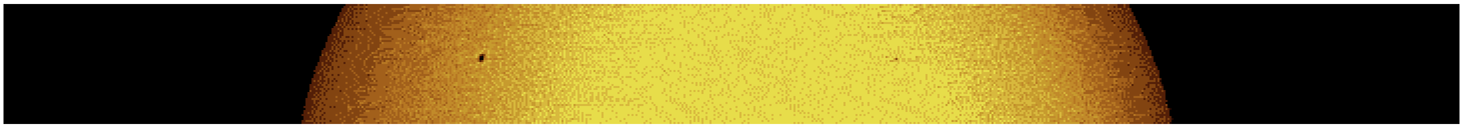

Methane on Mars

By David Tytell

Does Mars have life? Recent spectroscopic observations of the Red Planet have found methane, a gas that is predominantly produced by organisms on Earth. This image, which is centered on Valles Marineris, is a mosaic of pictures from NASA's Viking 1 orbiter. *Courtesy NASA / USGS.*

September 8, 2005 | Mars keeps surprising the experts. Consider methane (CH_4), for example. On Earth, more than 90 percent of this gas comes from biological sources that include cows, termites, rice plants, and other lifeforms. Geological processes such as volcanism contribute hardly any methane at all.

Given that no evidence for life has been found on Mars, one shouldn't expect to find significant levels of methane being created. But observations from ground-based telescopes and the European Space Agency's Mars Express orbiter have turned up surprising amounts of the gas. A new study of Martian atmospheric chemistry by Sushil K. Atreya (University of Michigan) implies that methane production might be quite active on the red planet and that scientists cannot rule out a biological source. Atreya presented his results at this week's American Astronomical Society Division for Planetary Sciences meeting in Cambridge, England.

Atreya examined possible abiogenic sources of Martian methane and concluded that few of them work. Deposits from comets aren't likely, since the distribution of methane varies across the planet. Atreya also dismissed volcanoes because they cannot produce the detected amounts and because sulfur dioxide, which abundant in Earth's volcanic emissions, hasn't been detected on Mars.

Instead, Atreya concludes that the methane is probably leaking out slowly from beneath the surface. According to Atreya's models, deep vents heated to between 40° and 90°C (100° to 200°F) can generate the gas. In that temperature range, water is stable 1.5 to 10 kilometers deep. And if water is present, geologic hydrogen can react with silicate rocks

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and carbon dioxide (CO_2) to produce methane.

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But Atreya also notes that scientists could be vastly underestimating the volume of methane observed thus far (the measured global methane abundance requires that some 125 tons is produced per year). According to models, solar ultraviolet light breaks apart carbon dioxide in Mars's atmosphere, and the resulting free oxygen molecules combine with hydrogen atoms to form hydrogen peroxide (H_2O_2) at high altitudes.

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Now Atreya proposes a new mechanism, electrochemistry, to produce vast quantities of H_2O_2. Electrostatic fields generated in Martian dust devils and dust storms can break down water vapor and carbon dioxide to make H_2O_2. But unlike the ultraviolet-light process, electrostatic H_2O_2 forms near the surface where the densities of H_2O and CO_2 are larger. Moreover, while the H_2O_2 produced in the atmosphere will break down quickly in same ultraviolet radiation that helped to form it, the hydrogen peroxide molecules made close to the Martian surface can more easily hide in the soil from ultraviolet light. There they accumulate, and that's a problem for methane. Hydrogen peroxide is a powerful oxidant and it "scrubs" organics such as methane from the ground, says Atreya.

Further tests are required to determine just how much methane is destroyed by H_2O_2. Future Mars missions, specifically NASA's Mars Science Laboratory (scheduled for launch in 2009), should reveal the methane's source. This large rover will measure the amounts of carbon isotopes for signs of biological activity. On Earth, biology sorts carbon-12 from carbon-13 differently than geological processes do. Therefore, if Martian methane has an excess of carbon-12 relative to carbon-13, it would suggest a Red Planet teeming with organisms. "We don't have any proof that there is biology happening on Mars," stresses Atreya. But we can't declare Mars sterile just yet.

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