

Recent developments in science: oceanography, neuroscience, planetary astronomy

Scientists use gravity to map Earth's ocean floor

Our reporters
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Researchers led by David Sandwell at Scripps Institution of Oceanography at UC San Diego have used radar measurements from the satellites CryoSat-2 and Jason-1 to produce a new gravity map of Earth's ocean floor, one twice as accurate as the previous one made nearly 20 years ago. Previously undiscovered features found include an underwater mountain range in the Gulf of Mexico, a major fault line in the South Atlantic Ocean, many smaller hill-like features on the ocean floor and thousands of previously unknown underwater mountains and volcanoes.

Geological structures on the ocean floor reflect plate tectonic activity over the past 150 million years, allowing geologists to better understand the motion of Earth's crust over such long time spans. They are, however, poorly understood because the vast majority of them are concealed by at least 3 kilometers of ocean. Maps of the entire surface of Mars are far more accurate than those of the entire surface of Earth.

Traditional methods to peer into the ocean past about 100 meters—about how far visible light can penetrate—involve mapping the sea floor with sonar-based instruments mounted on ships that can interpret the shape of features beneath the water. The main weakness of this method is that it relies on the ships themselves, which primarily travel along the shipping routes of the world. As a result, only at most 15 percent of the globe's ocean floor has been mapped in this way.

In contrast, one can measure the shape and gravity field of Earth, a field known as geodesy. Features on the ocean floor such as mountains are more massive

than the surrounding sea floor, causing gravitational anomalies one-millionth the average strength of Earth's gravitational field. This nevertheless pulls more water toward them. As water is incompressible, this results in minute but measurable bumps on the ocean's surface that are then carefully translated to geographic features on the abyssal plain. This latest map is accurate at a scale of 5 kilometers per picture.

This new data will allow oceanographers to conduct more-accurate shipboard surveys, pointing them more clearly to plate tectonic activity in the deep ocean. It will also allow for more-accurate air and sea navigations across oceans, which in part rely on Earth's gravitational field to maintain an accurate heading.

New insights into symptoms of dementia

Studies conducted by the University of Bristol and University of Exeter Medical School in the UK have shown how one of the early symptoms of dementia, loss of orientation, is associated with the disruption of cells in two parts of the brain, the hippocampus and entorhinal cortex. The research was conducted on the brains of healthy mice and mice induced to have similar neurodegeneration seen in humans with dementia, one of the ways to closely approximate the brains of *Homo sapiens* without direct human experimentation.

Both the entorhinal cortex and hippocampus are areas

that play key roles in the brain's memory-formation process and understanding of geometric space. The entorhinal cortex is located near the base of the brain and helps control memory formation and navigation using so-called grid cells. In healthy mice, these cells fire impulses in specific patterns depending on whether they are at the top or of the bottom of the cortex.

Similarly, the hippocampus has a structure within it made up of "place cells," which aid individuals in understanding where they are located in relation to other objects.

In both regions of the brain, affected mice had none of the peculiar cell patterns or neural activity of healthy mice. Without this, spatial information and spatial memory are wrongly encoded in the brain, suggesting a cause for the decreased spatial awareness found in those with dementia. This is the first time that the grid cells have been linked to the onset of dementia and may offer a way to detect it at an earlier stage. Further testing to connect the studies on mice to humans is ongoing.

According to the World Health Organization, 47.5 million people have dementia worldwide. Though it is not a normal part of aging, about 10 percent of people develop the disorder sometime in their lives, the most common form being Alzheimer's disease. It is a major cause of disability among older people and is estimated to cost more than \$600 billion each year.

Dawn spacecraft reveals new features of the asteroid Ceres

Images sent back to Earth by NASA's Dawn spacecraft have revealed hitherto undiscovered features about the dwarf planet Ceres, including many fractures and grooves across its surface. While many are likely a result of impacts with other objects, some appear to be generated by internal stresses as a result of tectonic activity. Dawn has also revealed a variety of salts and sulfates on the surface of this asteroid belt object.

Dawn currently orbits Ceres at an average height of 385 kilometers, closer than the International Space Station is to Earth, and will remain there indefinitely. This is the final phase of the spacecraft's primary

mission, which also included orbiting the dwarf planet Vesta for more than a year in 2011-2012 before venturing to Ceres. As a result of its low altitude, the latest images are more than 600 times more precise than those that could be taken by the Hubble Space Telescope.

The instruments aboard Dawn include the framing cameras, which provide images used both for science and navigation, a visible and infrared spectrometer, and the gamma ray and neutron detector, which uses radiation coming from Ceres to probe the dwarf planet's internal structure and composition. Ground controllers also use slight perturbations on Dawn's expected orbit to make a gravity map of Ceres.

Since its discovery in 1801, Ceres has been of great interest to astronomers for the clues it provides to the solar system's formation. It is thought that moderately large objects like Ceres acted as embryos for the larger rocky worlds of the inner solar system, including Earth. That it did not was likely caused by the gravitational domination of Jupiter. As a result, however, Ceres seems to be geologically unchanged since its formation 4.6 billion years ago, providing insight into the conditions of the early solar system.



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