Earth Science

Richard Monastersky reports from Baltimore at the spring meeting of the American Geophysical Union

Stone Age technology for tectonics

Taking a clue from Neolithic civilizations, English geophysicists are using ancient designs to create an extremely stable surveying site intended to last for decades, if not millennia. The mixture of Stone Age and Space Age methods will enable them to track the subtle movements of the continents with extreme precision, says Geoffrey Blewitt of the University of Newcastle in England.

Blewitt and his colleagues monitor crustal motion using a receiver that picks up signals from the Global Positioning System (GPS), a constellation of 24 satellites orbiting Earth. To ensure the quality of these measurements, they need to place the receiver's antenna on a solid benchmark whose position will not shift over many decades. Their study site in northeast England, however, has little exposed bedrock.

Many geodesists get around that problem by putting antennas on top of buried concrete pillars, but Blewitt rejected this approach because concrete can deform and shrink over the years. Instead, the Newcastle team took inspiration from the standing stones known as menhirs that dot the landscape of western Europe. Some of these monuments have endured for 4,000 years, a testament to their stability.

The scientists carved a replica of a menhir out of a single piece of carbonate rock, a flat-topped pyramid measuring 2.4 meters high and 1.6 meters across at its base. To ensure that the modern menhir does not move, the researchers excavated a hole in a field and cemented the base of the monument into the natural bedrock. The top of the menhir is flush with the ground surface.

"We basically built our own rock outcrop," says Blewitt. "The only way it would move is if someone digs it up. But it's going to be very difficult to take it out. It weighs 4.5 tons." By making measurements every 30 seconds, they hope to monitor its position relative to other sites with an error of less than 1 millimeter.

The creep before the quake

A study of California's San Andreas fault reveals that Earth's crust gets antsy when a tremor is impending—an observation that may help predict some quakes.

The central part of the San Andreas fault is known as the creeping section because land on either side of the fault often shifts a few millimeters without producing any vibrations. Clifford H. Thurber of the University of Wisconsin-Madison wondered whether these small movements along the central region of the fault tended to precede earthquakes measuring magnitude 3.3 or larger.

In periods of heightened quake activity, Thurber found, a statistically significant number of jolts did come fewer than 5 days after the fault shifted. The link is far from perfect, though. Between Feb. 1, 1972, and Jan. 31, 1973, six quakes occurred right after episodes of creeping. Yet three quakes hit without any preceding creep, and seven creep incidents were not followed by a quake, he reports in the April 4 NATURE.

Thurber has since extended the study to show that no link exists between creep and quakes when seismic activity is below average, perhaps because stress in the crust is relatively low.

The correlation between quiet shifts and earthquakes may provide a prediction tool for the small subset of faults that creep, he says. If they notice that creep starts to coincide with quakes, it could indicate an increase in stress along the fault, thus raising the odds that a sizable quake will occur in the near future. By this test, the San Andreas near Parkfield, Calif., is not yet ready to pop. Seismologists had predicted that a magnitude 6.0 quake would strike Parkfield by 1993, but it never came. Because creep and tremors there remain uncorrelated, Thurber says the quake is not imminent.

Materials Science

Tilting at LCDs

The familiar squinting required to read faint digits on the liquid crystal displays (LCDs) of digital watches, calculators, and computers stems from their finicky optics. Images on the gray screens show up boldly only when viewed head-on.

That weakness results from the way that long, tubular molecules sandwiched in the displays align themselves in the presence of the magnetic field that determines what digits appear. When relaxed, the threadlike molecules hang loose, so to speak, showing no image. In the presence of a magnetic field, they stand at attention, reflecting light back to an onlooker viewing the display straight on.

To increase the range of angles and types of lighting in which LCDs can be viewed, Martin Schadt and his colleagues at ROLIC Ltd. in Basel, Switzerland have devised an alternate method of liquid crystal patterning.

During the manufacture of today's LCDs, the liquid crystals' molecular alignment is patterned when the polymer material sandwiching the magnetic material is rubbed with a velvet cloth. Schadt's group uses polarized ultraviolet light instead of a velvet cloth, they say in the May 16 NATURE.

The new method varies the liquid crystals' angle of orientation—making it easier to see the displays from a wider range of viewpoints and lighting types.

A switch made of proteins

Arm a motion detector, then pass a hand through its electronic beam. An alarm sounds, signaling that someone has entered the detector's space.

Scientists are looking to make molecule-sized switches that detect the presence of certain molecules. Lino Gonzalez Jr., a molecular biologist at the University of California, Berkeley, and his colleagues have used the alpha-helical strands of proteins to engineer a benzene-sensitive switch.

Normally, such strands form twisted pairs, or double helical "coiled coils." When the redesigned strands encounter benzene, they re-form as triple helical coiled coils, the scientists explain in the June NATURE STRUCTURAL BIOLOGY.

Besides proving that proteins can act as switches, the researchers observe, this technique might be useful in monitoring benzene, a known carcinogen, in the environment.

Herringbones in gold

Although the acronym SAM sounds as though it refers to a new type of missile, to materials scientists the term stands for self-assembled monolayers.

These are organic thin films whose molecules readily pull themselves out of a solution to form distinctive, close-packed patterns on surfaces. They have widespread uses in chemical sensors and optical devices.

Exactly how SAMs form, however, long remained a mystery. Now, G.E. Poirier and his colleagues at the National Institute of Standards and Technology in Gaithersburg, Md., have used an ultrahigh-vacuum scanning tunneling microscope to image the self-assembly process and reveal its mechanism.

Watching molecules form characteristic herringbone patterns on gold surfaces, Poirier's team was able to distinguish the steps. The group describes them in the May 24 SCIENCE.

At first, a patchwork of "nucleation islands" peppers the gold surface as molecular crystals congeal from a gas into a solid. Then, the molecules arrange themselves into characteristic zigzag stripes that, viewed from above, look like a hilly landscape. Finally, the gaps between the stripes fill in, and the monolayer film takes on its final, smooth form.

Knowing the mechanism of self-assembly will no doubt prove useful for improving tiny circuits and computer memories, says Shirley Chiang, a physicist at the University of California, Davis.