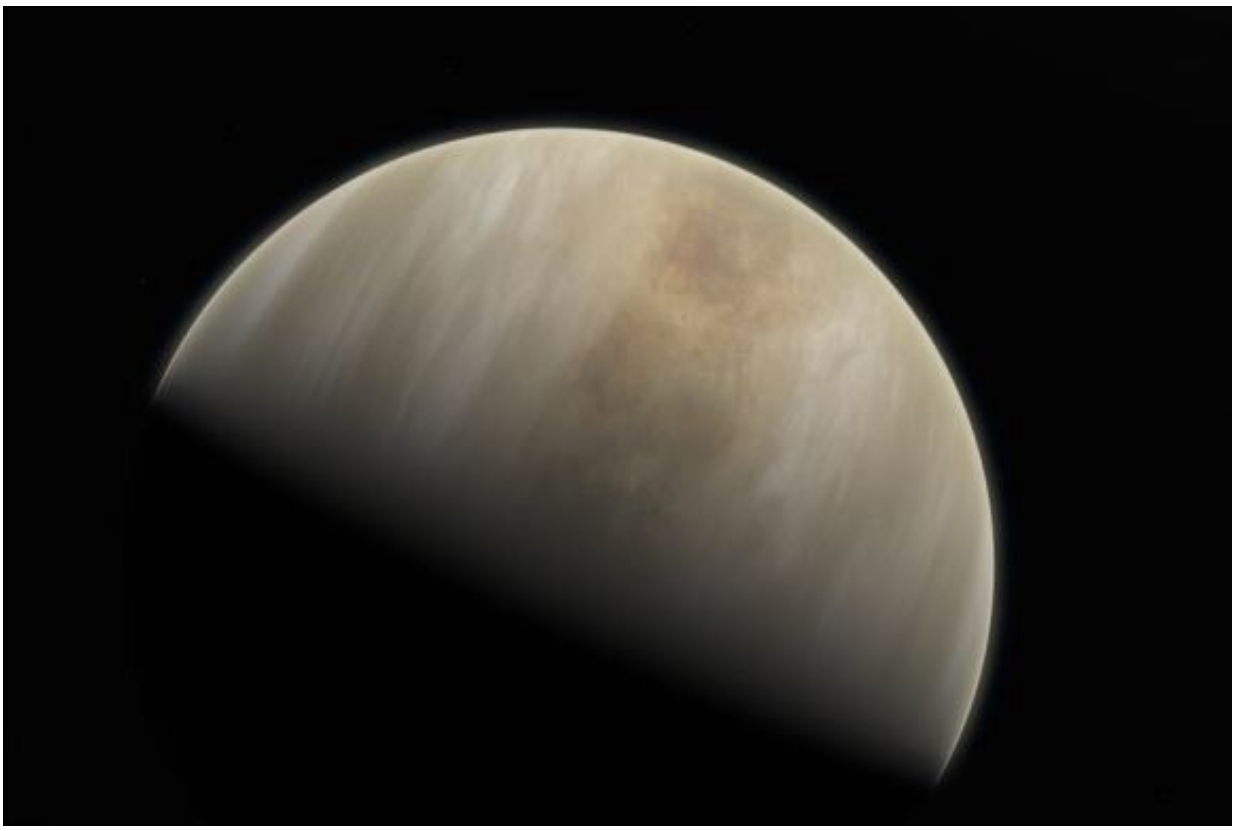
Scientists have re-analyzed their data and still see a signal of phosphine at Venus—just less of it

November 23 2020, by Matt Williams



This artistic impression depicts Venus. Astronomers at MIT, Cardiff University, and elsewhere may have observed signs of life in the atmosphere of Venus. Credit: ESO/M. Kornmesser & NASA/JPL/Caltech

In September, an international team announced that they had discovered phosphine gas (PH_3) in the atmosphere of Venus based on data obtained by the Atacama Millimeter-submillimeter Array (ALMA) in Chile and the James Clerk Maxwell Telescope (JCMT) in Hawaii. The news was met with its fair share of skepticism and controversy since phosphine is considered a possible indication of life (AKA a biosignature).

Shortly thereafter, a series of papers was published that questioned the observations and conclusions, with one team going as far as to say there was "no phosphine" in Venus's atmosphere at all. Luckily, after re-analyzing the ALMA data, the team responsible for the original discovery concluded that there is indeed phosphine in the cloud tops of Venus—just not as much as they initially thought.

In the original study, which was published in the Sept. 14th issue of *Nature Astronomy*, the team presented findings from ALMA and the JCMT that indicated the presence of PH_3 around Venus' cloud deck. On Earth, phosphine is part of the phosphorus biochemical cycle and is likely the result of phosphate reduction in decaying organic matter. On Venus, there are no known chemistry or photochemical pathways for its creation.

The only non-organic (AKA abiotic) mechanism for the production of phosphine involves high temperatures and pressures, which are common within the atmospheres of gas giants. In fact, phosphine has been detected in Jupiter's atmosphere, where it forms as a result of planet-sized convective storms that generate tremendous amounts of energy. The only other explanation was bacteria floating in Venus's cloud deck.

"Spurious"

In one study, which was led by researchers from NASA Goddard and appeared in a *Nature Astronomy* article (Oct. 26, 2020), also cast doubt

on the analysis and interpretation of the ALMA and JCMT datasets. Here, the research team indicated that the spectral data that was interpreted as phosphine (PH_3) was actually too close to sulfur dioxide (SO_2), which is common in Venus atmosphere.

Artist's impression of the surface of Venus. Credit: Greg Prichard

According to another study that was led by Leiden University (November 17, 2020, *Astronomy & Astrophysics*), the spectral data obtained by ALMA could be explained by the presence of compounds other than phosphine gas. From this, they concluded that there "no statistically significant detection of phosphine" in Venus' atmosphere and that the previous results were, in fact, "spurious."

Jane Greaves, who led the discovery team (and is an astronomer at Cardiff University, U.K.), claims that they were motivated to reexamine their original conclusions because the original ALMA data contained a "spurious signal" that could have thrown off their results. When the corrected ALMA data was posted on November 16th, Greaves and her colleagues ran a fresh analysis and posted it ahead of peer review on arXiv.

This is the team's first public response to the criticisms that were made in the wake of their original findings. Their revised findings were also presented at a meeting of the Venus Exploration Analysis Group (VEXAG), a NASA community forum, that took place on November 17. While they have since indicated that their results are "tentative," they remain confident about the presence of phophene in Venus' atmosphere.

So… Less?

According to Greaves and her colleagues, the ALMA data demonstrated a spectral signature that cannot be explained by anything other than the compound phosphene. This, they claim, is further bolstered by the JCMT spectra that indicated the chemical fingerprints of phosphine. Based on the new ALMA data, the team estimates that phosphine levels average at about 1 ppb—about one-seventh of their earlier estimate.

These levels, they indicate, likely peak at five parts per billion (ppm) and vary over time and depending on location. If true, this situation is similar to what scientists have observed on Mars, where methane levels wax and wane over the course of a Martian year and vary from place to place. In addition to criticism, supporting evidence was also inspired by the team's original paper—which was also presented at VEXAG on November 17.

Artist’s impression of the Pioneer Venus Orbiter. Credit: NASA

Inspired by the possibility, biochemist Rakesh Mogul of the California State Polytechnic University in Pomona and his colleagues reexamined data from NASA's Pioneer Venus mission. In 1978, this missions studies Venus' cloud layer using a probe that it dropped into the atmosphere. Based on their reanalysis of the data, Mogul and his colleagues found evidence of phosphorus.

This could evidence of phosphine or some other phosphorus compound, though Mogul and his team believe phosphine is the most likely candidate. Regardless, several scientists argued at VEXAG that a modest

level of even 1 ppm phosphine cannot be attributed to processes like volcanism or lightning. There was also the recent announcement that the amino acid glycine was discovered in Venus's atmosphere, another potential biomarker.

What's Next?

For obvious reasons, finding evidence of phosphine on Venus would be very appealing. In the past, scientists have speculated that life could exist in the planet's cloud deck, where temperatures are stable enough that extremophiles could survive. If this compound is confirmed in Venus' atmosphere, it would indicate that Venus is capable of supporting extreme lifeforms in niche habitats.

In any case, these results demand further investigation and have led to renewed proposals for missions to Venus," possibly in the form of a balloon or an airship. In the meantime, Greaves and other researchers hope to have more time with Earth-based telescopes (including ALMA) to confirm the presence of phosphine. Whether this compound exists there or not, Venus is still a bundle of mysteries just waiting to be solved!

More information: Alexandra Witze. Prospects for life on Venus fade—but aren't dead yet, *Nature* (2020). DOI: 10.1038/d41586-020-03258-5

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