# SPACE SCIENCES

## Landsat 1 shut off

On Jan. 16, after nearly five and a half years of observing mineral deposits, crop conditions, water pollution, land use and other aspects of earth's resources, Landsat 1 was shut down by the National Aeronautics and Space Administration. Originally known as Earth Resources Technology Satellite 1, the craft has taken nearly a third of a million photos of the planet since its launching on July 23, 1972.

Designed to a specified lifetime of only one year, the spacecraft has "more than achieved its goals — in fact, beyond any stretch of the imagination," says Landsat project manager Ron Browning of NASA's Goddard Space Flight Center. It was shut off only after several deteriorating systems had combined to drastically limit its usefulness.

The satellite was provided with two tape recorders to store its images so that they could be "read out" by selected tracking stations. A month after launching, the first recorder stopped working; the second hung on until July of 1974. Even then, however, tracking stations could receive "live" images if they were taken while the spacecraft was within range. The fatal malady was a problem with the "pitch wheel" in the satellite's attitude control system, responsible for keeping the craft's cameras and antennas properly aimed at the earth.

The probe was renamed Landsat 1 shortly before the January 22, 1975, launching of its mate, Landsat 2, which is still in operation. Both probes carried "multi-spectral" camera systems capable of photographing the earth at four different wavelengths, which could be combined in various ways to emphasize different aspects of the images. A third Landsat is scheduled to be launched in March, equipped with those same four channels plus a fifth that works in the 10-micron thermal infrared band. A still more advanced fourth Landsat is being developed for a possible 1981 launch from the space shuttle. (The shuttle's retrieve-and-repair capability could enable still longer working lifetimes.)

From its first days, Landsat 1 was used by more than 300 principal investigators in a wide range of research projects, and a much larger number of people have since made use of its imagery through the facilities of the Earth Resources Observational Satellite Data Center in Sioux Falls, S.D.

## Desert details from orbit

Photos taken during the 1975 Apollo-Soyuz space rendezvous mission have shown that desert color variations recorded from orbit can be correlated with several different types of surface characteristics, according to Farouk El-Baz of the Smithsonian Institution. Besides being carefully processed, the films were color-checked against visual observations by the U.S. astronauts, who compared their perceptions with a chart of 54 standard Munsell color chips that they carried with them during the flight.

Photos of Australia's Stuart and Simpson Deserts confirm that sand grains become redder (due to an iron-oxide coating) as distance from their source increases, reports El-Baz in PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING (January). Egypt's Western Desert shows three distinct color zones that have since been field-correlated with (1) arable soil composed of quartz, clay and calcium carbonate particles; (2) relatively "active" sand with or without sparse vegetation; and (3) relatively "inactive" sand mixed with dark ("desert-varnished") pebbles.

These and other visible details, such as patterns of sand shifting, prompt El-Baz to recommend that high-resolution color images be made in stereo on future manned (i.e., shuttle) flights. Human observers in orbit are vital, he believes, for their ability to make subtle, calibrated color distinctions.

# PHYSICAL SCIENCES

*Dietrick E. Thomsen reports from the meeting of the American Physical Society in San Francisco*

## Melting under shocking pressure

Solids under heavy pressure melt at different temperatures from the ones commonly listed in reference books for unpressured matter. In fact, says John Shaner of the Lawrence Livermore Laboratory, there are no theoretical or empirical models that can predict the melting behavior of solids under severe pressure, severe in this context meaning generally greater than 15 million pounds per square inch.

Yet there are many instances in which scientists wish to know the details of such behavior. Planetary science and pressure bonding are two examples. Knowledge of the structure of the earth's core depends on what scientists know about the melting of iron under 45 million pounds per square inch, and the current estimates run from 3,500 degrees K to 7,000 degrees K. This is too great an uncertainty for geologists to get an accurate idea of heat flow and temperature distribution in the planet. Fabrication of exotic materials under high pressure or bonding two materials together by pressure depend for their success on not applying so much pressure that the materials melt instead of bonding together.

Experimentation is the only way to find out the high-pressure melting behavior, and this is done by subjecting the material to shock waves generated by explosions. The explosions, unfortunately, destroy the material sample as they are compressing it, so it is only the current development of ultrafast measuring devices that makes the experimentation successful. These devices measure the temperature, density, viscosity, electrical resistivity, sound velocity or crystal lattice structure of the material before it is destroyed. Separately none of these data give certain indication of melting, but together they can give a picture of the melting behavior of the substance under extreme pressure.

## Dangling neutrinos

Particle physicists have discovered two kinds of neutrinos, massless, extremely penetrating particles that are involved in phenomena that characteristically include electrons and related particles. One kind of neutrino always accompanies the electron; the other accompanies the electron's relative, the muon. Recent experimental discoveries about the behavior of neutrinos and related particles, the so-called neutral weak current interactions (SN: 6/1/74, p. 350), raise the possibility that a beam of one kind of neutrinos can change to the other kind as a result of the influence of atomic nuclei in the matter the beam passes through.

Lincoln Wolfenstein of Carnegie-Mellon University suggests that an experiment originally proposed for another purpose may show this effect. The experiment was originally proposed by Alfred Mann of the University of Pennsylvania, and would consist of sending a beam of neutrinos generated at the Fermi National Accelerator Laboratory in Illinois through 600 miles of earth and detecting them in Canada. The experiment was originally intended to test a proposal of the Soviet physicist Bruno Pontecorvo that neutrinos could change while traveling through empty space if they simply had enough time. The discovery of the neutral current phenomena raises the possibility of discovering the effect of this kind of interaction with atomic nuclei instead. If it should be found that this happens, Wolfenstein suggests, it may explain the lack of the flux of neutrinos from the sun that the theorists expect to see. The experiment to detect solar neutrinos is designed to find one kind. If they change to the other kind on their way out of the sun, due to the influence of atomic nuclei in the sun, that would explain why the experiment doesn't see them.