rent ideas about the relationship between eukaryotes and archaebacteria might shift. In the current picture, eukaryotes originated near the base of the tree. They branched off from the archaebacteria long before those organisms diverged into the main groups present today, such as the methanogens. Martin and Müller's hypothesis would shift the first eukaryotes well up the tree, tying them more closely to the archaebacteria.

But Gray and others still have reservations about the scenario. "It's possible, but it's not as plausible as the standard idea" that the original host of mitochondria was a bacteria eater, says evolutionary biologist Tom Cavalier-Smith of the University of British Columbia in Vancouver. "It makes more sense if the host came from a bacterium that had experience digesting food and had transporter enzymes already," so that it could import small molecules and feed its guest.

Martin and Müller say that an analysis of the complete sequences of eukaryotic and archaebacterial genomes should show who is right. Their theory predicts that on the whole, the genes that eukaryotes derived from archaebacteria will look most like those of methanogens. It also suggests that direct descendants of the earliest eukaryotes may still lurk in dark, anaerobic environments. The best places to search for a living example of the ancestor of us all, Müller says, "are, of course, foul-smelling, muddy, or inside of a digestive tract."

–**Gretchen Vogel**

PLANETARY SCIENCE

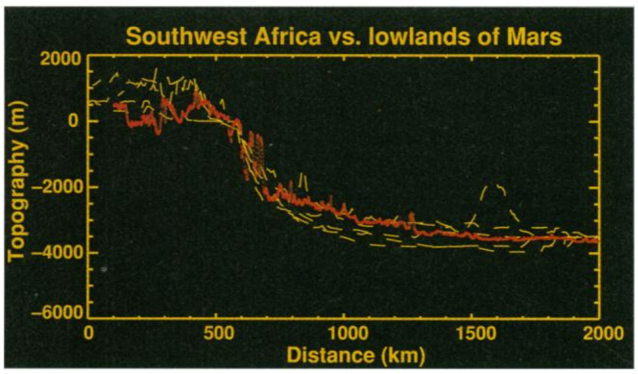
Surveyor Shows the Flat Face of Mars

Every planet harbors a mystery that is key to understanding its fundamental nature. Earth's concerned its division into either low-lying ocean basin or high-standing continent. Once researchers realized that plate tectonics created dense ocean crust that sinks to form deep basins and light continental crust that floats high, the mystery was solved and the essential forces shaping Earth's surface were understood. Now, the first results from the altimeter aboard the Mars Global Surveyor (MGS) spacecraft are helping to solve an equally fundamental puzzle about that planet.

On Mars, the mystery is a great crustal dichotomy: Much of the planet's northern hemisphere is a low-lying plain roughly centered on the north pole, while the rest of that hemisphere and all of the southern hemisphere are ancient highlands. Explanations have ranged from Earth-like plate tectonics to the cosmic catastrophe of a huge impact. The MGS altimeter results, reported on page 1686 of this issue by a team led by geophysicist David Smith of NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland, hint that Earth-like tectonic forces and perhaps even an ancient ocean have shaped Mars's northern lowlands.

The MGS results show that the northern lowlands are remarkably flat across thousands of kilometers and smooth on a scale of hundreds of meters. It's "the flattest surface in the solar system for which we have data," says geophysicist Maria Zuber of the Massachusetts Institute of Technology, a teammate of Smith's. "The only thing that comes close is the heavily sedimented floors of Earth's oceans; it's actually flatter than that." The similarity to Earth's oceans suggests that Mars's great basin formed the same way—by plate tectonics. But altimetry alone can't solve the riddle of martian topography or rule out other origins for its giant basin, she warns.

The tantalizing new data come from the Mars Orbiter Laser Altimeter (MOLA) aboard the MGS. MOLA works much the way a ship's acoustic depth finder traces out the sea floor, but instead of using sound waves, it bounces an 8-nanosecond laser pulse of infrared light off the martian surface at 300-meter intervals.



Matching a martian profile. The flat martian lowlands resemble the topography of the South Atlantic ocean floor off Africa.

By measuring the light's round-trip time, MOLA gauges with 10-meter accuracy the height of the land, averaged over the width of the laser's 150-meter-wide beam. Changes in the shape of the pulse after reflection provide a measure of the smoothness of the surface the beam scanned.

After 18 north-south tracks, "the remarkable thing is that the northern hemisphere is flat over thousands of kilometers," says Zuber. On the scale of the 2000-kilometer-long tracks within the lowlands, the surface is level or slopes up toward the south at about 0.05°, she says. In most places between 50°N and the polar ice cap at 80°N, topography rises and falls by only 50 meters over hundreds of kilometers. This means, Zuber says, that the northern lowlands are flatter than the lava floods of the lunar maria, flatter than the vast volcanic plains of Venus, flatter than deserts on Earth. The smoothest part of the central Sahara, for example, is twice as rough as the martian lowlands. The most comparable topographic profiles Zuber could find are from terrestrial sea floors, for example the one running from the middle of the South Atlantic Ocean onto the edge of South America (see diagram for a similar oceanic profile). On the 100-meter scale, the smoothness of the martian lowlands is also comparable to that beneath terrestrial oceans. "You can see where this is going," says Zuber.

Indeed, this tempting match between Mars's lowlands and Earth's ocean basins fits a 1994 proposal by geophysicist Norman Sleep of Stanford University. He suggested that the lowlands are an "ocean" basin created by a martian version of plate tectonics that long ago ground to a halt. The lowlands would be underlain by dense crust produced by sea-floor spreading, and plate motions would have raised and roughened the boundary between the lowlands and highlands, another feature seen by MOLA.

Others have proposed that whatever the basin's origins, there might once have been water filling it (*Science*, 12 February 1993, p. 910), a notion consistent with the extreme smoothness. Such smoothness is typically produced by some kind of sedimentation, such as the steady rain of tiny particles that smooth out the roughness of ocean crust.

But other explanations of the basin's origins remain. For example, some researchers have suggested that one or several large asteroids or comets blasted Mars billions of years ago, leaving a thinned crust that sank as it cooled, an idea favored by MOLA team member Herbert Frey of the GSFC. No one knows just what kind of topography such a monumental impact would leave, so the altimeter data can't yet support or refute that idea. And Frey also points out that massive lava flows might account for the smoothness of the lowlands, especially with a patina of windblown sediments on top.

Finding out what made northern Mars so flat will take more data. For now, says planetary geologist Michael Carr of the U.S. Geological Survey in Menlo Park, California, "we just don't know" what created the great martian dichotomy. But an Earth-like ocean basin is the hometown favorite.

–**Richard A. Kerr**