Venus' skin shows familiar tectonic scars

Like a maniacal plastic surgeon, plate tectonics continually reshapes Earth's face, tearing the planetary skin in some places and tucking it away in others. Geophysicists who study Venus have long thought that Earth's twin did not undergo the same type of facial surgery, but new images of Venus suggest that elements of plate tectonics have indeed scarred this nearby planet.

Topographic data collected by the Magellan spacecraft, currently orbiting Venus, reveal for the first time that this planet has deep trenches very similar to those found on Earth. "Their appearance topographically is basically identical to the trenches around the Pacific Ocean," says geophysicist Gerald Schubert of the University of California, Los Angeles.

Schubert and David T. Sandwell of the Scripps Institution of Oceanography in La Jolla, Calif., compare Venus and Earth trenches in the Aug. 7 SCIENCE.

On Earth, deep trenches form when one plate — a patch of Earth's outer shell — dives beneath another. Called subduction, this process represents a major component of plate tectonics. The discovery of quite similar trenches on Venus suggests that subduction also occurs there, Schubert and Sandwell assert.

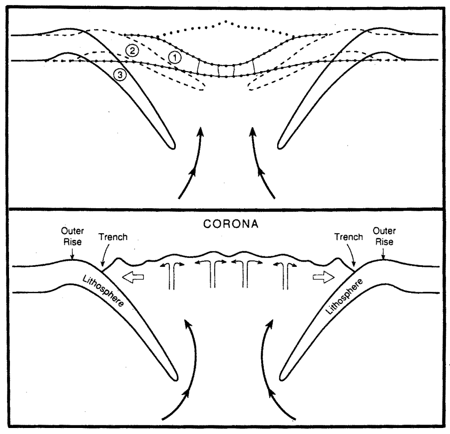
The trenches on Venus occur around large circular structures called coronae and at deep depressions called chasmata. Prior to the Magellan mission, scientists lacked a clear enough picture of the planet's topography to recognize these features as possible subduction zones, says Schubert.

The first person to identify the Venusian subduction evidence was Dan McKenzie of the University of Cambridge in England. McKenzie and several colleagues, including Sandwell, present arguments for Venusian subduction in a paper soon to be published in the JOURNAL OF GEOPHYSICAL RESEARCH.

In their own paper, Schubert and Sandwell analyze in detail the topography of trenches on both planets. On Earth, subducting plates bend upward before they dive down into the mantle, creating a gentle rise that parallels the trench. Schubert and Sandwell report that similar rises run alongside Venusian trenches.

Although Venus and Earth sport similar trenches, not all elements of plate tectonics occur on Venus, the researchers say. On Earth, the outer shell, or lithosphere, moves mostly in the horizontal plane. It is created in the middle of the oceans at volcanic ridges and then migrates conveyor-belt fashion over thousands of kilometers to the subduction zones, where it dives back into the mantle. Magellan scientists have not found any evidence that Venus' lithosphere moves horizontally over such long distances (SN: 5/4/91, p.280).

Subduction on Venus may be primarily a vertical affair, says Schubert. He suggests it starts when heat from the mantle weakens the lithosphere and creates a tear. The edges of the lithosphere on either side of the rupture then sink downward as molten rock from Venus' mantle rises to fill in the area above the foundering edges. The large circular coronae may form when the lithospheric edges continue to sink, causing the trenches to migrate farther and farther from the original tear. Magellan will soon collect gravity measurements that can address whether or not subduction caused the Venusian trenches.



Sandwell, Schubert/SCIENCE

Upper diagram shows how large coronae may form. Hot material rising from the mantle weakens the lithosphere (1), creating a tear (2). Edges of the lithosphere then sink (3). Mature corona shown below.

The identification of possible subduction zones has intrigued scientists because it represents one step toward understanding how Venus works. Although many other aspects of the planet remain a mystery, "there is at least something on the planet that we can recognize," McKenzie says. — *R. Monastersky*

Ever upward: Shake, rattle, and roll

Shake up a tin of mixed nuts, and you're likely to find the larger nuts on top and the smaller nuts at the bottom. This phenomenon exemplifies one of many processes that segregate particles according to size.

Now researchers have developed a simple, three-dimensional model that appears to capture several key features of particle segregation. Computer simulations based on this model reveal that voids, which typically form beneath large spheres surrounded by smaller spheres, play an essential role in the upward movement of large spheres during shaking. The model also suggests that no segregation occurs below a certain critical diameter ratio.

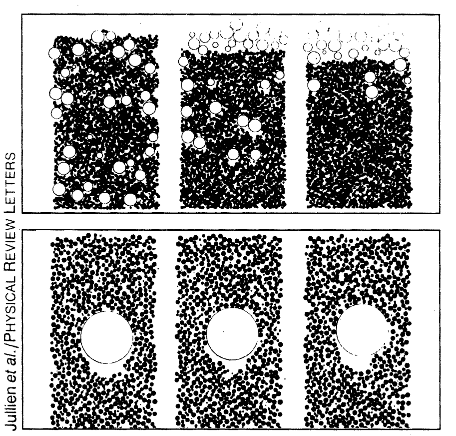
Rémi Jullien of the University of Paris (South) in Orsay, France, and his collaborators describe their findings in the July 27 PHYSICAL REVIEW LETTERS.

The researchers simulated the shaking and segregation process by depositing spherical particles of different sizes one at a time from random positions above a surface of a certain size. As the pile grows, particles roll down the slopes until they reach the bottom or get stuck at a higher position.

After constructing this initial packing of spheres, the researchers list the particles in order of ascending height, then redeposit them in that order, keeping their horizontal positions the same until contact with the pile. Then the particles are free to roll until they stop. Repeating this procedure many times serves as a stand-in for shaking.

Although this model neglects many details that may contribute to the arrangement of particles after shaking, it does enable researchers to track the behavior of much larger numbers of particles in three dimensions than has been possible with many previously developed models of this segregation process (SN: 3/28/87, p.201).

"Despite these approximations, we believe our model captures the essential features of the segregation process," the researchers say. — *I. Peterson*


Jullien et al./PHYSICAL REVIEW LETTERS

Top: Vertical cut through a three-dimensional array made with 250 large spheres and 50,000 small spheres. The sequence, from left to right, shows the initial arrangement, the packing after 30 shakes, and the packing after 60 shakes. Bottom: Vertical cut through a packing containing only one large sphere, revealing a void beneath the large sphere. This sequence shows the results of three successive shakes.