between the equator and the poles is small compared to that on Earth.

Other experiments aboard Mariner 10 indicate that planetary Venus is more nearly round than the Earth, the Moon, or Mars; has an electrically charged upper atmosphere but practically no magnetic field; and is possessed of a comet-like tail of protons and electrons that extends away from the Sun.

Mariner 10 has also radioed back measurements that confirm the presence of hydrogen in the Venusian atmosphere. Some of that element is locked into sulfuric acid and water molecules in the clouds, but its presence as a gas in greater-than-predicted amounts may challenge one theory that the hydrogen was released by comets colliding with the surface of the planet. Another theory suggests that the hydrogen was swept into the atmosphere by the solar wind—particles "blowing" out from the sun. It also seems clear that this hydrogen prevents solar radiation from breaking down the carbon dioxide atmosphere of Venus into a more Earth-like one.

Important as it is, the information transmitted from Mariner 10 in its brief encounter with Venus is only a minor by-product of the mission's prime target—Mercury. The innermost planet of the solar system, Mercury is not much larger than the Moon, yet it is denser than Earth. Because of its position in relation to the Sun, it cannot be observed in detail by Earth-based telescopes; in fact, the 750-km-resolution (about 500 miles) observed from Earth is worse than that of the Moon seen by the naked eye. Mariner 10 is scheduled to execute a week-long picture-taking mission in which the spacecraft and its cameras will zoom in closer and closer to Mercury, until the final pictures are at a resolution of 0.1 km (about 350 feet). That is just as good as the best Mariner 9 photos of Mars.

Research Notes

Earthquake Side Effects

The days are slightly longer during periods of intense earthquake activity around the world. Also, during these periods, the earth's poles wander faster.

Don Anderson, professor of geophysics and director of Caltech's Seismological Laboratory, made this surprising correlation after studying three periods in history when giant earthquakes were prevalent—1835 to 1847, 1896 to 1911, and 1933 to 1942. (A giant earthquake is one of magnitude 8.5 or greater—or one that causes a large tsunami or seismic sea wave.) In addition to the giant earthquakes, the general level of seismic activity was also greater during those periods.

Don Anderson

During these seismically active periods the earth's rotation rate was abnormally slow, meaning that the days were slightly longer. During the 1896-1911 period the length of the day increased by about eight milliseconds. The rate is known back for many centuries from astronomical studies of the motions of the stars, sun, moon, and planets.

It is not yet clear whether the earthquakes slow the earth's rotation rate, or whether the slowdown activates great earthquakes. But earthquakes are only part of the story. The much larger movements involving the shifting of mass near the earth's surface are probably responsible for both the earthquakes and changes in the rotation rate. This motion is provided by the activities of the huge tectonic plates that make up the lithosphere, the outer 45 miles of the earth.

Most geologists believe that the earth's entire surface down to a depth of 45 miles is made up of a mosaic of massive plates that move in relation to each other, riding and sliding on a layer of plastic rock about 80 miles thick. The largest of these is the Pacific Plate, which extends from Japan to the west coast of the United States and from Alaska southward many thousands of miles.

The Pacific Plate is moving faster than the others and seems to dominate the earth-rotation effect among the plates. It is diving under the Aleutian Islands and Japan and is scraping past California along the San Andreas Fault. A piece of the Pacific crust is diving under Chile. Nearly all the largest of the earthquakes during the "great earthquake years" occurred around the edge of the Pacific Basin—in South America, Japan, and the Aleutians.

When an edge of the Pacific Plate dives under the Aleutians or Japan, the lithosphere bends until big chunks of it crack and break, causing earthquakes. Anderson believes that this "decoupling" at plate boundaries leads to accelerated plate motions, and this is the major process affecting the earth's rotation. Plate motions occur in jerks, lasting some five to ten years rather than being continuous.

In the past 70 years the lithosphere has been diving under Japan about 10 times faster than in the past 1,500 years. The present rate is about eight inches a year, much greater than the average rate over the past several million years. After certain large "decoupling" earthquakes—given this name by Hiroo Kanamori, professor of geophysics—the plate rates can be faster still.

Anderson developed his conclusions from studies of the earthquake records of Japan, China, and Chile. Quakes have been recorded on seismological instruments since 1900, and a fairly complete record of giant quakes is available back to the year 1800. Japan and China have adequate records back to the year 400 A.D.

Anderson's theory is not yet useful in predicting specific earthquakes at a particular place. But by monitoring the location of the pole of rotation and the length of the day very precisely, particularly after large earthquakes, he believes it might be possible to determine when conditions are getting ripe for major seismological activity elsewhere on the globe.

He's chairman of the committee on research with warm-blooded animals, but Jean-Paul Revel also works with cold-blooded specimens like this whelk.

Creature Comforts

When the Kerckhoff Animal Care Facility was built at Caltech 25 years ago, it was as carefully designed and up to date as a hard-working committee could devise. But if the animals haven't changed very much, standards for their care have; and the time has come for large-scale renovations and remodeling.

A major portion of this work will be funded by a $195,000 grant from the National Institutes of Health. Caltech will provide another $75,000. Jean-Paul Revel, professor of biology and chairman of the committee on research involving warm-blooded animals, is in charge of the project, which is slated to start this month.

The 7,500-square-foot facility now houses about 2,600 animals used by 15 investigators in the Divisions of Biology, Chemistry and Chemical Engineering, and Engineering and Applied Science.

With the installation of modern cages and sterilization equipment, the animals will have even better care than they have had in the past—and operating costs should be reduced.