Space Sciences

Soviet findings from Phobos and Mars

Of the two Soviet Phobos spacecraft sent last year toward Mars and its larger moon Phobos, the first failed en route due to an incorrect ground command and the second reached its Mars-circling orbit but operated there successfully for less than two months. Even so, Soviet and Western scientists writing in the Oct. 19 NATURE report some intriguing preliminary findings from the truncated mission.

One group puts the overall density of Phobos at about 1.95 grams per cubic centimeter, less than the 2.2 g/cc determined in 1976 from measurements by the two U.S. Viking spacecraft. The researchers note that the change results from more accurate tracking of the spacecraft, which improved knowledge of Phobos' position in its orbit by "an order of magnitude."

Spectral measurements suggest that the potato-shaped moon, no more than 25 kilometers at its largest dimension, resembles a class of meteorites called carbonaceous chondrites. Their densities appear closer to the earlier estimate of Phobos' density. Scientists say that the new, lower number suggests either that Phobos has a porous interior or that its interior contains a significant amount of ice of some type.

Though Phobos 2 never got close enough to send its landing craft down to sample the surface, infrared instruments obtained measurements in orbit from as close as 190 km away, showing differences in the spectral and thermal properties of surface areas less than 2 km across. Some scientists have suggested that fine, rocky grains cover the moon's entire surface, but the Phobos researchers note that while some areas may indeed represent deposits of fine material, others seem more solid, like "localized exposures of consolidated rock."

An instrument called an infrared spectrometer accumulated more than 36,000 spectra, not only of Phobos, but also of Mars. They cover more than 25 percent of a Martian area that includes the huge canyon called Valles Marineris, as long as the United States is wide, and the large volcanoes atop an uplift known as the Tharsis Montes.

The spectra show variations of as much as 20 percent in the amount of hydrated minerals on the Tharsis volcanoes. Furthermore, the data suggest that the slopes of the volcanoes appear consistently richer in such minerals than do the "much dryer" surrounding plains.

The two Viking landers measured the elements on the Martian surface, but only those in the fine materials within a few feet of where the craft touched down. Phobos 2 provided much broader measurements from orbit by recording gamma rays emitted from the surface in response to solar and galactic cosmic rays. (The Soviet Union's Mars 5 craft made similar measurements, though with less precision, in 1974.)

The readings presumably represent a mixture of surface material and underlying bedrock, but one researcher suggests that it should be possible to separate the two components. "The closest analogue of the rock on Earth," according to one of the Phobos mission teams, "has been found to be subalkaline basalt occurring on oceanic seabeds."

Element	Phobos 2 (%)	Mars 5 (%)	Viking 1 (%)	Viking 2 (%)
O	48 ± 5	44 ± 5	50.1 ± 4.3	50.4
Mg	6 ± 3	—	5.0 ± 2.5	—
Al	5 ± 2	5 ± 2	3.0 ± 0.9	—
Si	19 ± 4	14 ± 3	20.9 ± 2.5	20.0
S	—	—	3.1 ± 0.5	2.6
Cl	—	—	0.7 ± 0.3	0.6
Ti	1 ± 0.5	—	0.51 ± 0.2	0.61
K	0.3 ± 0.1	0.3 ± 0.1	0.25	0.25
Ca	6 ± 3	—	4.0 ± 0.8	3.6
Fe	9 ± 3	14 ± 4	12.7 ± 2.0	14.2
U	$(0.5 \pm 0.1) \times 10^{-4}$	$(0.6 \pm 0.1) \times 10^{-4}$	—	—
Th	$(1.9 \pm 0.6) \times 10^{-4}$	$(2.1 \pm 0.5) \times 10^{-4}$	—	—

Yu. A. Surkov et al./NATURE

Technology

Listening to the breaths of 1,000 cells

Like a stone dropped into a lake, biochemical changes in a cell ripple across its sea of metabolism. And as different stones produce similar ripples, many biomolecules have common effects, for example, changing the rate at which mammalian cells turn food (glucose) and oxygen into energy and waste products, mostly lactic acid and carbon dioxide.

Using these products as reporter molecules, a team of scientists from Molecular Devices Corp. in Menlo Park, Calif., and Stanford University has developed a biosensor that measures the metabolism of as few as 1,000 cells under different chemical and physical conditions. The scientists say the biosensor might serve as an alternative for some animal testing and as a means for screening candidate drugs.

Called a silicon microphysiometer, the device monitors metabolism by measuring acidity changes of a nutrient bath that flows over tumor and other test cells stuck to a flat silicon base or immobilized in tiny wells micromachined into the base. The bath's acidity depends on the cells' expulsion of lactic acid and carbon dioxide. When liquid flows through the biosensor, the acidity remains constant. Stopping the flow for several-minute periods, though, allows the acidic waste molecules to accumulate in amounts determined by the hormones, drugs or other test chemicals dissolved in the bath.

In the Oct. 13 SCIENCE, the researchers reported using their biosensor to screen a panel of eye irritants previously evaluated by the Draize Test, a consumer safety test in which chemicals are applied to the eyes of rabbits. The irritants depressed metabolism in test cells by amounts that closely parallel Draize test results. The researchers say that in addition to providing a possible alternative to *in vivo* toxicological tests and a tool for basic molecular biological studies, the biosensor may help doctors to identify new compounds that kill cancer cells or to choose which cancer drug to use with particular patients.

Making plastics in Galileo's shadow

Soon after the Jupiter-bound Galileo probe left its berth on Atlantis on Oct. 18, the shuttle's Polymer Morphology experiment began collecting data that now amount to 15 stories worth of stacked typewritten pages. Scientists at 3M Co.'s Space Research and Applications Laboratory in St. Paul, Minn., aim to learn how weightlessness affects plastic materials.

"We hope this experiment will teach us more about the physical properties, such as strength and elasticity, of polymers," notes chemist and principal investigator Debra L. Wilfong. "Knowledge gained could be used to improve how we make tapes and adhesives on earth." The experiment is the company's fifth space project and the first under a 10-year research agreement with NASA.

Since a polymer's physical properties depend on its underlying chemistry and how it is processed, the 3M researchers designed an experiment to eavesdrop on molecular changes occurring during the processing of polymers. Each of 17 sample cells held a disk-shaped film of either polyethylene, nylon-6, or a polymer blend. Each sample in turn was heated and allowed to cool while an infrared spectrometer took a snapshot of infrared emissions about every 3 seconds. Chemists use such data to infer the types of chemical bonds in samples. By examining the sequences of snapshots, the scientists hope to view a veritable motion picture of polymerization and crystallization processes in space. Earlier materials processing projects in space lacked consistent surveillance of real-time molecular changes.

The scientists will now compare the space-processed plastics with lab samples processed in the normal gravity conditions of St. Paul.