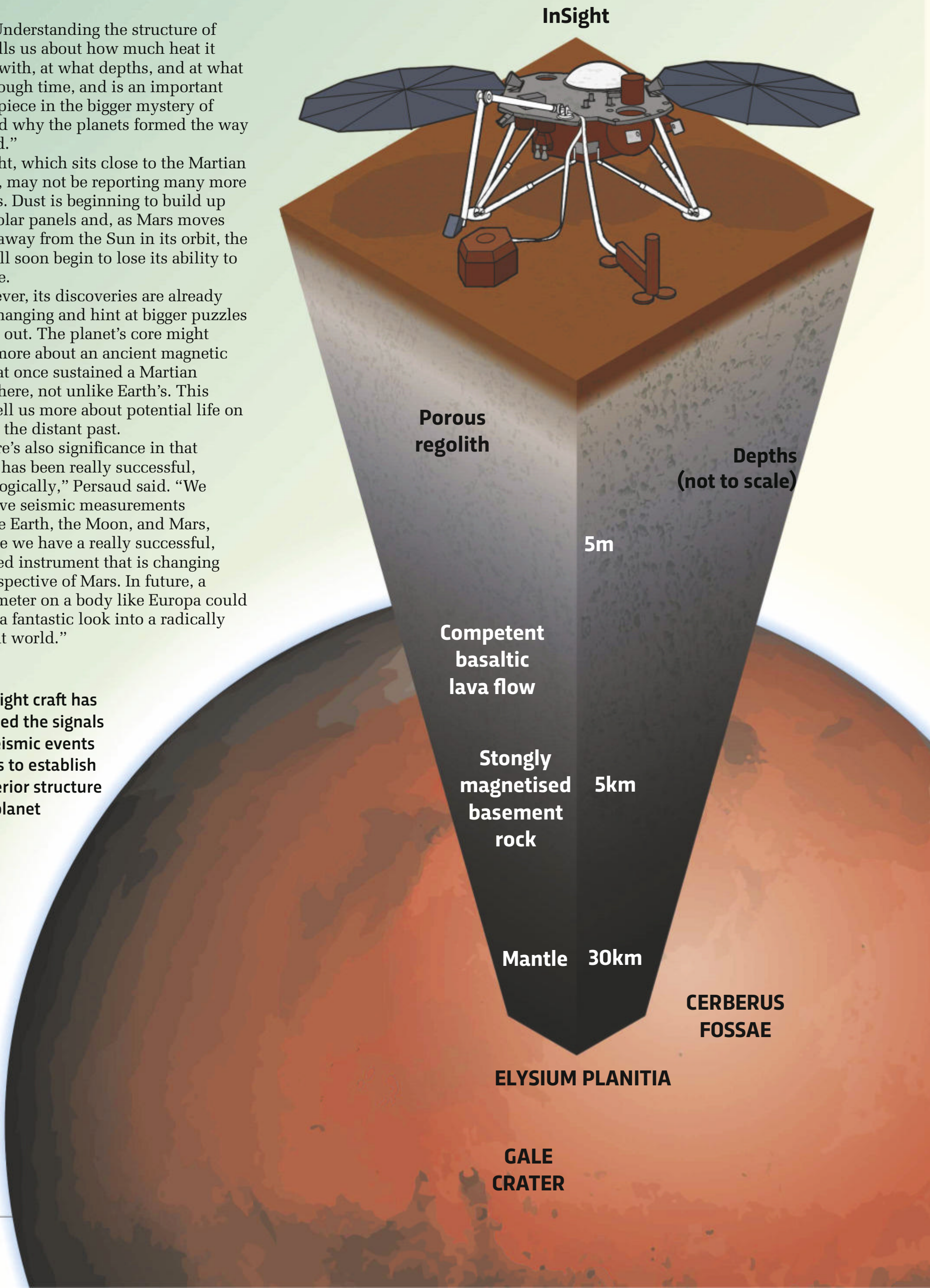
Persaud is intrigued that the core isn't as dense as expected, because it may lead to new understandings about how planets and the wider Solar System evolved. "Cores also tell us about energy in the Solar System over time, not just for Mars but all of the terrestrial planets which formed at the same time but in very different ways from each other," she

said. "Understanding the structure of Mars tells us about how much heat it started with, at what depths, and at what rate through time, and is an important puzzle piece in the bigger mystery of how and why the planets formed the way they did."

InSight, which sits close to the Martian equator, may not be reporting many more findings. Dust is beginning to build up on its solar panels and, as Mars moves farther away from the Sun in its orbit, the craft will soon begin to lose its ability to recharge.

However, its discoveries are already game-changing and hint at bigger puzzles to work out. The planet's core might tell us more about an ancient magnetic field that once sustained a Martian atmosphere, not unlike Earth's. This could tell us more about potential life on Mars in the distant past.

"There's also significance in that InSight has been really successful, technologically," Persaud said. "We only have seismic measurements from the Earth, the Moon, and Mars, and here we have a really successful, advanced instrument that is changing our perspective of Mars. In future, a seismometer on a body like Europa could give us a fantastic look into a radically different world."




**The InSight craft has measured the signals from seismic events on Mars to establish the interior structure of the planet**

MARS

# The Perseverance rover is sending weather reports back from Mars

And now for the weather… from Mars. NASA scientists have analysed the first meteorological reports recorded by its Perseverance rover on the Red Planet. The short version: if you're planning to spend some time at the Jezero Crater, you'll need a coat (yes, and a spacesuit) because it's -20°C on a warm day.

The rover, which landed in February, is equipped with a planet-hopping weather station called the Mars Environmental Dynamics Analyzer (MEDA). Its sensors record wind speed and direction, air and ground temperature, as well as pressure, humidity and radiation. Its first measurements were taken the day after it landed and MEDA wakes itself up every hour to take fresh readings. The forecast: cold with strong gusts and an ever-present risk of a dust storm. Perseverance has so far recorded lows of -83°C and wind speeds of 35km/h (22mph). Over the next year, it will give NASA scientists useful information such as temperature cycles, dust patterns, solar radiation readings and cloud formations.

Just like we check our weather apps before heading out for a walk, the MEDA data will help engineers plan the rover's movements and experiments, including flights of the Ingenuity Mars Helicopter. It will also be important for future crewed missions to the Red Planet – and not just to give astronauts something to talk about. Understanding how conditions fluctuate over time will inform things like the kinds of habitat required for future Mars bases.

"We're very excited to see MEDA working well," said Manuel de la Torre Juárez, deputy principal investigator for MEDA. "MEDA's reports will provide a better picture of the environment near the surface. Data from MEDA and other instrument experiments will reveal more pieces of the puzzles on Mars and help prepare for human exploration. We hope that its data will help make our designs stronger and our missions safer."

It's not the first time scientists have received weather reports from Mars. Two other missions – Curiosity and InSight – have sent home meteorological data from their landing sites. Together with MEDA's forecasts, as well as satellite and telescope data, these are helping scientists build a complete picture of weather patterns on the Red Planet.

**Artist's impression of Jezero Crater, how it may have looked billions of years ago**