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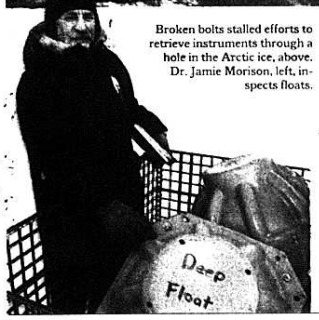
Doing Science at the Top of the World

Photographs by Andrew C. Revkin/The New York Times

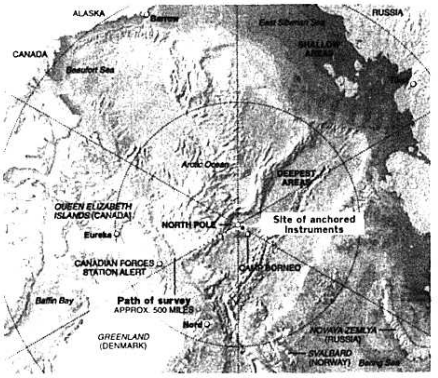
Researchers recently endured subzero temperatures along with numerous colliding ice floes as they camped near the North Pole to retrieve and install instruments that were designed to track big changes in the Arctic.

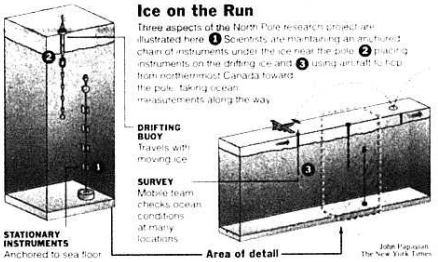


Broken bolts stalled efforts to retrieve instruments through a hole in the Arctic ice, above. Dr. Jamie Morison, left, inspects floats.

Peter West/National Science Foundation

A buoy tracks the flow of heat in the water below the ice.





By ANDREW C. REVKIN

ON THE SEA ICE 30 MILES FROM THE NORTH POLE — Three broken bolts A vital part of the first sustained effort to monitor big climate shifts at the top of the world was being threatened by three broken bolts.

The bolts were in a simple winch used to haul up a $200,000 array of instruments, strung on a two-mile Kevlar strand, that had spent a year collecting data on currents, salinity and other conditions in the ocean at the pole.

Six leading polar oceanographers and marine engineers huddled around the broken winch next to a manhole-size opening that had been melted the day before through the nine-foot-thick ice, staring at the line dangling in the slushy green water.

If they could find no replacements for a few dollars' worth of fasteners, the winch would be useless scrap, the instruments might be stuck in the sea, and the replacements for the coming year would not be deployed.

Such is the craft of science at the ends of the earth — particularly this end of the earth, where the pole sits over a 14,000-foot-deep ocean cloaked in shifting ice.

Hand-held satellite navigation devices and telephones provide a welcome sense of connectedness. But in a place where sea-ice runways crack apart, even the simplest setback can threaten ambitious research and, potentially, the researchers themselves.

The winch problem was just one of myriad challenges, large and small, that confronted scientists who recently ventured north to decipher disturbing changes in the polar ice, ocean and atmosphere.

The anchored instrument array was the centerpiece of the North Pole Environmental Observatory, a five-year $4 million effort to establish the first year-round record of conditions here.

Such a portrait was much needed, given that polar ice had been retreating record

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Heart Pump and Brain Injury: A Riddle Deepens With Time

By GINA KOLATA

Each year, 300,000 Americans have bypass surgery to improve blood flow to their hearts. Most of the operations succeed. But a minority of patients leave the hospital confused or forgetful, unable to think clearly or unable to concentrate.

"Pumpheads," some doctors privately call those patients, and the information shows that a third or more may be affected. As the term implies, doctors attributed the problems to the pump, the heart-lung machine that takes over during surgery when doctors literally stop a heart from beating so that they can repair its blocked vessels.

Doctors theorize that something about the pump — little fat fragments or tiny clots that may be thrown into the blood or maybe blood pressure levels in the brain that are too high or too low — may be causing damage.

Doctors also thought they had a solution to the problem, avoiding the pump altogether with surgical tours de force in which they actually operate on a slippery blood-coated beating heart.

But now, some of the most fervent believers in the so-called off-pump operations are turning from it, saying the information just does not back up the theory.

Yet converts to off-pump surgery and skeptics of it say the field faces a huge problem, one that is in a sense emblematic of modern medicine: the practice seemed to be reasonable and took hold before anyone could conduct a controlled randomized clinical trial on its merits. Now, doctors wonder how the can truth emerge.

In this case, doctors and patients may find an answer in 2007, when the Department of Veterans Affairs is to complete a large study comparing surgery with a heart-lung machine to surgery without it. Meanwhile, doctors are deciding for themselves, often by

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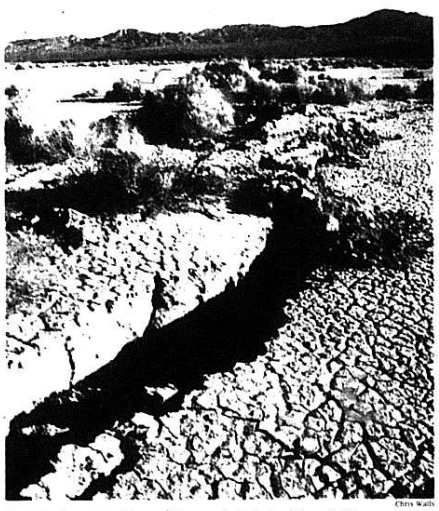
Quake Forecasting Booms, but Results Lag

By KENNETH CHANG



Chris Wells

A quake in 1999 at Hector Mine, north of Joshua Tree, Calif., preceded the weakening of the Landers fault six miles away, researchers say.

Dr. Lowell S. Whiteside predicts that a moderate earthquake, possibly strong enough to rattle dishes, will shake Mammoth Lakes in California in a few days.

"Around the 15th of May," said Dr. Whiteside, chief forecaster for GeoForecaster Inc. of Lafayette, Calif.

GeoForecaster says it has successfully forecast 16,520 earthquakes of magnitude 3.0 or larger in the last few years, including a rare magnitude 4.6 earthquake last month in Alabama.

But Dr. Whiteside's forecasts did not include an earthquake in eastern Turkey two weeks ago that killed more than 150 people. "That was a miss," he said.

For other geologists, the assertions of successes are not convincing, either. GeoForecaster, they say, has yet to provide statistical evidence that its forecasts are better than random guessing. After many failures, most geologists say accurate forecasting remains far in the future.

But a small revival in earthquake forecasting is occurring at the scientific fringes. GeoForecaster announced its forecasting services in February, and the subscription section of its Web site, geoforecaster.com, lists more than 120 quakes it expects globally in the next seven days, including small temblors today in the Northern Panhandle of Texas and on Thursday in northeastern Ohio.

Next month or in July, another small California company, QuakeFinder of Palo Alto, plans to launch a satellite on a Russian rocket to look for low-frequency electromagnetic waves that may emanate from the ground before quakes.

Dr. Whiteside said he was sure that the

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LETTERS

Epic Struggle for Health Care

To the Editor:

Dr. Floyd Bloom, the renowned scientist and physician, strongly endorsed universal health care to fix a badly broken system in "A Zealous Quest for Chemicals to Heal Ailing Brains" (May 6).

Presidents Franklin D. Roosevelt, Harry S. Truman, Lyndon B. Johnson and Bill Clinton were thwarted by powerful special interests opposed to universal health care.

Yet the struggle for universal health care is as important as the struggle for civil rights for minorities and women, if not more so. It will take an aggressive grass- roots organization dedicated to universal care and strongly endorsed by progressive leaders in science, humanities, business, the arts, education, labor, religion and the communications media to make health care a human right.

The struggle is one of epic proportions. Every day people suffer and die needlessly because of lack of access to basic medical care.

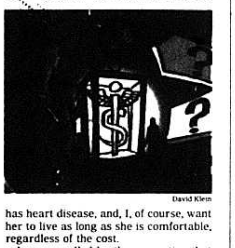
DR. JERRY FRANKEL
Plano, Tex.

The writer is on the board of Physicians for National Health.

The Ethics of Denying Care

To the Editor:

Re: Cases column "Buying Time: Doctors Debate the Ethics of Care and Cost" (May 6): My 86-year-old mother



David Klein

has heart disease, and, I, of course, want her to live as long as she is comfortable, regardless of the cost.

I was appalled by the suggestion that since elderly patients might not contribute as much to society in their later years, they should perhaps be denied life-prolonging medical treatment.

It is a tragedy that we do not guarantee that everyone receives the best medical care possible, regardless of cost, income or age.

CLAUDE M. GRUENER
Austin, Tex.

Who Has the Wisdom?

To the Editor:

I refer to two articles: "A Conversation With Dr. Floyd Bloom: A Zealous Quest for Chemicals to Heal Ailing Brains" quotes the complaint of his wife, a neurologist, that a clerk vetoes her recommended treatment. And, in the Cases column "Buying Time: Doctors Debate the Ethics of Care and Cost," the writer, a doctor, confronts the ethical and economic quandaries of expensive cardiac therapeutic technology. He states, "I wish policymakers would enter this debate."

Who has the wisdom to devise a system to satisfy both such legitimate complaints?

DR. IRWIN M. WEISBROT
Norwalk, Conn.

The Challenges of Doing Science at the Top of the World

Continued From First Science Page

distances in summertime over the last decade and that sharp warming around the Arctic perimeter was prompting serious talk of an ice-free polar sea by midcentury. The changes could be a temporary shift in the range of normal variation. Or they could be an early result of global warming from rising concentrations of heat-trapping greenhouse gases.

But this climate puzzle could only be solved at the pole itself, where pirouetting ice floes cloak the ocean in crackled whiteness and make it impossible to establish anything more than a fleeting foothold.

Unlike almost anywhere else on the planet, this environment required a research team that combined the intellectual power of scientists with the brute strength of furniture movers, the wile of backcountry mechanics, the courage (or recklessness) of extreme athletes and the willingness to carry a shotgun to ward off polar bears.

Over three weeks in late April and early May, the project leader, Dr. Jamie Morison, an oceanographer at the University of Washington, and 14 colleagues from the West Coast and Japan brought this suite of skills to the Arctic as they successfully — albeit sometimes just barely — completed the fourth year of the observatory mission.

Spring is the only time of year when daylight is constant but the ice is not yet warmed so much that its surface turns to knee-deep slush.

Eventually, in their offices and labs in Seattle and Tokyo, the scientists will sift figures and report their findings in learned journals. Now, though, they were nursing bashed and frost-split knuckles and struggling with countless mechanical and logistical crises.

Working nearly around the clock in the constant daylight, they lived on power naps and stray bits of food, including juice boxes whose contents chilled to the consistency of a Slurpee and, in one case, a shared day-old salmon sandwich rendered crunchy by the frigid air.

Their mission was to measure vagaries in the ice, the influx of heat from the sun and from warm currents deep in the sea and the chemistry and dynamics of water layers from the surface on down.

They would swap the old and new underwater instrument chains and install three drifting instrument-studded buoys in the sea ice around the pole. Several scientists would hopscotch by plane and helicopter from northernmost Canada toward the encampments, measuring ocean and ice conditions along the way.

As a whole, the project is a work in progress, with problems and successes one year leading to modifications the next.

The goal, Dr. Morison said, is eventually to devise a permanent means of monitoring changes in the ice and the waters flowing beneath it from the Pacific, the Atlantic, and the great rivers of Siberia and Canada.

The work could improve weather forecasts and clarify whether a warming world, by unbalancing the Arctic system, could lead to calamitous climate changes around the Northern Hemisphere.

"We're trying to establish a pretty much automated way of keeping track of how the Arctic Ocean and sea ice are changing, and they've changed quite a bit in the last 15 years," Dr. Morison said.

The work is "about the toughest kind of oceanography you can imagine," said Dr. Neil R. Swanberg, program director for Arctic system science for the National Science Foundation, which is financing the observatory project.

It is vital because the pole is an ideal place to study whether the changes afoot are a wiggle or the first stage of a sharp turn, Dr. Swanberg said, adding, "The North Pole observatory is right on the interface where a lot of these things are happening."

Now if someone could just find some bolts.

Dr. Morison and five members of his team worked on the winch, debating options as their flash-frozen exhalations built white frost on their beards.

"There's three good mechanics here, so let's figure this out," said Eric Boget, one of the divers who had snared the mooring 12 hours earlier and who is an ocean engineer at the University of Washington.

The winch was perhaps the simplest piece of equipment in the two-tent encampment. But like everything else in sight, from the soot-stained Russian helicopter to the Iridium satellite telephones, it had to function for the project to succeed.

As the winch was dissected, the second diver, Jim Osse, who is also an ocean engineer, scooped thickening "grease ice" from the hole. The slush was the sea's way of announcing that it was preparing to close the portal as the 28-degree water was chilled by the 15-below-zero air.

Jim Johnson, an engineer from the university who helped design the instrument string, sat at a table nearby, frowning as he entered notes on the new problems in his log with a pencil. (Ink freezes.)

Even in a place where time loses all meaning, with today starting in March and ending in September, time was the enemy. For one thing, no one knew how long the Russian helicopter crew would be willing to wait. The tiny camp here was set up for just four people. There were six extra people, and before long they would have to be ferried back to Camp Borneo, a commercial base camp set up 60 miles from the pole each spring by Russian and French entrepreneurs.

For now, the copter pilot and crew idly smoked and snapped pictures of one another near a whimsical "North Pole Was Here" sign set up by the mooring team (a tribute to the fact that the ice camp was drifting 400 yards an hour). At any moment, they could be radioed to pick up the dozen ski trekkers who were nearing the pole or to ferry six Muscovite skydivers who were arriving soon on a plane from Siberia.

At any moment, an open-water crack could split the encampment, just as one, in late March, sundered the first runway built for Borneo just three hours after two 20-ton Russian airplanes lifted off. Or colliding floes could jolt a pressure ridge like one that crushed the snowmobile hut of an expedition near Alaska years earlier.

For the scientists at the winch, many of whom had made 12 or more trips to the Arctic, those are just some reasons the North Pole is little studied. Science here is mainly a grueling process of packing, loading, getting there, unloading, unpacking, waiting, rushing, breaking things, repairing things and always improvising.

There is the cold, which for this expedition rarely rose above 10 below zero and can cause liquid crystal displays on instruments and laptops to solidify.

Then there is the distance. From Camp Borneo, it is a two-and-a-half-hour 510-mile flight to the northernmost permanent human outpost in the world, a Canadian military base called Alert. Distance translated into a lack of vital things.

Some scientists were stranded in a marginally heated tent at the runway, miles from all the camps, when helicopter fuel ran short after storms in Siberia grounded Russian supply planes.

In sharp contrast to the South Pole, where researchers from 29 countries efficiently operate out of a host of permanent research stations, here scientists sat for hours then worked in frenzied bursts on the fast-changing icescape. One described it as "adrenalin moments surrounded by slabs of time."

Dr. Timothy D. Stanton, an oceanographer from the Naval Postgraduate School in Monterey, Calif., went 18 hours without a sip of water on the day when he hiked a half-mile from the Borneo runway to install his "baby," an automated $40,000 buoy designed to measure small amounts of heat flowing through the waters beneath the ice. The information could help improve computer models of the polar climate.

It took 10 hours for Dr. Stanton to drill a foot-wide hole in the ice with an auger and wrestle the buoy and its antennas and "top hat" dome into place. Then he had to test its systems and make sure that it could send the information back to Monterey as it drifted past Greenland in the months to come.

Out on the ice, a distant dot from the runway, Dr. Stanton plugged his laptop into the buoy and gave it a farewell checkup. And there was no sign of life.

The buoy, which had traveled 5,000 miles on two bumpy airplane rides and had then been hauled behind the old bulldozer over the rough ice, might be dead. Perhaps the fault lay in an adjustment that Dr. Stanton had tried a few days earlier. He had modified a microchip in the buoy innards and then hastily had to undo that repair.

"These are showstopper things I had to resolve sort of here and now," he said. "You couldn't say, 'Well, I'll sleep on it.' "

Dr. Stanton ferreted out the fault and soldered new connections. He was nearly euphoric when he was finally able to trek back to the tent near the runway and found that Dean Stewart, an engineer, had fired up a stove and produced a pot of drinking water by melting ice.

[True euphoria struck a week later, when Dr. Stanton was back in Monterey and saw figures from the polar waters flowing in regularly from the buoy.

"It calls in twice a day, like a good child," he said in a recent e-mail message.

But that would be later.]

For now, Dr. Stanton huddled on the ice with the divers and Dr. Morison and the balky winch and the broken bolts, trying to help.

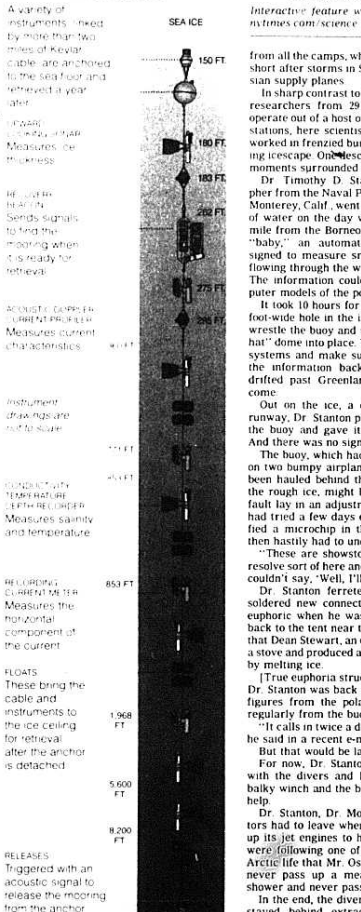
Dr. Stanton, Dr. Morison and some visitors had to leave when the helicopter fired up its jet engines to head to Borneo. They were following one of the three axioms of Arctic life that Mr. Osse had listed earlier: never pass up a meal, never pass up a shower and never pass up a flight south.

In the end, the divers and engineers who stayed behind extracted three identical bolts from the brake on the opposite side of the device, and they fit perfectly in place of the ones that had fractured.

From a grab bag of fasteners, the scientists found others to replace the ones that had been scavenged.

Someone fired up the generator, the winch spun, and the strand of instruments with their yearlong lode of data rose from the steaming, slushy hole.

Far Beneath the Ice



ON THE WEB: THE NORTH POLE

Interactive feature with audio is online at nytimes.com/science

Better Than Guessing? Earthquake Forecasting Booms, but the Results Lag

Continued From First Science Page

Mammoth Lakes quake would occur. Indeed, it may have already occurred. Under the GeoForecaster guidelines, a small magnitude 2.3 quake that wiggled Mammoth Lakes on Saturday already qualifies as a modestly successful fit to the forecast.

But such a prediction is of no use to emergency planners. They are looking for accurate predictions, at least a few days ahead of time, of large deadly temblors.

Last month, scientists reported that they had developed software that could detect the onset of an earthquake and sound a warning before a quake's most destructive shaking arrived, but that would provide only a few tens of seconds of warning at best.

Some hopeful progress in prediction in the 1970's was followed by clear failures, predictions that did not come to pass and devastating earthquakes that struck without warning. Most scientists gave up.

"We finally decided what we needed to do is understand the physics of earthquakes," said Dr. John Filson, manager of the earthquake hazard program at the United States Geological Survey in Reston, Va. "To understand what was going to happen, we needed to understand how it was going to happen."

When the earth's sliding tectonic plates become stuck along an earthquake fault, stress builds up until the fault breaks, setting off a quake. Scientists can estimate the number and size of local aftershocks that can be expected after a large earthquake.

The aftereffects can also be distant. To their surprise, seismologists observed that a quake in 1992 at Landers, Calif., in the Mojave Desert, set off seismic temblors more than 800 miles away, in Yellowstone National Park.

This year, researchers led by Dr. John E. Vidale, a professor of geophysics at the University of California at Los Angeles, found that in addition to the redistribution of stress, the seismic shaking could damage nearby faults, perhaps making them more likely to rupture. The researchers have been tracking how the Landers fault is recovering from 1992 as rocks on the two sides of the fault become cemented together again. Their reports show that the fault noticeably weakened after the 1999 Hector Mine earthquake six miles away.

Seismologists can also calculate how fault stresses shift after a quake, indicating what other faults may be likely to give way next. Since 1939, the North Anatolian fault in northern Turkey has ruptured, east to west, in a series of magnitude 7.0 and larger quakes, most recently a magnitude 7.4 in 1999 that killed 17,000 people. If the westward procession continues, the next major temblor will devastate Istanbul.

But all of this information is insufficient to zero in on the when and where of the next big quake.

Geophysiists had hoped that a weakening fault might give telltale warning signs. They even had one resounding success. In 1975, the Chinese authorities ordered the removal of the one million residents of Haicheng because of an ominous series of small earthquakes, changes in ground water levels and strange behavior by animals. A few days after the removal, a magnitude 7.3 quake flattened Haicheng.

The next year, however, no such warning signs preceded a magnitude 8.0 earthquake in Tangshan, China, killing hundreds of thousands of people. The Haicheng success has not been repeated.

In the 1980's came the Parkfield prediction. In Parkfield along the San Andreas fault in central California, moderate earthquakes seemed to strike fairly regularly, in 1857, 1881, 1901, 1922, 1934 and 1966.

In 1985, scientists from the Geological Survey theorized that Parkfield was due and announced that they were 95 percent sure that a moderate-size quake, about magnitude 6.0, would occur there by the end of 1993, and they installed a barrage of instruments to observe it.

The instruments remain in place and operating. The quake has not occurred.

"I don't feel embarrassed by it," Dr. Filson said. "You try and test a hypothesis. It was an honest, open public experiment."

A few years later, the agency dispersed the $15 million a year that it had been spending on earthquake prediction to other research, Dr. Filson said.

Dr. Whiteside said he had followed research on quake forecasting for three decades. In his thesis research at the University of Colorado, completed in 1999, he looked for statistical correlations between quakes and phenomena like other quakes, hurricanes and even sunspots. He said he found patterns.

"We had a series of types of phenomena which were related somehow," Dr. Whiteside said, "even if we didn't know exactly how."

A thesis adviser, Dr. Roger Bilham, said that Dr. Whiteside had plotted the distance and time of all earthquakes after one earthquake and found straight lines in his graphs that indicated waves of new earthquakes propagating from the epicenter.

"These lines should just not be there," Dr. Bilham said. "Somehow there is some strain adjustment propagating out from the earthquake."

Officials at GeoForecaster will not disclose their methods, saying the information is proprietary. Dr. Whiteside said they were based in part on his thesis work, but also pulled in other research.

While GeoForecaster's exact methodology remains secret, it sells forecasts to the public, $9.95 a month for local seven-day forecasts and $240 a month for the global 30-day forecasts.

Dr. Whiteside and Dr. Michael Kozuch, president of GeoForecaster, said they decided to start a commercial venture, because they thought that forecasting research would not garner research grants and that academic journals would not publish their findings.

Other geologists are doubtful that the predictions are any better than guessing. For example, Dr. Whiteside's forecast of a quake in the Mammoth Lakes region, 200 miles east of San Francisco near the Nevada border, will certainly come true, to some extent. Several imperceptible magnitude 1.0 and magnitude 2.0 occur there every day, and magnitude 3.0 earthquakes are not rare.

"They may be shooting fish in a barrel," said Dr. Susan E. Hough, a geophysicist at the Geological Service in Pasadena, Calif.

Scientists have also complained that GeoForecaster is overly generous with its self-grading. GeoForecaster did not exactly predict the magnitude 4.6 quake on April 30 in Alabama. The company forecast was for a magnitude 3.0 earthquake in Tennessee 125 miles north the next week.

On the Web site that day, Dr. Whiteside still claimed success. "The relationship between today's event and this forecast is probably not coincidental," he wrote, "but should suggest that the techniques GeoForecaster uses led to some advance knowledge, however imperfect, that the seismic hazard of the area had increased at this time."

To judge the results fairly, scientists would need to compare the forecasts with randomly generated ones. GeoForecaster has not performed such comparisons. Dr. Kozuch said he was working to have outside experts conduct that test.

"The way these people are doing it is a bit odd," Dr. Bilham said. "But I think they should be given a fair chance."

Dr. John E. Ebel, a professor of geophysics at Boston College, is also issuing quake forecasts, but on a much smaller scale, based simply on the observation that after earthquakes of 2.7 magnitude or larger in New England, there was a one in five chance of another quake elsewhere in New England the next week. For a magnitude 3.5 temblor, the chances of another event rise to one in three.

If quakes were completely random, there chance of a follow-up quake the next week should be one in 10.

"We are, I think, 0 for 2," Dr. Ebel said. "From a scientific point of view, it's interesting. From a public point of view, it's not so interesting, so far."

Other people continue to look for other phenomena that can act as warning signals. The $1 million satellite that QuakeFinder is launching is designed to detect low-frequency electromagnetic waves, from 1 to 1,000 hertz.

In 1989, instruments set up by Dr. Antony C. Fraser-Smith, a professor of electrical engineering and geophysics at Stanford, detected such emissions rising before the Loma Prieta quake and persisting for weeks after.

Also in 1989, a Russian satellite and a French satellite appeared to record similar signals from other quakes.

"Certainly, the data from those two satellites were tantalizing," said Tom Bleier, technology officer of QuakeFinder.

It does not appear to be a universal phenomenon. Measurements after the 1999 Hector Mine quake found no emissions.

Mr. Bleier said the satellite, which is designed to last six month to a year, should be able to observe whether that is common among large quakes.

"We are really in the data gathering mode," he said. "We're not claiming to be able to predict earthquakes."