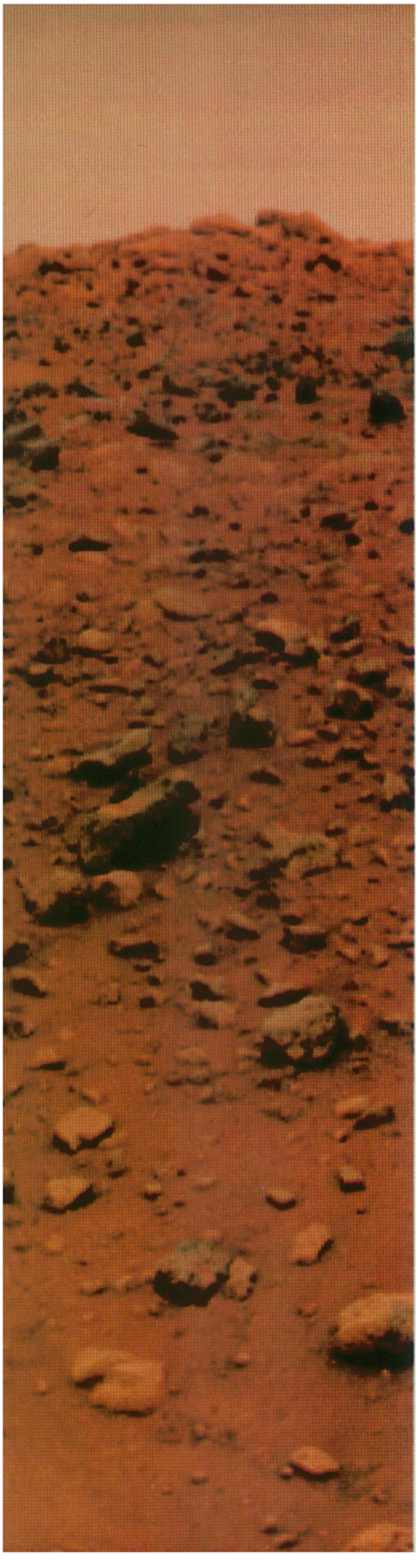


SCIENCE NEWS OF THE WEEK

Viking: A Lively Look for Life

Harold P. Klein is about as low-key a scientist as there is on the Viking project's huge scientific team, even when presenting data with such adjectives as "important, unique and exciting." When he said those words on the afternoon of July 31, however, everyone in his audience at Jet Propulsion Laboratory in Pasadena knew what the mission's chief biologist meant. The rumor mill had already been at work for half a day, and the tension was nearly tangible as Klein moved through a carefully considered introduction, meticulously rejecting sensationalism as he approached his sensational subject: startling findings, at the very first look, from the first instruments ever to seek life on another planet.

Three days before, on July 28, the three instruments in the Viking lander's automatic biology laboratory had received tiny samples of the soil of Mars, delivered by the craft's telescoping scoop from a site carefully chosen only after many days of study. The project's biologists had been preparing themselves for months and even years to monitor developments inside the soil-containing test chambers at precisely determined rates, expecting for the most part to be observing relatively gradually evolving data curves and peaks as the samples responded to nutrient mixtures and other test conditions. *Gradually?* The very first time they looked at their early results, stunned scientists on two of the three teams found themselves faced with readings that placed them abruptly face-to-face with their ultimate question: possible signs of life on Mars.

One of the instruments, a gas-exchange experiment designed to detect a variety of atmospheric changes in the test cell caused by the life-processes of Martian microorganisms, exposed its single cubic centimeter of soil to 0.51 cubic centimeters of nutrient only two hours before taking its first reading. Several gases were reported by the gas chromatograph monitoring the chamber, but the eye-opener was the discovery that the tiny cell now contained 15 times more oxygen than could be accounted for either by the Martian atmosphere or by impurities in the predominantly carbon dioxide test atmosphere that supplemented the "native" air. Twenty-four hours later, a second reading showed an additional 30 percent oxygen rise.

The second instrument, the labeled-release experiment, wet its sample down with 0.1 cubic centimeters of a nutrient containing simple carbohydrates, amino acids and other ingredients, each of whose carbon atoms was radioactive carbon 14, detectable by geiger counters if the carbon 14 should be released from the soil in gaseous compounds—such as in the exhalation of microscopic life forms. Almost as soon as the nutrient was administered, the readings began to shoot upward, at first climbing nearly vertically up the scale before easing off slightly to a level, only 9 hours and 20 minutes later, of 4,537 counts per minute above the instrument's background reading.

Were these to be the first signs ever recorded of the fabled Martians? Extraterrestrial life? Aliens from space? The question could not be immediately answered, and expectations this week were that far more data would have to be accumulated (including that from a third instrument, due for its first readout this week) before the question could be answered—if ever. No one can yet say for sure that inanimate Martian chemistry cannot mimic the reactions of earthly microorganisms or that life on Mars is perfectly disguised to Viking's instruments as mere gas-solid interactions. But the sudden and dramatic data gave the scientists an immediate place to begin, an unambiguous green flag to perhaps the most important search ever undertaken.

Before the exotic possibility of Martian biology can be confirmed, the more mundane possibilities first must be disposed of. The oxygen, Klein points out, might simply represent gas adsorbed or trapped in some way to the soil particles until it was set free by the warmth and moisture of the test cell. "As an alternative," he says, "there may be some highly oxidizing compound or material or superoxide in the soil." Hydrogen peroxide (H_2O_2), for example, commonly used for bleaching hair, is only too ready to give up its extra oxygen atom. Or, if the oxygen was adsorbed onto the soil grains, perhaps it originally got there following photodissociation of water molecules near the surface. Soil samples, after all, came from barely two inches down, and if there is a deep layer of permafrost, the low atmospheric pressure could possibly encourage it to release some of its substance as vapor.

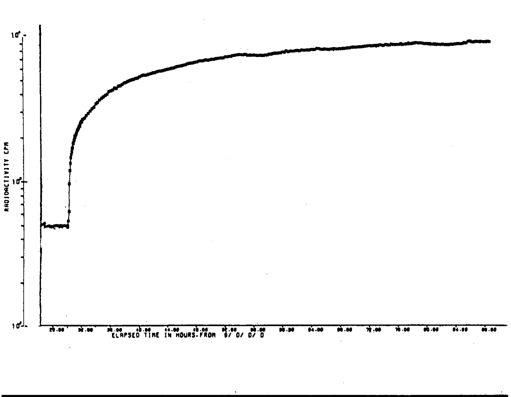
Yet it is impossible to absolutely rule out the chance that the gas is produced by living things; most of earth's oxygen is kept available for animal life by the complementary respiration cycle of plants. Furthermore, even if this initial output is of inanimate chemical origin, there could still be life in the soil sample, perhaps already beginning to release more

The reddish color of the Martian surface is clearly evident in this segment of first color photo. One suggestion: surface coatings of hydrated iron oxide, limonite.

gradual traces that will culminate in the Great Discovery. On the other hand, says Frederick S. Brown, project scientist at TRW, Inc., where the biology package was developed, if peroxides or superoxides caused the initial reading, it could bode ill for potential life forms, since such molecules can break down the organic molecules that make at least terrestrial life possible.

The leading argument against life processes as a source for the quick-rising carbon 14 radioactivity readings in the labeled-release experiment is simply that their steep climb didn't last. After they reached more than 4,500 counts per minute in less than 10 hours, it took the next 24 hours to bring the total to 8,000, and less than a day later, the graph of the data appeared to have leveled off at about 8,500 counts per minute. Some Viking biologists feel that if micro-Martians were indeed consuming the nutrient and expelling its radioactive carbon, the resultant data curve would climb much more gradually, following an exponential path as the well-fed organisms spawned successive generations of consumers. Also, the rapid observed initial growth rate of the counts suggested to some researchers that the inferred Martian life forms would have to be considerably more active than earthly microorganisms, although some terrestrial soil samples tested by the experiment's scientists produced initial rates nearly as high under test conditions.

The problem is that the observed growth rate didn't last. The curve flattened out, suggesting as one possibility that a finite quantity of inanimate material was taking part in a chemical reaction that petered out as the supply of material ran down. One suggestion was that the oxygen from the nutrient itself was combining with oxygen in the soil (supported by the nonbiologic interpretation of the gas-exchange data), and then joining with the nutrient's carbon 14 to release it in gaseous form, probably carbon dioxide. But again, reminds the experiment's team leader, Gilbert Levin, it is impossible to rule out life, despite the discouraging interpretations. The data curve, he says, really resembles neither chemistry nor biology on earth. Terrestrial nonbiologic processes tend to yield much lower initial production rates, rapidly reaching a plateau, according to Levin, while living earthly microorganisms typically proliferate for as long as 168 hours in the Viking instrument before running out of food or growing room and reaching their plateau. Late in the week, said Levin, a second dose of nutrient would be injected into the experiment's test chamber to see if possible life forms could be inspired to reproduce anew, which ought to produce a second steep curve. Also due this week were the first results from the third biology instrument, which would pyrolize, or burn, a soil sample that had been exposed to a carbon 14-labeled atmosphere to see if organisms in the soil have assimilated the tracer into their bodies.



G. Levin, P. Straat et al.

Abrupt climb in data from labeled-release biology experiment soon leveled off.

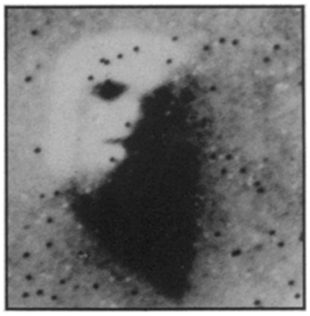
Meanwhile, as rapt attention focused on the prospects for life on Mars, another group of researchers was analyzing the soil that the Martians might be living in. A first look at data from the lander's X-ray-fluorescence spectrometer revealed the major constituents to be iron, calcium, silicon, titanium and aluminum, although it was too early to calculate precise percentages. "Silicate rock material is definitely present," reported team leader Priestley Toulmin, and a high calcium-to-potassium ratio indicated a relatively undifferentiated, basaltic—rather than granitic—composition. Trace elements such as rubidium, strontium and zirconium were scarce enough, if present at all, to require additional study to detect them, though interest in them runs high because of their possible biological importance as well as their significance for the planet's geologic history.

If the iron in the sample (also delivered by the scoop) was indeed in the form of surface coatings, said Toulmin, they must have been thin ones, since, as colleague Benton Clark pointed out, more than a few microns of iron oxide coating would have masked the signs of silicon. The nature of the planet's reddish coat was still unresolved this week, with estimates ranging from a hard surface of limonite (SN: 7/31/76, p. 68) to loose deposits of wind-blown dust. Apart from the color, careful study of photos of the ground around the Viking lander did suggest a possible, weak physical crust, however, and the X-ray-fluorescence data offered a possible explanation, though the early data were too scanty to be certain. "There's something in the region of the spectrum that corresponds to sulfur and chlorine," Toulmin said. "That is consistent with evaporite deposits." Both elements are quite soluble in water, he points out, and it is possible that past traces of water might have caused them to become a weak "cement" that gives the surface of the soil a little extra cohesion.

Even below the immediate surface,

Photos: NASA-JPL

Trench excavated by Viking sampler: Soil showed intriguing activity in first tests.



The "face" seen from orbit. Below, lander footpad No. 2 completely buried in soil.

however, there seems to be more cohesion among the particles than expected. The walls of the trench dug by the lander's scoop failed to collapse inward as anticipated. A close study of the trench and its environs, says geophysicist Henry Moore, suggests a soil cohesion of about 1,000 dynes per square centimeter, about like that of wet beach sand, although this is unlikely to imply a wet landing site. The cohesiveness, however, was not too great to prevent one of the lander's footpads from becoming completely buried in the soil, aided apparently by the fluidizing effect of trapped atmosphere, the minimal particle-packing due to low gravity and the apparent slight doming of the pad's impact site. The bulk density of the soil at the trench, says Moore, is about 1.8 to 2.0 grams per cubic centimeter. This, he adds, is the sort of bulk density produced by packing together soil particles with individual grain densities like the 3.0 grams per cubic centimeter of typical lunar rocks or the 2.6 grams of common terrestrial feldspar.

As the pace of activity accelerated on the surface, the Viking 1 orbiter continued its rounds, providing data on the planet's large-scale features and seeking a landing site for Viking 2, which would reach Mars orbit on Aug. 7. One of the Viking 1 photos revealed a huge domed feature in the planet's northern latitudes, fully a mile across, with an uncanny resemblance to a human face. Said Viking site-selection chief Harold Marsursky: "This is the guy that built all of Lowell's canals." □

'And now a message from Uranus . . .'

It took nearly two decades for pioneering radio astronomers to realize that the earth was not the only planetary source of nonthermal radio emissions in the solar system. Jupiter's powerful radio bursts were discovered in the early 1950s, after which another 20 years passed before Larry W. Brown of NASA's Goddard Space Flight Center in Maryland detected the same phenomenon coming from the planet Saturn (SN: 12/14/74, p. 372). Now Brown has tentatively added a fourth planet to the list: Uranus.

The evidence is subtle indeed, consisting of no more than 6 brief radio bursts, each less than 3 minutes long, painstakingly extracted from about 500 *days* of data from the IMP-6 satellite, sixth in the so-called Interplanetary Monitoring Platform series. Since Uranus is much farther from earth than Jupiter or Saturn, and is also smaller and less massive with presumably a proportionately smaller magnetic field, its radio emissions are extremely weak by the time they reach an earth-orbiting satellite. As a result, Brown first had to pare away numerous possible sources of confusion before he could tell whether such signals were present.

First, because the sun is the "loudest" radio source in the sky, he scrapped all data gathered when the sun was within 20° of the line between Uranus and the satellite. Earth is another big noisemaker, so out went everything taken when the satellite was less than 4 earth-radii from the planet. To weed out spurious signals, Brown then rejected all of the remaining data except that in which at least three adjacent channels in the IMP-6 receiver indicated the direction of Uranus, and then chopped off all frequencies below 185 kilohertz to eliminate powerful terrestrial interference which could exceed his previous 4-earth-radii limitation. (The frequency cutoff alone, says Brown, knocked out 999 of every 1,000 bursts in the data.) He then excised all remaining signals with intensities greater than 20 times that of the galactic background radiation in order to filter out ultra-strong solar and terrestrial bursts whose very strength could mislead the satellite as to their true direction of origin. But because the strongest galactic radiation happened to be coming from the approximate direction of Uranus at the time, he also rejected everything with *less* than three times the galactic signal strength.

The remainder was Brown's prize: 6 bursts, with peak strengths at about 475 kilohertz and ranging from 375 to 600 kHz. But he strongly emphasizes that the analysis was "very, *very* difficult" and that the results are "very iffy." The Saturn emissions were detected in the same batch of IMP-6 data, but those, besides being stronger, could be double-checked by matching pulses in the signals against the planet's 10.5-hour period of rotation. Uranus, tilted 98° on its axis, offered no such possibility. Also, the Saturn data were later confirmed by the moon-orbiting Radio Astronomy Explorer satellite, which could get extremely precise positional fixes by timing the signal cutoff at the sharp limb. Uranus was in the wrong position for this to work either. The only possibility of confirmation, Brown says, lies in a satellite to be launched in 1978 as part of the U.S.-European International Sun-Earth Explorer series, one of whose instruments will have the right frequency range and aiming system to possibily do the trick.

It is just possible that Brown has found the last major radio source in the solar system that can be detected from earth. Mercury's slight magnetic field may produce some emissions, but they would be extremely weak, and the planet is so close to the sun that they would be almost impossible to detect anyway. Neptune is a likely emitter, but its smaller size (relative to Jupiter, Saturn and Uranus) probably means that its bursts are at such low frequencies that they are completely lost in earth's own radio noise. Mars has a field so weak that the Viking orbiters don't even carry magnetometers, and Pluto is simply too small. Of course there *are* some large, interesting moons. . . . □

Getting a charge out of charm

Most of the recent discoveries in particle physics have involved new objects related to a theoretically conjectured property of particles (quantum number) known as charm (SN: 6/26/76, p. 408). Two months ago we reported the discovery of the first particle that seemed to exhibit the new property openly, or "nakedly" as some physicists like to say (SN: 6/5-12/76, p. 356). This, like nearly all the previous new particles of the last two years, had been found in the products of electron-positron annihilation collisions in the SPEAR storage ring at the Stanford Linear Accelerator Center.

The particle found in the spring was electrically neutral. It often happens in particle physics that electrically charged particles of similar nature exist to match a neutral one, and SLAC now reports the discovery of negatively and positively charged particles that appear to go with the neutral one. The experiment that did the work is the same one that found all the others. It is operated by a consortium including a few dozen physicists from the staffs of SLAC and the Lawrence Berkeley Laboratory.

The newly found particles have masses of about 1,876 million electron-volts (1,876 MeV). This compares favorably to the mass of the neutral one, 1,865 MeV. Usually there is a slight mass difference between electrically charged and electrically neutral particles that share the same characteristics otherwise. In this case, according to one of the experimenters, Harvey Lynch of SLAC, the missing mass—the mass of the uncharged particle or particles involved in the action—comes out equal to that of the neutral one, a seeming indication that all three are made at the same time.

The evidence for all of these particles comes from their radioactive decay products. The particles themselves are not recorded, and there is no equipment that detects charm directly. What appears in the data is a resonance, a sudden sharp increase in the ratio of one class of particle (hadrons) to another class (leptons) in the decay products. The narrower the resonance, the more certain the experimenters are that they are dealing with a short-lived particle of a definite mass as the stage between the electron-positron annihilation and the recorded decay products. This one is extremely narrow, Lynch says, too narrow for the detectors to resolve in fact, or less than 40 MeV wide.