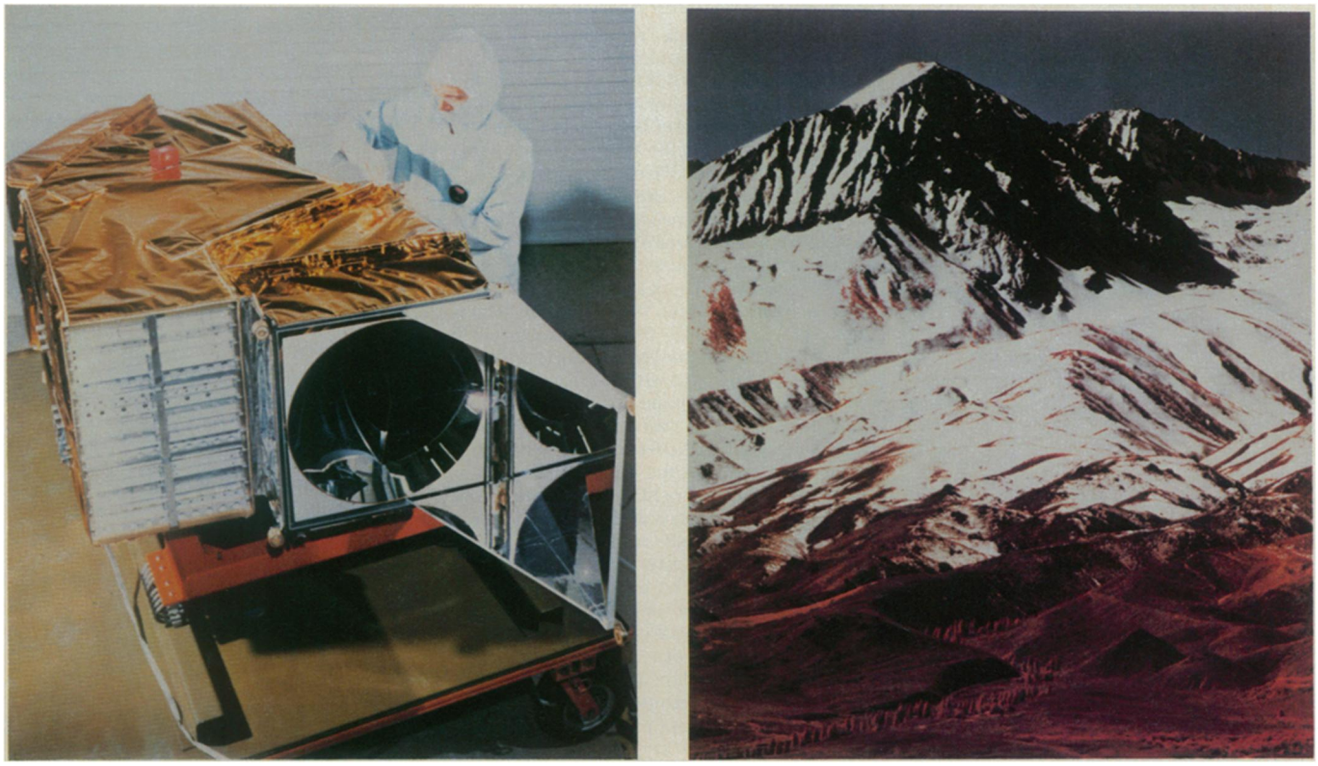
Landsat D: Reflections in an Orbital Eye



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A technician adjusts the thermal blanket on the thematic mapper (left), an advanced sensing device to be tested on NASA's Landsat-D satellite. Three of the mapper's seven spectral bands were used to produce the high-resolution, false-color test image of California's Birch Mountain. The mountain's top was 14 miles away.

Early this month, a modified Delta rocket is scheduled to lift into orbit a new, sophisticated instrument that scientists hope will provide geological data and other information never before available from a space vehicle. The instrument, called a thematic mapper, will be carried on Landsat D, the fourth in the National Aeronautics and Space Administration's earth resources satellite series. By capturing the earth's reflected light and thermal energy, this new "eye" will be able to provide better information on the condition of vegetation, the spread of pollution and mineral deposits.

The launch, scheduled for July 9, also focuses attention on concerns about the future of the remote sensing satellite program in the United States and the limitations of Landsat D. Although an identical backup spacecraft, Landsat D′, is part of the program and could be launched, if necessary, as early as July 1983, a recent Office of Technology Assessment (OTA) report says one reason Landsat has not attracted a larger number of users "is the uncertainty about whether the Landsat system will continue."

Vincent Salomonson, project scientist at the Goddard Space Flight Center, says users are looking forward to Landsat-D data with considerable excitement. "We're building on a plateau of success that was carved out by Landsats 1, 2 and 3," Salomonson says. "We could have proceeded with the Landsat-D mission in a very conservative mode. Instead of doing that, a very aggressive and bold approach was taken."

One example of that approach was coupling the proven multispectral scanner, which also flew on the first three satellites, with the advanced, experimental thematic mapper. The scanner monitors reflected solar energy in the green, red and infrared parts of the spectrum, while the mapper detects light in more sharply defined spectral bands that extend into the thermal region of the infrared. The scanner's presence assures the continuity of data collected for the past 10 years.

With the addition of a detector for blue-green light, the thematic mapper will be able to produce natural-color pictures instead of the false-color pictures of the past. The new infrared bands distinguish different types of vegetation and the effects of stress by detecting differences in the amount of water present. Mineral and petroleum exploration companies are excited about using data from these bands for detecting clays, measuring differences in surface soils and isolating ore-rich areas.

The thematic mapper will greatly improve on the images provided by the scanner. Each spot of light (a pixel) will represent 30 meters on the earth's surface compared with the scanner's resolution of 80 meters. Thus, the mapper can monitor smaller agricultural fields and provide sharper pictures of urban areas. Each pixel will be divided into 256 light-intensity levels, rather than the previous 64.

Putting the two instruments into the same satellite, however, may create problems. John Barker of Goddard says, "It may be that one system will not work well when the other is working. There are potential interferences." At the same time, the National Oceanic and Atmospheric Administration will take over managing data from the multispectral scanner on Jan. 31, 1983. NOAA will then be responsible for controlling the spacecraft, scheduling the use of the sensors, data processing and distributing the data. NASA will continue its research program on the thematic mapper independently.

The OTA report says, "The prospects for successfully achieving the quite different objectives of a NASA R&D program and a NOAA demonstration program within this single flight effort seem limited . . . [A] fair degree of tension exists between NASA and NOAA on account of their differing objectives for the program. In addition, technical problems with the thematic mapper have made the effort even more of a devel-

opment rather than demonstration undertaking."

Other problems plague the Landsat-D mission and limit the usefulness of the thematic mapper initially. The satellite carries no tape recorder. The 300 million picture elements that make up each mapper scene must be relayed to the ground immediately, and only the station at Goddard is now capable of receiving the signal. This means coverage is limited to the eastern half of the United States. Gerald Schaber of the U.S. Geological Survey says, "The limited coverage is more frustrating to us than anything." The situation will improve next spring when the space shuttle places the first tracking and data relay satellite in orbit, with worldwide coverage possible by the end of 1983.

The greatly increased data flow has also called for a new computer processing center at Goddard. The center will be able to handle multispectral scanner data, with a capacity of 200 scenes per day, within 90 days of the launch. Barker says users can expect to get requested data within a week, in contrast to delays in the past of up to six months. However, longer delays may occur if users request data that must be collected at any of 12 foreign stations equipped to receive scanner data.

The separate ground facilities for processing thematic mapper data will not be ready until July 1983. Until then, Goddard personnel will use a temporary "scrounge" system to process one scene per day. The number should increase to 100 mapper scenes per day by 1985. DG Park, administrator for The Geosat Committee, Inc., says, "We are concerned over just one scene a day being released. A point of even greater concern is whether they are going to archive the remainder. We want to collect just as much data as we possibly can." Barker says that currently there is no provision in the NASA budget for storing the data for later processing.

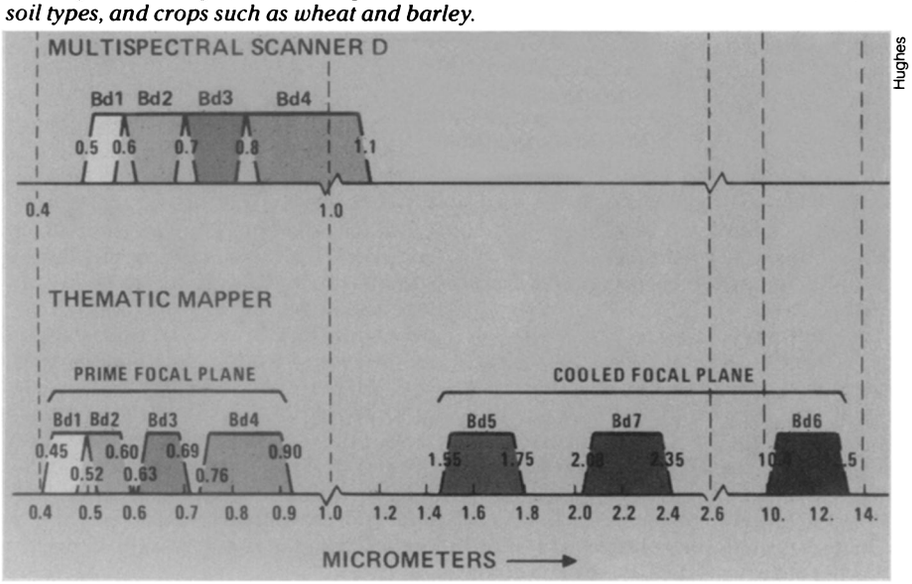
The U.S. Landsat system may face direct commercial competition from France's SPOT satellites starting in 1985. Designs, using technology originally developed in the United States, call for multispectral observation with 20-meter resolution and black-and-white observation with 10-meter resolution. SPOT will be able to "point" its sensors to the side to provide successive views of the same area from different angles (a semistereoscopic effect). Images can be stored on tape recorders for delayed transmission. Using a succession of satellites, with a design life of two years each, the system is planned to operate for at least 10 years, so that users can count on continuity of data for long-term, remote-sensing programs.

A. J. Rosenberg of General Electric, which built the Landsat-D spacecraft (Hughes Aircraft Co. built the sensors), says, "To assure an uninterrupted flow of data through 1988 and beyond, we must act now to procure the long-lead items required to launch future satellites. To not do so would make us vulnerable to foreign competition from the French SPOT system and the other nations' systems."

Frederick B. Henderson III, Geosat Committee president, says the launch of Landsat D is a major step forward in geological exploration. "Certainly, in light of our depleting natural resources such exploration is well within the national interest, and of concern to the rest of the world," he says.

The OTA report concludes that many of the Landsat problems "are not hardware or technology problems, but rather derive from the management and structure of the system." It suggests that care "will be needed in planning for a future operational system; whether operated by the government, the private sector, or a mix of both." —*I. Peterson*

The thematic mapper detects a wider range of reflected light wavelengths than the multispectral scanner, which flew on the first three Landsat satellites. The three bands in the longer wavelength, infrared region will better differentiate snow and cloud cover, soil types, and crops such as wheat and barley.



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Methane: A swamp gives and takes

While it has long been known that swamps supply generous quantities of methane to the atmosphere, research at one swamp reveals that under dry conditions a swamp also may remove the gas. This unexpected switch, reported in the June 24 NATURE, complicates generally accepted estimates of methane emissions from wetlands and challenges the assumption that soil is not a major avenue by which methane is removed from the atmosphere. Most methane, say prevailing hypotheses, is destroyed during photochemical reactions in the atmosphere.

The subject is of growing interest because recent studies show that concentrations of the gas in the global troposphere are increasing by about two percent per year (JOURNAL OF GEOPHYSICAL RESEARCH, Vol. 86, p. 9826). With other gases such as carbon dioxide and freon compounds, levels of which also are rising, methane can affect atmospheric chemistry and possibly reduce the amount of heat the earth radiates back into space, contributing to global warming.

The objective of the latest study, says one of its authors, Robert C. Harriss of NASA Langley Research Center in Hampton, Va., is to understand the major natural sources of atmospheric methane. Swamps and marshes are thought to be a major source, but so are cows and other ruminant animals that give off the gas as a by-product of digestion. Rice paddies and termites also may be significant sources.

With Daniel I. Sebacher, also of NASA/Langley, and Frank P. Day of Old Dominion University in Norfolk, Va., Harriss conducted his studies in Virginia's Great Dismal Swamp, a 210,000-acre forested peat bog. Like freshwater wetlands such as the Florida Everglades, the Okefenokee Swamp and most rice fields, the Great Dismal Swamp is dry several months each year depending on seasonal rainfall and temperature. It is during the dry season that the soil acts as a sink, removing the gas from the atmosphere.

The swamp contributes more methane than it removes. Nonetheless, the finding that soil may act as a sink for methane may be pertinent as more of the world's swampland is drained for agricultural use. The conversion to dryland, Harriss says, could turn the former swamps into sinks on a larger scale.

The authors draw an analogy to lakes, where bacteria are instrumental in breaking down the gas and removing it from the atmosphere. If the comparison is correct, microbial activity in the swamp soil is stratified, with microorganisms that oxidize the methane living in the shallow surface layer and those that produce the methane living in lower depths where the soil is oxygen-depleted. —*C. Simon*