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COVER: The varying veils of Venus are shown in this series of ultraviolet images of the planet's cloud patterns taken by the Pioneer Venus orbiter. Even prominent structures such as the huge, horizontal "Y" visible in many frames shift, grow and occasionally disappear. For more on Venus, see p. 372. (Photos: NASA)

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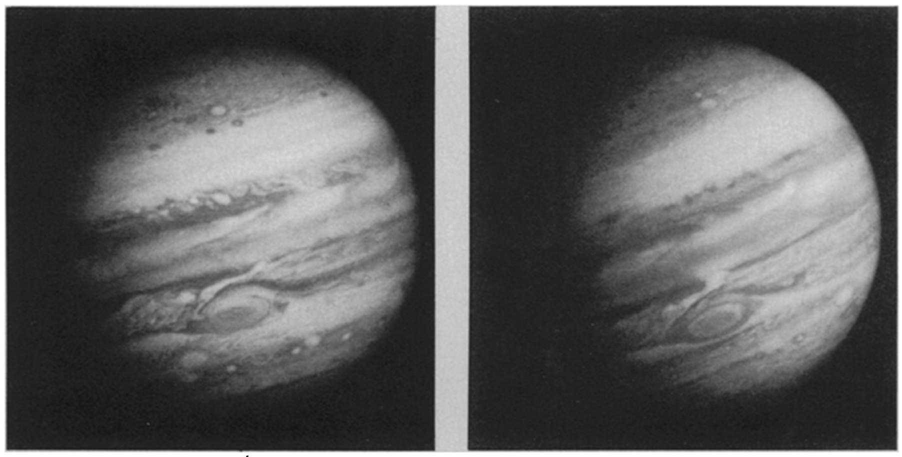
SCIENCE NEWS OF THE WEEK

Jupiter and Io: Competing Stars

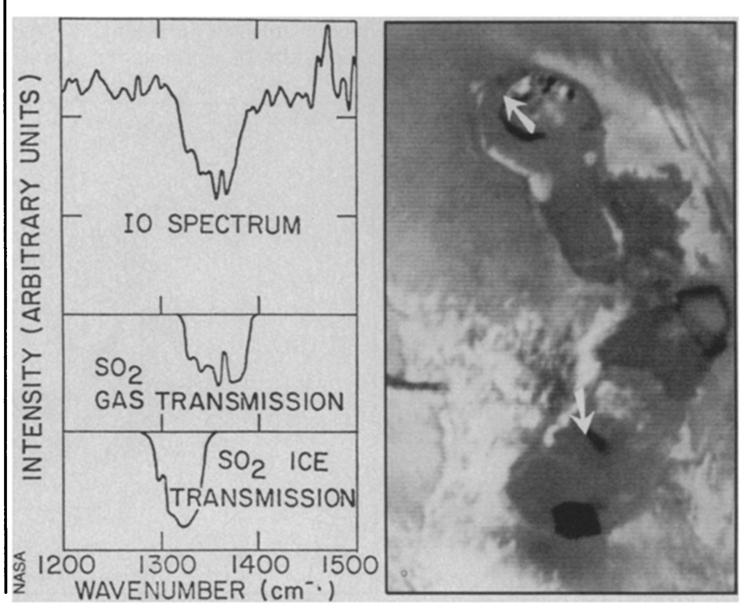


NASA

Jupiter shows many changes in Voyager 1 and 2 photos, less than four months apart.

At last week's sprawling spring meeting of the huge American Geophysical Union, hordes of scientists descended on Washington to compare studies of the earth, from the continents of the past to the earthquakes of the future. Other worlds also have a place at the multidisciplinary AGU, however, and giant Jupiter, together with its remarkable family of moons, was a major attention-getter, thanks largely to the torrent of new information from the Voyager 1 spacecraft's March visitation. The data do not give up their secrets overnight, and some of Voyager's scientists have been almost as busy addressing meetings and colloquia as they have working in their laboratories. But with nearly three months elapsed since the flyby, the AGU became the first major forum for a broad-based airing of new Voyager results.

Yet the star was not the mighty planet itself, but its satellite Io, whose active volcanism is one of the major discoveries of planetary research. Voyager's photos have now revealed about eight active volcanoes, whose eruptions were estimated by one scientist at the meeting to last for at least hours to days. More than 100 calderas — volcanic holes — have been identified on Io's surface, some of them showing radial flows of whatever passes for lava on the strange object, though the flows were described as "very thin and runny." The currently favored explanation for the unexpected eruptions — tidal heating caused by varying gravitational stresses — is still in vogue, but nothing involving Io comes easy: The theory says that most of the heating should be taking place at the poles, says Lawrence Soderblom of the U.S. Geological Survey, yet most of the eruptions are within about 30° of Io's equator. Furthermore, the polar regions, where (the theory says) the crust might be expected to be the least substantial, are the only places on Io where high mountains and other major topography are prominent.



NASA

Infrared spectrum of Io (far left) shows better match with lab spectrum of sulfur dioxide in gaseous form than with SO_2 ice. Io photo indicates (arrows) possible SO_2 "snow" (top) and possible molten sulfur (bottom).

Apart from — or perhaps because of — the volcanoes, Io's surface still poses problems for researchers trying to understand its composition from earth-based and spacecraft spectra, where unusual infrared features have prompted a variety of exotic explanations. At the AGU meeting, Douglas B. Nash and Robert M. Nelson of Jet Propulsion Laboratory suggested a particularly complex candidate: grains of sublimated salts such as sodium sulfide, potassium sulfide and sodium hydrosulfide, with quantities of such (presumably volcanic) gases as sulfur dioxide and hydrogen sulfide adsorbed on their surfaces, and with the result then bombarded by protons trapped by Jupiter's magnetic field. Another possibility may be SO_2 frost.

As for what's coming out of the volcanoes, SO_2 gas has been detected by Voyager's sensors, and there are probably other components. Conspicuously missing, however, is water, suggesting that Io has been active (and spewing its water away) for much of its history. Once the gases are in the open, there are signs that they may condense in part and fall back to the surface. Ultraviolet data indicate fine-grained solid particles, possibly less than a micron across, and some bright blue spots on color photos of Io have been tentatively identified by some researchers as "blue snow," in sharp contrast to the satellite's red and yellow surface.

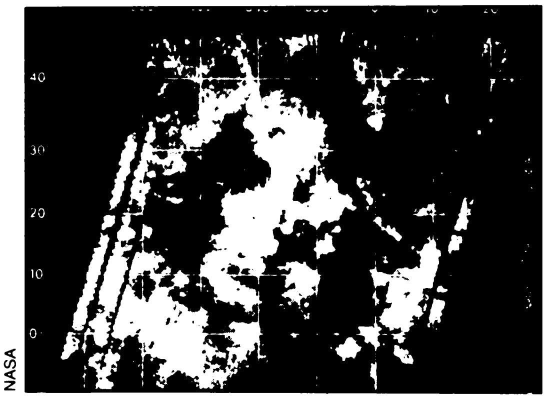
Another Io-related feature is a torus of ionized sulfur that surrounds Jupiter along Io's orbit. Pre-Voyager, earth-based observations had identified singly ionized sulfur in the torus, and the hotter, doubly ionized form turned up in Voyager's data. Now the torus appears more energetic still, with a report from refined Voyager measurements that there are significant amounts of *triply* ionized sulfur.

But Io was not the whole show. Ganymede, another Jovian moon studied by Voyager, was described at the meeting as having a surface covered with fist-sized rubble—except for the significant fraction that is criss-crossed by fault-like features hundreds of meters deep and several kilometers wide. Callisto, which has several large, multi-ringed basins, has yet to reveal topography above several hundred meters.

There was more about the moons, and about Jupiter itself. Data on the famous Great Red Spot indicate that its vorticity is strongest at depth, and that its turbulent winds move more slowly at higher levels. (One researcher raised the possibility of a correlation between solar-cycle activity and the "darkness" of the spot's color.) Norman Ness of the NASA Goddard Space Flight Center described the planet's huge magnetic tail, with a diameter 300 to 400 times Jupiter's radius, and noted the odd eccentricity of the planet's auroral zones, which are centered on neither the magnetic nor rotational axes.

It was a heady dose of Jovobilia — and Voyager 2 will add more in July. □

Venus: The unveiling continues

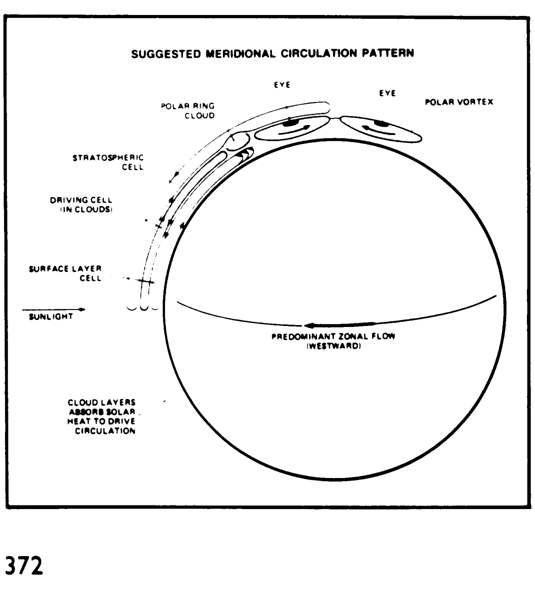


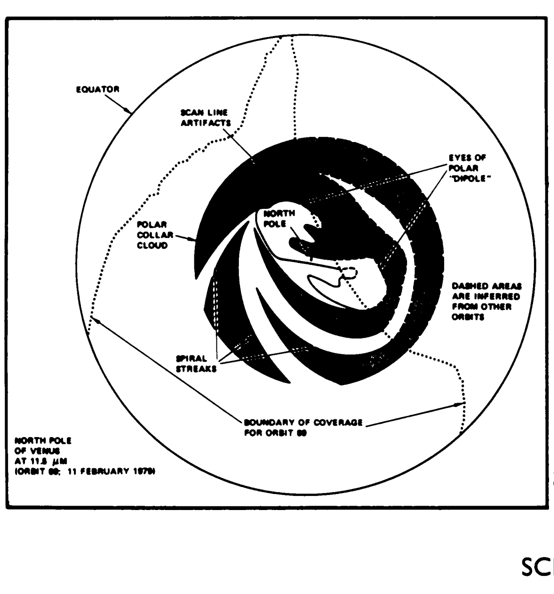
Radar image shows ancient impact craters, with central peaks, in Venus's lowlands.

The portrait of Venus that is emerging from the spacecraft of the Pioneer Venus project is a strange one, combining similarities to earth with dramatic differences. Some of the involved scientists are still working to understand the initial burst of data from the mission's cluster of atmosphere probes, while other researchers wait impatiently for the slowly precessing orbiter (whose orbital low point shifts only 1.5° per day) to complete its trip around the planet. But the portrait, as presented at last week's AGU meeting and in recent journal articles, is definitely taking shape.

The atmosphere's all-concealing cloud structure is now described as five-layered: a high, thin haze from 70 to 90 kilometers up, a broken cloud deck below that, a "continuous, planetwide" cloud layer beneath that one, another broken layer still farther down and finally another hazy region, decending from about 48 km down to a surprisingly abrupt cutoff some 32 km above the surface. The 1974 Mariner 10 spacecraft's ultraviolet photographs revealed complex circulation patterns in the atmosphere, but half a decade later, with far more data to go on, the Pioneer Venus researchers are still unsure of what atmospheric components are absorbing the sun's UV light to render the patterns visible. One candidate is sulfur dioxide, shown by the orbiter's UV spectrometer to exhibit planetwide variations that correlate with the dark markings photographed at longer UV wavelengths. But SO_2 is not enough, according to the University of Colorado's L. W. Esposito, and some additional, "broad-band" absorber is likely. Without them, Venus by UV would look as bland as it does by visible light.

One of the most prominent cloud features resembles a huge letter "Y" lying on its side with its stem wrapping around the equator. When the "Y" was first identified in Mariner 10's photos, some researchers believed that it was a permanent feature, circling the planet every four days (far faster than Venus itself). Hundreds of Pioneer Venus photos, however, have shown the "Y" to be much more quixotic, circling sometimes in five days, sometimes in three. Sometimes the stem of the "Y" wraps three-quarters of the way around Venus, sometimes it simply disappears, leaving the whole planet girdled by the concentric arcs of the "Y's" throat.





Poleward heat transport on Venus (far left) consists of stacked circulation cells, driven —unlike earth's system—from the middle cell, where cloud particles trap the heat. North-polar view (left) shows cool, high cloud "collar," containing hotspot "eyes."