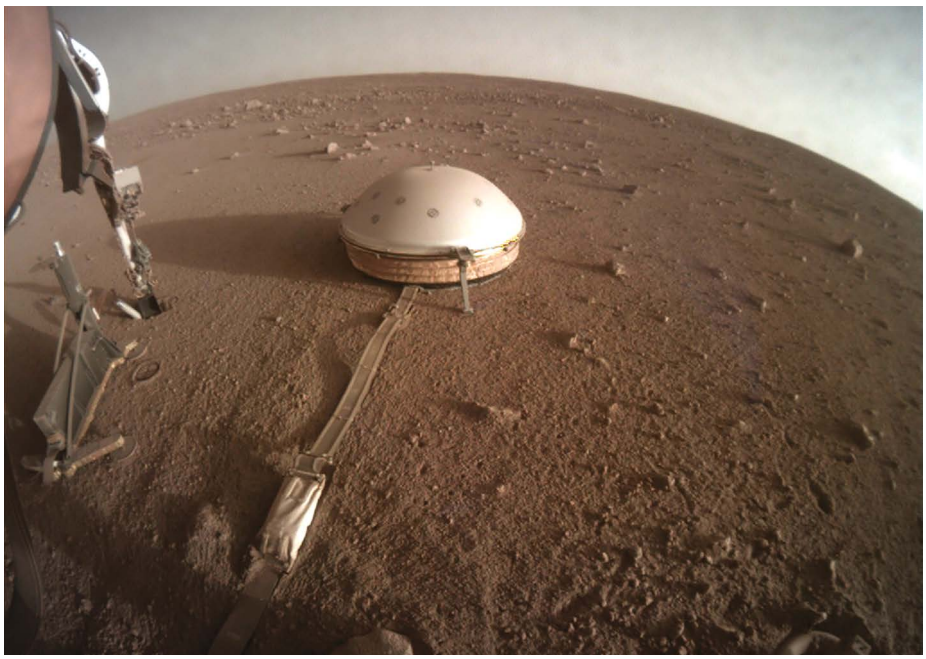

NASA/JPL-CALTECH

The Mars lander's seismometer contains three sensitive sensors nestled inside a dome.

'MARSQUAKES' REVEAL RED PLANET'S HIDDEN GEOLOGY

NASA's Mars InSight lander has detected more than 300 quakes and traced some back to their source.

By Alexandra Witze, San Francisco, California

The marsquakes are coming fast and furious. From its landing site near the Martian equator, NASA's InSight mission is detecting about two quakes per day — and the rate is going up.

"We have a lot," said Bruce Banerdt, a geophysicist at the Jet Propulsion Laboratory in Pasadena, California, and InSight's principal investigator. He reported the findings on 12 December at a meeting of the American Geophysical Union in San Francisco, California.

Since arriving on Mars just over a year ago, InSight has detected 322 marsquakes. They are the first quakes ever detected on any body other than Earth or the Moon. Scientists aim to use them to probe the Martian interior, including mapping how the planet's guts are divided into layers of crust, mantle and core.

Most of the marsquakes are tiny, much smaller than anything that would be felt on Earth. But some have been big enough — up to nearly magnitude 4 — for scientists to be able to trace them back to their source.

Two of the biggest marsquakes came from a geologically active area known as Cerberus Fossae, which lies about 1,600 kilometres east of InSight. The quakes there might have been caused by the build-up of stress along geological faults in the Martian crust, and then released in a marsquake.

Other early findings from the mission include mysterious magnetic pulses that appear at about midnight each night around the lander. But one of InSight's main goals — to hammer a heat probe 5 metres into the Martian ground — remains frustratingly out of reach. The probe, dubbed 'the mole', has encountered more friction in the soil than scientists had expected. In October, it even unexpectedly backed out of its hole.

The biggest discoveries so far have come from the ever-expanding catalogue of marsquakes. InSight's highly sensitive seismometer hunts for quakes at night, after the winds that shake the ground during the day die down.

The marsquakes come in two types. The most common shakes the ground at high frequencies. Less common is a type that is detectable at lower frequencies. The high-frequency signals might be coming from quakes that rupture the shallow Martian crust, whereas the low-frequency ones might be travelling from deeper within the planet, in its mantle, said Domenico Giardini, a seismologist at the Swiss Federal Institute of Technology in Zurich.

Two of the biggest marsquakes hit in May and July. Both were of the low-frequency type. Team members were able to trace the seismic energy back to Cerberus Fossae. This area is home to recent geological activity, including faults that seem to have moved in the past ten million years.

Before InSight launched, researchers had predicted it might be able to detect quakes coming from Cerberus Fossae. The faults there could build up stress at their ends, said Alice Jacob, a planetary scientist at the Paris Institute of Earth Physics. An analysis she led suggests that this could be the source of the marsquakes picked up by InSight.

The rate of quakes has been increasing, Banerdt said — from a few sporadic tremors reported after InSight landed, to the current pace of two a day. Mission scientists aren't sure why.

Equally mysterious are the magnetic pulses that show up every night. InSight measured them with its magnetometer, and they are thought to be related to something happening in the space environment around Mars. One idea is that they are created when charged particles from the solar wind slam into Mars.

Probe problems

InSight's greatest drama so far has come with its mole. This initially began burrowing into the ground as planned, but hit disaster in October, when it suddenly squirted out of its hole.

Mission engineers designed the mole to work in a type of soil different from that it actually encountered. It was designed for cohesionless soil, in which particles flow with little to no friction between them — as in a vat of sugar. But InSight's landing place turned out to have cohesive soil, in which the particles stick together, more like those in a vat of flour, says Tilman Spohn, a space scientist at the German Aerospace Center in Cologne.

When the mole began burrowing, the soil around it became compacted into a pit. The mole could not build up enough friction against the pit's walls to keep moving into the ground. Spohn says that he and his colleagues had seen this happen in laboratory experiments involving cohesive soils, but that they expected InSight's landing place to have cohesionless soils, in common with other Martian landing sites.

Mission engineers have been trying to get past the problem by pinning the mole to the side of the pit with the lander's arm, to give it more friction to keep going. And it is starting to bury itself into the ground again, slowly and carefully.

"By Christmas time, maybe our present will be that we're back to square one," says Spohn. "Which at this point in time would be a very, very welcome situation."