move the core. A thin aluminum sleeve (comprised of tubing assembled in sections) is then inserted into the empty hole. The probe optical package is then lowered inside the sleeve by an aluminum shaft, assembled in sections. The sleeve has a machined slot running the length of the sleeve, except at the joints, allowing the probe optics to view the snow surface horizontally through the slot.

The reflectance probe couples light reflected from the snow surface into an optical fiber bundle that carries the light to a spectrometer on the surface, which records the reflectance spectrum. A manual clamping mechanism mounted to the top of the sleeve allows the user to move the shaft up and down and clamp in place during each measurement. Vertical location measurement is accomplished manually by observing the align-ment of centimeter graduation markings on the shaft with the top of the clamping mechanism.

The fiber optic bundle coming from the reflectance probe is bifurcated as it comes out of the probe, so that two separate cables go to the surface. One cable connects to the spectrometer, and the other cable connects to another light source on the surface. With this configuration, two different modes of operation are possible. In the first, the external light source is not energized, and the internal light source on the probe tip is energized, shining directly onto the snow surface. This provides strong lighting and is preferable to use under low reflectance conditions, such as large crystals in the snow or large amounts of contamination. The second mode uses the external light source through the fiber optic cable and does not use the in-bore light. This mode couples less heat into the snow and eliminates any melting concern due to the light source.

The probe provides approximately 1 cm vertical spatial resolution for measuring the stratigraphy. Grain size is determined by integrating the normalized 1,020-nm absorption feature in the ice reflectance spectrum and comparing it to a lookup table generated from an optical scattering model of uniform ice spheres.

The entire probe assembly can be dismantled and stowed into a large backpack for cross-country transport over large distances.

This work was done by Daniel F. Berisford, Noah P. Molotch, and Thomas Painter of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47992

Portable Fourier Transform Spectroscopy for Analysis of Surface Contamination and Quality Control

Goddard Space Flight Center, Greenbelt, Maryland

Progress has been made into adapting and enhancing a commercially available infrared spectrometer for the development of a handheld device for in-field measurements of the chemical composition of various samples of materials. The intent is to duplicate the functionality of a benchtop Fourier transform infrared spectrometer (FTIR) within the compactness of a handheld instrument with significantly improved spectral responsivity.

Existing commercial technology, like the deuterated L-alanine triglycine sulfide detectors (DLATGS), is capable of sensitive in-field chemical analysis. This proposed approach compares several subsystem elements of the FTIR inside of the commercial, non-benchtop system to the commercial benchtop systems. These subsystem elements are the detector, the preamplifier and associated electronics of the detector, the interferometer, associated readout parameters, and cooling.

This effort will examine these different detector subsystem elements to look for limitations in each. These limitations will be explored collaboratively with the commercial provider, and will be prioritized to meet the deliverable objectives. The tool design will be that of a handheld gun containing the IR filament source and associated optics. It will operate in a "point-and-shoot" manner, pointing the source and optics at the sample under test and capturing the reflected response of the material in the same handheld gun. Data will be captured via the gun and ported to a laptop.

This work was done by Diane Pugel of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16002-1

In Situ Geochemical Analysis and Age Dating of Rocks Using Laser Ablation-Miniature Mass Spectrometer

Instrument offers a more quantitative assessment of elemental composition than techniques that detect laser-ionized species produced directly in the ablation process.

NASA's Jet Propulsion Laboratory, Pasadena, California

A miniaturized instrument for performing chemical and isotopic analysis of rocks has been developed. The rock sample is ablated by a laser and the neutral species produced are analyzed using the JPL-invented miniature mass spectrometer. The direct sampling of neutral ablated material and the simultaneous measurement of all the elemental and isotopic species are the novelties of this method.

In this laser ablation-miniature mass spectrometer (LA-MMS) method, the ablated neutral atoms are led into the electron impact ionization source of the MMS, where they are ionized by a 70-eV electron beam. This results in a secondary ion pulse typically 10–100-μs wide, compared to the original 5–10-ns

laser pulse duration. Ions of different masses are then spatially dispersed along the focal plane of the magnetic sector of the miniature mass spectrometer and measured in parallel by a modified CCD (charge-coupled device) array detector capable of detecting ions directly. Compared to conventional scanning techniques, simultaneous measurement of the ion pulse along the focal plane effectively offers a 100% duty cycle over a wide mass range. LA-MMS offers a more quantitative assessment of elemental composition than techniques that detect laser-ionized species produced directly in the abla-

tion process because the latter can be strongly influenced by matrix effects that vary with the structure and geometry of the surface, the laser beam, and the ionization energies of the elements. The measurement of high-precision isotopic ratios and elemental composition of different rock minerals by LA-MMS method has been demonstrated. The LA-MMS can be applied for the absolute age determination of rocks. There is no such instrument available presently in a miniaturized version that can be used for NASA space missions. Work is in progress in the laboratory for geochronology of rocks using LA-MMS

that is based on K-Ar radiogenic dating technique.

Besides the MMS that has a double focusing focal plane geometry and a modified-CCD array ion-detector, the major components of the instrument include the laser, pumping, and its housing subsystem. These have been miniaturized for other NASA missions and when combined with the LA-MMS, make the instrument deployable on a rover or lander.

Physics Mining of Multi-Source Data Sets

Goddard Space Flight Center, Greenbelt, Maryland

Powerful new parallel data mining algorithms can produce diagnostic and prognostic numerical models and analyses from observational data. These techniques yield higher-resolution measures than ever before of environmental parameters by fusing synoptic imagery and time-series measurements. These techniques are general and relevant to observational data, including raster, vector, and scalar, and can be applied in all Earth- and environmental-science domains. Because they can be highly automated and are parallel, they scale to large spatial domains and are well suited to change and gap detection. This makes it possible to analyze spatial and temporal gaps in information, and facilitates within-mission re-planning to optimize the allocation of observational resources.

The basis of the innovation is the extension of a recently developed set of algorithms packaged into MineTool to multi-variate time-series data. MineTool is

unique in that it automates the various steps of the data mining process, thus making it amenable to autonomous analysis of large data sets. Unlike techniques such as Artificial Neural Nets, which yield a blackbox solution, Mine-Tool's outcome is always an analytical model in parametric form that expresses the output in terms of the input variables. This has the advantage that the derived equation can then be used to gain insight into the physical relevance and relative importance of the parameters and coefficients in the model. This is referred to as "physics-mining of data." The capabilities of MineTool are extended to include both supervised and unsupervised algorithms, handle multi-type data sets, and parallelize it.

The innovations include: (1) Physics mining algorithms, enabling derivation of analytical relations and physical models from observational data; (2) Automated, parallel algorithms, enabling a high degree of automation and paral-

lelization, scaling to large spatial domains well-suited to change and gap detection; (3) Local versus global modeling, to generate locally optimal models appropriate to a specific geospatial region accounting for the unique setting and conditions; (4) Fusion of multi-source, multi-type data that yield higher-resolution measures than ever before by fusing synoptic imagery and independent time-series measurements; and (5) Calculation of Palmer's Drought Severity Index Analogue.

Successful completion of this project will lead to a major breakthrough in the climate study in particular, and to analysis of multi-source data as applied to the hydrologic cycle affecting climate change impacts and resource management.

Photogrammetry Tool for Forensic Analysis

This acquires visual crime and accident scene data for later processing.

John F. Kennedy Space Center, Florida

A system allows crime scene and accident scene investigators the ability to acquire visual scene data using cameras for processing at a later time. This system uses a COTS digital camera, a photogrammetry calibration cube, and 3D

photogrammetry processing software.

In a previous instrument developed by NASA, the laser scaling device made use of parallel laser beams to provide a photogrammetry solution in 2D. This device and associated software work well under

certain conditions. In order to make use of a full 3D photogrammetry system, a different approach was needed.

When using multiple cubes, whose locations relative to each other are unknown, a procedure that would merge the