SCIENCE NEWS of the week

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.

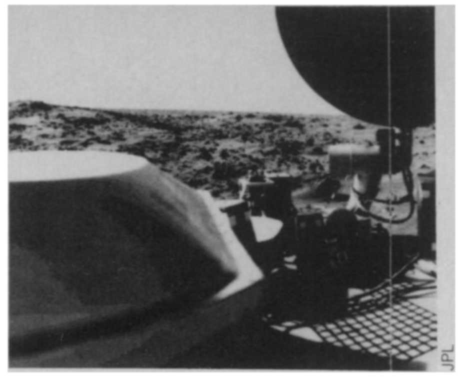
The lander touched down on July 20, 1976, designed for a mission of 90 days. In its remarkable longevity, however, it has provided thousands of photos and ongoing weather reports, working so well that in 1980 it was programed to keep going, automatically, all the way into December of 1994. The Viking 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.



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-