Earth Science

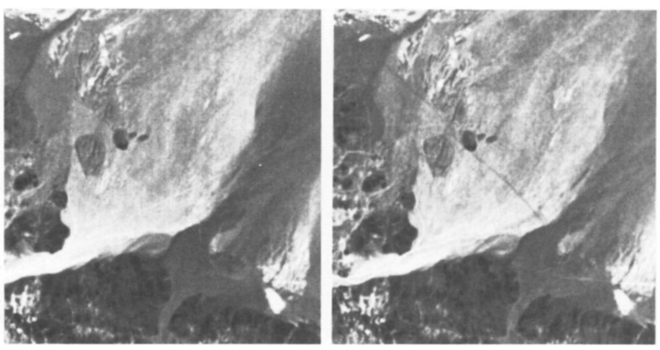
Richard Monastersky reports from San Francisco at a meeting of the American Geophysical Union

Satellite catches earthquake in act

Last spring, geologist Robert E. Crippen compiled a wish list describing his dream quake. Crippen, who works at NASA's Jet Propulsion Laboratory in Pasadena, Calif., was convinced that satellite pictures of Earth's surface could show an earthquake in motion, provided the jolt met certain criteria. The quake should be big – enough to cause at least five meters of motion across the fault; otherwise, the satellite imagers would miss the action. It should occur in an open area without much ground-obscuring vegetation or cloud cover. And it would be nice if the epicenter lay close to home, although preferably in a desert area where relatively few people would be hurt.

As if by design, the Landers earthquake that rocked the Mojave desert on June 28 met all of Crippen's criteria, enabling him to make the first film of fault motion from space. Like time-lapse photography, Crippen's film consists of photographs taken at different times by a camera positioned in the same spot. In this case, the camera sits on the French SPOT satellite, which orbits 830 kilometers above the Earth's surface. Crippen obtained two images: one taken on July 27, 1991, and another taken when the satellite passed over the same spot on July 25, 1992, just a month after the Landers jolt. By shifting back and forth between these two images, he produced a video that shows movement across the fault.

During the quake, land northeast of the fault slid past land southwest of the fault, like two trains running in opposite directions. The two parcels of land slipped past each other by up to six meters, an amount actually smaller than the 10-meter resolution of the satellite sensors. But the earthquake moved the land surface enough to alter individual image pixels, making the motion discernible during the video.



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The SPOT shots even show evidence of ground cracks along the fault. Individually, the cracks measure only a few centimeters across, so a single crack can't appear on the images. But so many fissures laced the ground along the fault that they collectively show up as a dark line in the satellite photo taken after the earthquake (right). The prequake image (left) does not show any fault cracks.

Yellowstone geyser shows quake effect

While Yellowstone National Park lies over 1,100 kilometers from the site of the Landers earthquake, the California jolt nonetheless altered geyser eruptions in the park, according to Roderick A. Hutchinson of the National Park Service. Hutchinson made this discovery only because he had fortuitously installed a portable seismometer near the Echinus geyser two days before the earthquake last June.

The prequake record from Echinus shows that the geyser erupted quite regularly, every 56 minutes on average. But immediately after the Landers jolt, that regularity stopped and the geyser erupted erratically over a period of 34 hours. Hutchinson has seen other earthquakes trigger changes in Yellowstone geysers, but the Landers quake was the most distant one to have an effect. He plans to search for similar changes in the eruption records of the Old Faithful geyser, where a permanent infrared sensor monitors eruption frequency.

Several hours after the Landers quake, a swarm of small earthquakes began underneath Yellowstone. The California jolt triggered many swarms at other distant sites around the western United States (SN: 8/1/92, p.72), and seismologists are now trying to understand how the quake could set off such activity at so great a distance.

A moss's tale of gassy climate burps

A study of ancient moss in Chile suggests that the atmospheric concentration of carbon dioxide gas jumped quite dramatically 12,700 years ago – by an amount and at a speed that has astonished climate experts. The new data show that in just a few decades, levels of this greenhouse gas climbed by about 80 parts per million, an increase roughly equaling the human-caused accumulation of carbon dioxide during the last two centuries.

James White of the University of Colorado at Boulder and his colleagues discovered the evidence of a planetary burp in carbon dioxide by analyzing the ratio of two carbon isotopes in moss preserved within peat deposits. White sees similarly abrupt, but less major changes in such gas concentrations at other times in the moss record. This is the first evidence that carbon dioxide concentrations have undergone such rapid natural jumps, he says.

Because carbon dioxide traps heat in the lower atmosphere, climate researchers expect that such a major buildup of this greenhouse gas should have warmed the planet at that time. White notes that the jump in gas concentrations comes right before a major melting of northern hemisphere ice sheets left over from the last ice age.

Researchers face a difficult time explaining how levels of carbon dioxide could change so much in just a few decades. But they do know the answer probably lies somewhere in the ocean, which holds much more carbon dioxide gas than is stored in the atmosphere. White speculates that the carbon dioxide surge may have resulted from abrupt changes in ocean circulation.

Satellite spots prelude to ozone hole

Since the late 1970s, when it first appeared, the annual Antarctic ozone hole has become a rite of spring in the southern hemisphere. Each September, sunlight beaming into the Antarctic sky energizes chlorine pollution, which efficiently destroys much of the protective ozone in the stratosphere over the southernmost continent. But data from NASA's Upper Atmosphere Research Satellite (UARS), launched last year, now reveal that many of the ingredients necessary for ozone destruction appear in the atmosphere by June, months before ozone levels start to decline.

Chlorine in the stratosphere normally resides in the form of inactive compounds, such as chlorine nitrate, that do not destroy ozone. But the UARS information shows that by June and July, much of the chlorine has switched from inactive forms into the more dangerous chlorine monoxide molecule, which can destroy ozone. This critical transformation, believed to occur on the surface of ice particles, takes place far earlier than scientists had expected, according to UARS researchers.

The satellite measurements suggest that all the ingredients for ozone destruction appear to be in place when the sunlight returns to the region in August, but the measurements do not show any ozone loss until September. UARS scientists say ozone-rich air from the tropics may penetrate into the polar region, masking any early ozone destruction.