PLANETARY SCIENCE

Don't Ignore the Planet Next Door

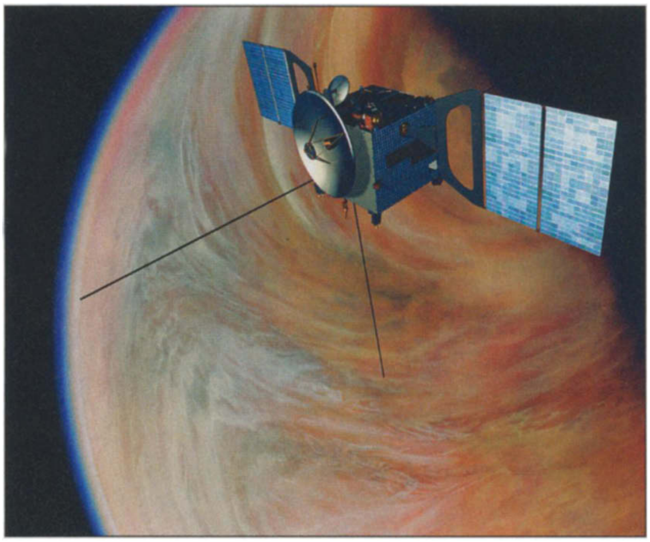
Is it time for a closer look at Venus? Some researchers say life could exist in its veil of clouds, and it could help us understand planets around distant stars

LONDON—Venus is the planet nearest to Earth, closest to Earth in size, and the brightest in Earth's skies. As such it would seem hard to overlook, yet overlooked it is. While NASA and the world's other space agencies lavish money on Mars—dispatching probes at an average of more than one per year—and eye other planetary prospects farther afield, such as Jupiter's moon Europa, they hardly spare a thought for Venus. The reason is water. Although Mars might look like a parched and frozen desert, its surface was marked by water in the distant past, and water may persist at some depth today. Water, the logic goes, means the possibility of life, in the past if not the present. Water thus makes a planet interesting. And water is something that Venus—with an average surface temperature of 460°C—conspicuously lacks.

Although inhospitable, Venus is not completely ignored. The European Space Agency (ESA) this month approved Venus Express—a mission to study the planet's atmosphere—for launch in 2005. But it's a cut-price project, cobbled together using instruments from ESA's Mars Express and Rosetta missions and built around a copy of the Mars Express spacecraft; it is not custom built for studying Venus. And even this modest effort was nearly cancelled earlier in the year because of budget problems.

Although Japan plans to launch a small satellite to study the atmosphere in 2007 or later, there is no major commitment to ongoing studies of Venus in any of the world's space agencies. NASA will have launched its first mission to look for Earth-sized planets around other stars well before it next sends a spacecraft to the Earth-sized planet next door. As Kevin Baines, a planetary scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, puts it, "There is little hope of finding life or signs of ancient life. So, Venus always seems to fall to the bottom of the list."

But not all of his colleagues accept Baines's premise. A few planetary scientists are starting to think it might be wrong to assume that Venus is a hopeless prospect for finding life. Their optimism stems not from any new information about Venus but from looking at what is known in a different way. Although it clearly lacks any extensive bodies of liquid water, Venus might still be conducive to life, they argue. Indeed, according to David Grinspoon, a planetary scientist at the Southwest Research Institute in Boulder, Colorado, Venus is as good a place to look for life today as either Europa or Mars—maybe better. "The case for possible life there is really as strong as on any other planet," says Grinspoon.



Neighborly visit. ESA's Venus Express will set off to study Venus's atmosphere in 2005.

So far, Grinspoon and his fellow Venus devotees haven't won over many of their colleagues. One eminent astrobiologist muses that it's interesting that a science which until very recently was viewed as on the fringe should now have a fringe of its own. But researchers in that fringe have started publishing papers and presenting ideas at conferences about both life on Venus and ways to study it. And if they haven't convinced many that Venus might harbor life, they have another argument that seems more compelling: We should be taking a closer look at Venus in order to prepare for what we might find when we look for life around other stars.

Grinspoon first started thinking about life on Venus in the mid-1990s. While writing the conclusion to a book about Venus, he tried to put together a case for life on the planet, just to see if such a case could be made. "My devil's advocate case was good enough to convince me, not that there is life there, but that there could be," he says.

The argument begins by noting that Venus might well have been as good a habitat for life as Earth or Mars were when the solar system was young; most opinion has it much cooler then than it is today, with every chance of liquid water. If Venus did not offer the right conditions for the origin of life—whatever they may be—it would still have provided a welcoming and clement landfall for any microbes on meteorites knocked off Earth or Mars. The chances of life on an early Venus are thus not that different from the chances of life on Mars at roughly the same time.

Unfortunately, both planets then underwent quite vicious changes of climate. On Mars, what surface water there might have been froze. Life would have been forced underground, where the planet's warmth would allow liquid water to cling on in deep aquifers and hydrothermal systems. It might persist there to this day. On Venus the problem was not the cold but the heat: a runaway greenhouse effect that boiled away the surface water. Grinspoon reasons that life on Venus, faced with the opposite problem of life on Mars, might have hit upon the opposite solution: migrating up into the sky to keep cool rather than down into the ground to keep warm.

Compared to its surface, the skies of Venus look positively alluring. The atmosphere contains some water vapor—although only a very little—and its clouds are at a sufficient height for that water to condense out in liquid form. Some of the cloud droplets at these altitudes are larger than the droplets in clouds above Earth are and thus are more than large enough to contain microbes. The clouds are continuous and permanent, and the individual cloud droplets stay aloft for months, so they could provide a reasonably stable environment. Thanks to presumed continuing volcanism, the clouds exist in an atmosphere rich in chemicals that living organisms might use to fuel their metabolisms, and there is plenty of sunlight for photosynthesis. Admittedly, the cloud droplets are composed of very highly concentrated sul-

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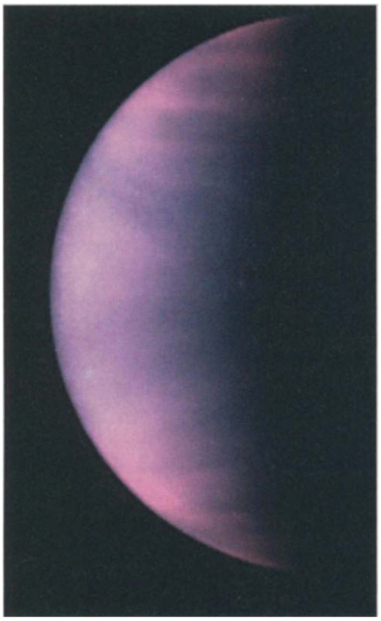
furic acid, and this might appear to be a showstopper. But microbes can survive in some very unlikely surroundings.

Indeed, since Grinspoon first started to advocate it, his devilish case for life above the hellish surface of Venus has received circumstantial support from studies of life on Earth. Earthly bacteria have been discovered in ever more acidic environments; some have now been found that thrive at pH levels as low as 0. And although it had long been thought that the only bacteria in cloud droplets were inert spores or were in suspended animation, recent measurements made in the Alps have shown that the bacteria in clouds can be metabolically active. If some earthly microbes can live in clouds and others in strong sulfuric acid, why shouldn't microbes on Venus have learned to do both at once?



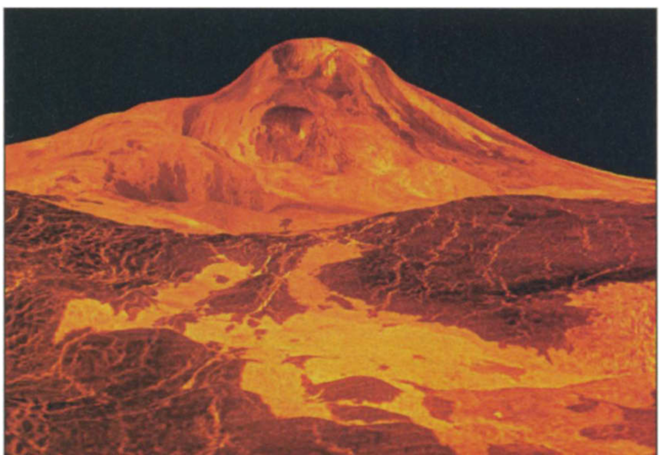
Acid skies. Could an organic pigment be absorbing ultraviolet light in Venus's sulfuric acid clouds?

In some ways, says microbiologist Dirk Schulze-Makuch of the University of Texas, El Paso, the permanent cloud cover of Venus might actually make a better home for microbes than the short-lived clouds of Earth. One possible energy source that venusian microbes might use, he speculates, is ultraviolet light. For decades, it has been known that there is something in the clouds over Venus that absorbs UV light very well. As yet, no one knows what it is—an organic pigment, perhaps?

Charles Cockell, a microbiologist at the British Antarctic Survey in Cambridge who wrote a paper about the astrobiological potential of Venus in 1999, is one of many who hold out little hope for such ideas of life in the clouds. Sulfuric acid is a powerful desiccating agent, and acid as strong as that in Venus's cloud droplets, he says, would pull the water straight out of any cells immersed in it. David Crisp of JPL, who chaired a panel that provided ideas about Venus to the recent decadal survey of planetary science done by the U.S. National Research Council, agrees. "[Schulze-Makuch and his co-author] make the assumption that there are water droplets, but that's fundamentally incorrect, as far as we know. There's no evidence for liquid water on Venus that's not bound in very, very concentrated solutions of sulfuric acid: 75% to 85% pure sulfuric acid."

Grinspoon does not accept that there is no overlap between the range of pH values earthly microbes can tolerate and the range found in the clouds of Venus. But even if the clouds of Venus are too acidic for any Earth-like life, that does not rule out life of other sorts. Steven Benner, a biochemist at the University of Florida, Gainesville, points out that the idea that water is necessary for life is far from proven. Some chemical reactions that might be the basis of different forms of life take place best under conditions where water is excluded, such as those of superacidity. And Benner thinks that if we can't imagine life existing in the clouds, that might just show our lack of imagination.

However plausible the case for life in the clouds of Venus is, it will be difficult to test. Bringing a sample of Venus's clouds back to Earth sounds quite simple: Design a probe to dip into the atmosphere as it flies by the planet, scoop up a bit of its surroundings, and carry on along a trajectory that brings it back to Earth. A mixture of aerobraking techniques like those used by Mars probes and sampling canisters like those on the Stardust mission to sample cometary dust would do the trick.



Welcome to hell. A computer reconstruction of Venus's scorching surface, showing lava flowing hundreds of kilometers from Maat Mons.

But Grinspoon worries that gathering up a sample at such speed might smash the very things that are being sought. And Crisp points out that designing a sample-return canister that can bring powerful and poorly characterized acids back to Earth in a pristine form is no easy task. Even if you could bring a sample back, looking for life in it would require a secure containment facility here on Earth. If the laboratory slated for dealing with the samples to be returned from Mars were used, then that cost could be avoided, but that laboratory is more than 10 years off.

Attempts to sample the atmosphere are hampered by the lack of a thorough understanding of how the planet works. Although more than 20 spacecraft from the United States and the Soviet Union visited Venus in the 1960s, 1970s, and 1980s, big questions—such as how its atmosphere works, what its surface is like, and how the two interact—still have not been answered. Crisp argues that this lack of understanding has led to the belief that small missions to Venus, such as those in NASA's Discovery Program, will not be up to the task of solving the outstanding problems, while at the same time making ambitious missions very hard to plan, because questions still remain about the environmental conditions they would have to work in. Before the tantalizing question of life above Venus can be answered, more basic spadework needs to be done, but neither NASA nor other space agencies are showing the necessary commitment.

That commitment could be crucial not just to understanding Venus but also Earth-sized planets around other stars. When scientists start detecting—and a decade or so later actually studying—such planets, they won't be little ones like Mars or moons like Europa. Researchers will be seeing planets the size of Earth and Venus. "What happens if we go out and we find primarily Venuses?" asks Crisp. Venus is both very much like Earth, in size and orbit and composition, and profoundly different. Without understanding these differences—including what they mean for the evolution of life on such planets—multibillion-dollar astrobiological efforts to make sense of Earth-like planets around other stars could be very frustrating.

–OLIVER MORTON

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CREDITS: (TOP TO BOTTOM) L. ESPOSITO/UNIVERSITY OF COLORADO, BOULDER/NASA; JPL