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changes that might precede an earthquake.

The plan was to leave those instruments in the hole to capture the many small repeating earthquakes that occur within a few hundred metres. For a few days, the devices worked well. But then they went quiet. William Ellsworth of the US Geological Survey in Menlo Park, California, another former principal investigator, says there may be an electrical short in one of the connections that carries data to the surface. Hot, corrosive groundwater in the hole could have damaged equipment.

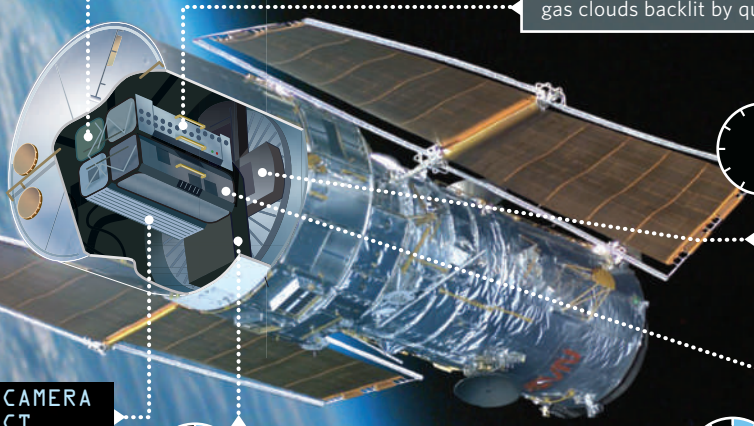
Because the instruments are mounted on thick pipe, it would take a crane or a drill rig to pull the package back up. Right now, the project does not have the money to do that. In December, the team lowered one temporary seismometer into the drill hole and is currently collecting data from that.

Ellsworth says some of the problems were discussed in December at a meeting of the American Geophysical Union in San Francisco. But there has been no general announcement to the public. "We were all embarrassed about it," says Zoback. ■

Richard Monastersky

Hubble: the last hurrah

On 11 May, the space shuttle Atlantis will head to the Hubble Space Telescope for a fifth and final servicing mission. With six batteries, six gyroscopes and a data interface system to be installed by astronauts, the telescope should be ready to perform for at least another five years. For scientists, the main feast will come with the new Wide Field Camera 3 and the Cosmic Origins Spectrograph, along with repairs to existing instruments. "I can hardly wait," says David Leckrone, senior project scientist for Hubble at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Eric Hand looks at some of the most highly ranked proposals from outside scientists.



SPACE TELESCOPE IMAGING SPECTROGRAPH (STIS)

The repaired STIS can take observation after observation across objects such as galaxies and black holes. It is also good for detecting chemicals in the atmospheres of transiting exoplanets. David Sing of the Astrophysics Institute of Paris wants to look for sodium in the atmosphere of a known 'hot Jupiter'. The measurements would provide stringent constraints on models that describe the exoplanet's atmosphere.

COSMIC ORIGINS SPECTROGRAPH (COS)

COS will be very sensitive to far ultraviolet light and well suited to splitting up the light created by point sources, such as quasars and stars. Absorption features in this light reveal details of the clouds of gas the light has passed through. At the moment, astronomers can't find all the gas that they expect. Todd Tripp of the University of Massachusetts in Amherst will use COS to look for cool gas clouds backlit by quasars.

FINE GUIDANCE SENSOR (FGS)

Hubble uses three fine guidance sensors to keep track of where it points. These can also be used to to look for wobbles associated with planets. One of its three sensors will be replaced.

NEAR INFRARED CAMERA AND MULTI OBJECT SPECTROMETER (NICMOS)

NICMOS, an actively cooled instrument in the near infrared, has been offline since September, and several reboot attempts haven't worked. Engineers suspect that an ice particle in its cryocooler could be causing problems.

WIDE FIELD CAMERA 3 (WFC3)

WFC3 will be by far the most popular instrument, and Leckrone says an experiment proposed by Garth Illingworth, an astronomer at the University of California, Santa Cruz, is the most highly ranked of all. Illingworth wants to use WFC3 to stare in the same spot as the Hubble Ultra Deep Field, a million-second exposure that captured 10,000 galaxies in one of the longest stares back at the beginning of time. In his 'ultra ultra deep field' image, Illingworth expects to find 100 objects as old as 13 billion years — providing the statistical strength needed to understand the timing and mechanism behind the build up of galaxies.

ADVANCED CAMERA FOR SURVEYS (ACS)

ACS, installed in 2002, is similar to WFC3 but slightly more sensitive to faintly red objects, such as the dwarf galaxies that Kristin Chiboucas, of the University of Hawaii in Honolulu, wants to find. Based on models for galaxy formation, an order of magnitude more dwarf galaxies are expected to be clustered near big galaxies such as the Milky Way than have been found. Chiboucas hopes to complete a census of the dwarfs surrounding the nearby spiral galaxy M81.

Indicates the percentage of observing time spent on each instrument.

HUBBLE/NASA/JPL/UCSD/JSC

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