Message from Earth: Viking Phone Home

Hours before dawn on Jan. 4, a small group of people met in Pasadena in a room of Jet Propulsion Laboratory's building 230 to wait and hope for a message from another world. It didn't come. Similar communications had been reaching earth regularly for nearly six and a half years, but since mid-November, the worried JPL engineers have been unable to coax so much as a single word from the Viking 1 landing craft on the surface of Mars.

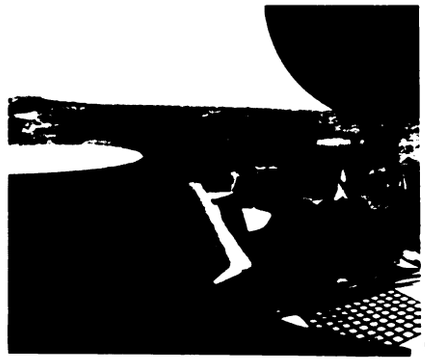
The lander touched down on July 20, 1976, designed for a mission of 90 days. In its remarkable longevity, however, it has provided thousands of photos and ongoing weather reports, working so well that in 1980 it was programed to keep going, automatically, all the way into December of 1994. The Viking flight team at JPL that once numbered 800 people dwindled to fewer than half a dozen, but the lander (whose Viking 2 twin had stopped working after a "mere" three and a half years) kept ticking away, beaming its findings home whenever it was asked.

The trouble happened last Nov. 19. On that day, the JPL team radioed up some instructions to the craft's computer, commanding it to change the timing of a cycle (instituted a year before) in which it was periodically charging and discharging its batteries to prolong their lifetimes. Following the "uplinked" message from earth, the lander was expected to "downlink" a response. But the answer never came.

One possible explanation is believed to be that the supposedly unoccupied "address" to which the instructions were sent in the lander's computer memory was not, in fact, unoccupied at all. The craft's automatically run mission was not originally expected to require any reprograming of its computer, notes a project official, so the "memory map" kept at JPL to remind the flight team of what was stored where in the memory had not been as fully updated as it was in the days of a full staff. The map had even served as a correct guide for several previous reprogramings, but this time, apparently, it was wrong. The supposedly empty address may instead have contained some particularly essential information — the lander's knowledge of its own position on Mars — which would have been "overwritten," or erased, by the incoming message. Without those key data, the lander would have lost its ability to predictably aim its antenna at earth for sending and receiving signals, instead slewing the antenna around through a wholly different pattern.

After careful analysis, the flight engineers felt that they understood the antenna's new motion, and set about trying to reestablish contact, a task made more difficult by the fact that the antenna was believed to spend much of its time angled away from the Mars-earth line, so that its receiving sensitivity was reduced. The changing relative positions of the two planets are believed to have been improving the chances of contact with the passage of time, but the failure of the Jan. 4 downlink (which would have been a response to an uplink on Dec. 30) suggests that there may be more to the problem.

One possibility, suggests George Gianopulos of JPL, could be that the lander's batteries weakened to the point where they tripped a built-in, power-saving shutoff switch that would have stopped the antenna's motion at some as-yet-unknown position. Another factor could involve uncertainties about the computer's "reasoning" processes. JPL has a computer programed to simulate the lander computer's operation, but though it seems to produce correct results from a given input, engineers are now looking to see if in fact it reaches its answers by exactly the same method.



JPL

Viking 1 post-landing photo of Mars shows craft's antenna and mounting at right.

NASA headquarters is providing full support, Gianopulos says, and a "tiger team" of consultants was being hastily assembled this week from such sources as the Martin-Marietta Corp. in Denver, the lander's builder. The craft potentially has 12 more years of work ahead of it, and, says one official, "Nobody here is writing an obituary yet." —*J. Eberhart*

Mark III interferometer measures earth, sky

Interferometry is a technique for combining signals received simultaneously from a given astronomical source at two or more different telescopes. The technique brings out details of the structure of the source that are too fine to be distinguished in the image provided by a single telescope. The latest thing in radio interferometry, according to two reports in the Jan. 7 SCIENCE (one by Alan E. E. Rogers of Haystack Observatory in Westford, Mass., and 20 others from six institutions; the other by M. V. Gorenstein of Massachusetts Institute of Technology and 10 others from five institutions), is a data recording and processing system called Mark III.

Mark III can be applied to various telescopes as desired. It can record and process up to 112 megabits per second from each telescope in a given interferometric array — as many as six in the experiments reported here. It provides about six times the sensitivity of previous systems. It has been used by Rogers et al. to plot the distances between radio sources in the sky with an uncertainty of only 3 milliseconds of arc and the distances between locations of telescopes on earth in an intercontinental array to within 5 centimeters. Gorenstein et al. used the system to determine the existence of a faint compact radio source that may be the long-sought "third image," in the first example ever found of a gravitational lens.

Interferometry began about a hundred years ago. It consists of taking signals received from a given source simultaneously at separated telescopes and combining them. When the signals are combined, they "interfere" — that is, they add together or subtract from each other according to what the phase relation between them may be. In the optical case, with which the technique started, interference produces a pattern of bright and dark fringes. Analysis of the appearance of these fringes and of the changes in them over time can yield information about the fine structure of the source that is completely invisible in a single telescope.

The first radio interferometers had separations up to a few kilometers and were connected by cable. Development of very precise clocks dispensed with the cables. Signals recorded with time ticks from precisely synchronized clocks could be combined later in a computer. One of the things on which interferometric sensitivity depends is the distance between telescopes. Therefore, radio astronomers hastened to use telescopes on opposite sides of the earth. Unable to get greater distance, astronomers now depend for greater sensitivity on the recording and processing equipment, and Mark III is an example of such a development.

Rogers et al. used Mark III on six telescopes, one each at Owens Valley, Calif.; Fort Davis, Tex.; the Haystack Observatory in Massachusetts; Onsala, Sweden; Effelsberg, West Germany; and Chilbolton, England. They have done geodetic and astrometric measurements since 1979 and in that time have noticed no significant changes in the distances between the telescopes. Theories of continental drift and gravity theories in which the earth expands over time would expect changes. The longest baseline they have is between Fort Davis and Onsala, which they give as 7,940,732.17 ± 0.10 meters.

The "double quasar" 0957+561 is be-

A step toward remote mineralogy

An experimental instrument carried by the Space Shuttle Columbia has demonstrated for the first time that it is possible to identify a range of different minerals and clays from space. The actual minerals detected, such as clays and limestone in Egypt and clays and iron oxide minerals in Baja California, may or may not indicate sites that are suitable for mining. But the finding that an instrument in space can identify minerals by measuring the amount of light that the earth reflects is certain to affect global mapping and the ways geologists glean information about the locations of mineral deposits.

"The significance of the experiment is that it opens a door to a whole new approach to geological remote sensing which will allow us to do mineralogy from space," says James V. Taranik, formerly with the National Aeronautics and Space Administration's Office of Space Science and Applications and now dean of the Mackay School of Mines at the University of Nevada. He anticipates that the measurements from space will lead to better geological maps, especially in remote areas where extensive field work is difficult, and to a more thorough assessment of the world's mineral resources.

The instrument, called the Shuttle Multispectral Infrared Radiometer, or SMIRR, was carried aboard the shuttle during November 1981 on its second flight. The findings were described at the recent International Symposium on Remote Sensing for Exploration Geology by Lawrence C. Rowan of the U.S. Geological Survey in Reston, Va., and Alexander F.H. Goetz of the Jet Propulsion Laboratory in Pasadena, Calif.

Based on earlier measurements taken from the ground and from aircraft, the researchers calibrated the instrument to measure 10 bands of light in the visible and infrared, or invisible, parts of the light spectrum. It was known that the structures of various minerals cause them to absorb light in specific ways. Consequently, clays and other minerals reflect light of different wavelengths that then can be measured within narrow bands in the spectrum. Limonite, a common group of iron-bearing minerals, had been identified previously by instruments in orbit, but the SMIRR results mark the first time that carbonate rocks and different types of clay minerals have been noted from space. Until recently identification of clay minerals required laboratory techniques.

"The shuttle experiment was just that—an experiment," Rowan says. "We weren't attempting to collect data on a worldwide basis to do mineral exploration. We were trying to determine whether these bands that we had found to be useful from aircraft and on the ground could be useful from orbit. It looks like they are."

The spectrometer will be a useful tool because "if you can identify particular kinds of clay, you can begin to categorize different kinds of mineral deposits" with which the clay is associated, Taranik says. For example, it is not yet known if the Baja California site is minable. However, the previously unprospected area is similar to ore-rich deposits in southern Nevada and Utah that, like the Mexico site, were formed millions of years ago when volcanic rocks were altered by superheated hydrothermal fluids.

The experimental data are not in a form easily usable by most geologists. Taranik says researchers have recommended a follow-up experiment using an instrument to be called a shuttle imaging spectrometer. The device, yet to be designed, would measure 30 different wavelengths of reflected radiation over swaths on the ground 10 kilometers wide. It would produce images similar to those compiled from Landsat D's data (SN: 7/3/82, p.4) and probably would not be ready for use until 1987 or 1988. —*C. Simon*

and gravity's lens

lieved to be two images of one and the same quasar that are formed by the bending of its light rays by the gravitational field of a cluster of galaxies lying between the quasar and us. The galaxy cluster is relatively transparent, so theory says there should be a third image, and one of the places it may be is in line with the cluster of galaxies. Using Mark III on the Effelsberg antenna, deep space tracking antennas at Goldstone, Calif., and Madrid, Spain, and three smaller ones, Gorenstein et al. found a very small, very faint source (0.02 seconds of arc across with a flux level only 0.6 millijansky) coincident with the galaxy cluster. But they cannot be sure whether it is the third image of the quasar or the core of one of the galaxies. They believe it will take observations with even more sensitive recorders to tell.

—*D. E. Thomsen*

Tokamak Test Reactor

The largest example in the United States of the type of thermonuclear experiment called a tokamak went into operation on Dec. 24. The Princeton Plasma Physics Laboratory of Princeton University announced that its Tokamak Fusion Test Reactor successfully confined its first plasma on that date. A tokamak is a doughnut-shaped vacuum chamber in which magnetic fields confine an ionized gas or plasma that is heated until the nuclei in it begin to fuse. TFTR is expected to be the first to reach ignition or "scientific breakeven," the condition of getting as much energy from fusions as is put in to confine and heat the plasma. □

Watt yields on wilderness leasing

Interior Secretary James Watt has encountered stiff opposition in his efforts to open up federal lands — especially designated wilderness areas — to mineral leasing and exploration. It now appears that opposition was effective. In an informal briefing with reporters on Dec. 30, Watt announced he will issue no more mineral-exploration or -development leases for wilderness lands or for areas under consideration for wilderness designation.

The announcement — a 180-degree departure from Watt's previously advocated posture — brought a generally guarded round of applause from the environmental community. "It looks like Watt's thrown in the towel and finally given up his one-man crusade to open up the wilderness system to mineral leasing," said Peter Coppelman of the Wilderness Society. However, he added, the society will reserve judgment on Watt's turnabout in policy until it sees "how he's going to implement that decision."

Coppelman noted that the society's continuing suspicions about whether Watt was acting in good faith had been fueled by what Coppelman described as the Interior Secretary's post-Christmas "midnight raid on the wilderness system." Coppelman was referring to Watt's Dec. 27 decision to remove 800,000 acres from study as potential wilderness areas and to reexamine whether another 5 million acres might not also be eliminated from a list of potential wilderness candidates.

Watt's decision had been prompted by three legal rulings by agency judges on the Interior Board of Land Appeals (IBLA) involving the eligibility of various categories of land for consideration as wilderness. One ruling excluded from wilderness consideration all non-island property less than 5,000 acres in size, saying that the agency lacked authority to protect parcels so small. A second ruling exempted any "split estates" — parcels where surface and subsurface mineral rights were owned by different governing bodies. Finally, on the judges' recommendation, Watt decided to review whether individual wilderness candidates had been evaluated for suitability based on their own merit (as opposed to the merit of important adjoining property).

That Watt issued these decisions after Congress finished its lame-duck session—something he had specifically been instructed not to do by the chairman of the House subcommittee on public lands — can only be viewed as underhanded, Coppelman says. Moreover, he added, "We think these decisions are not legally sound." As a result, "We and other groups will be challenging them in court," he said.

—*J. Raloff*