Martin A.J. Williams, a geographer at Australia's University of Adelaide. West of these contours, the terrain slopes gently toward the river, dropping about 15 centimeters across each westward kilometer. East of the features, the ground rises at a steeper gradient of 3 meters per kilometer.

The consistent level of the features, like that of a gargantuan bathtub ring, marks the wave-scoured shoreline of an ancient lake, says Williams. North of Esh Shawal, traces of the lake's eastern shoreline become vague, because sediments dumped there by the Blue Nile have covered the area. However, signs of erosion along the opposite shore can be found more than 200 km north of the town. Neither the satellite images nor previous surveys provide any clue about where the ancient lake's southern shore may have been located. Williams and his colleagues describe their findings in the November *Geology*.

Because the southeastern shoreline is well defined, the arc-shaped features probably took a long time to form, says Michael R. Talbot, a geologist at the University of Bergen in Norway. The apparent absence of multiple shorelines at various elevations along the river valley indicates the lake was a permanent and stable feature, not one that rose and fell with the seasons and reached different levels each year.

The White Nile's ancient lake couldn't exist today because the river doesn't carry enough water to keep up with evaporation over a lake-size area. At some sites in the region, reservoirs can lose as much as 1 cm of water per day, says Williams.

Analyses of clay-rich sediments excavated from a trench near Esh Shawal suggest that layers now 5 m below ground level were deposited on the lake bottom more than 250,000 years ago. Williams and his colleagues suggest that the lake formed and existed between 420,000 and 360,000 years ago, during a wetter-than-normal period between ice ages. —S. PERKINS

This Won't Hurt . . .

Tiny needles deliver drugs painlessly

Microscopic needles may one day join hypodermic needles and drug-loaded patches as a way to get medicines into the bloodstream. Whereas syringes hurt and patches work only for small molecules, painless microneedles could deliver medicinal proteins and other large molecules through the skin, say developers of the technology.

Mark R. Prausnitz of the Georgia Institute of Technology in Atlanta and his colleagues describe new methods for making

arrays of both solid and hollow microneedles, as well as the first proof of the efficacy of hollow microneedles. They report their findings in the Nov. 25 *Proceedings of the National Academy of Sciences*.

The solid needle would work by riddling the skin with tiny holes, allowing drugs from an overlying patch or on the needles themselves to seep into the body.

To make it to the clinic, however, microneedles will need to be mass-producible and cheap, says Prausnitz. His team used microfabrication and etching techniques to make molds hosting up to 1,000 solid microneedle forms in a thumbnail-size piece of silicon, metal, or polymer. Filling the forms with metals or polymers resulted in hair-thin needles no longer than the width of the period at the end of this sentence. Needles of these dimensions don't cause pain, since they can avoid nerves, but they also aren't as strong or penetrating as larger needles.

"There are various trade-offs between getting needles to go in, getting the needles to go in without hurting, and delivering

PRICKLY Unlike a normal hypodermic needle (right), microneedles, seen point on, have been shown to be painless.

enough of the drug," says Prausnitz. Microneedles would be especially beneficial for people with diabetes and others who need frequent injections, he notes. But Prausnitz suspects that the "real opportunity for microneedles is in the process of extended drug delivery."

To realize that possibility, the researchers have developed ways of fabricating hollow microneedles through which drugs can flow at controlled rates. The researchers have made such structures in several ways, including drilling microscopic holes through silicon and electroplating a thin layer of metal on only the inner surfaces of the needle forms the team created.

As a simple test of the efficacy of hollow microneedles, the scientists pulled glass pipettes to create microscopic tips and used them to inject insulin into diabetic rats. The treatment lowered the animals' blood sugar concentrations for at least 5 hours.

Showing that hollow microneedles can deliver drugs to animals "represents an

important milestone in the development of this technology," says Samir Mitragotri of the University of California, Santa Barbara.

Several biotechnology companies are developing microneedles for use in people. Robert Gale of Alza Corporation in Mountain View, Calif., notes that his company is developing solid, drug-coated microneedles, which the company hopes to market in 2 to 5 years. —K. RAMSAYER

Protein Portal

Enzyme acts as door for the SARS virus

A year ago, a mystery virus began to kill people in China. Causing an illness dubbed severe acute respiratory syndrome (SARS), the virus quickly spread beyond Asia and for a few months stirred fears of a worldwide epidemic.

With stunning speed, scientists identified the virus and decoded its genetic sequence (*SN*: 4/26/03, p. 262). Now, a research team has claimed victory in the race to identify the cellular receptor—the protein to which the virus attaches when it infects cells—for the SARS virus. Since the protein turned out to be a well-known one that had previously been implicated in heart disease, drugs that target the receptor are already under development. Some of those same compounds might serve as antiviral medications for SARS patients, say researchers.

Michael Farzan of Brigham and Women's Hospital in Boston and his colleagues went fishing for the receptor with a lure made of the molecule on the surface of the SARS virus that docks with the cell's receptor. They burst monkey-kidney cells, which the virus easily infects, and then cast the viral-surface molecule into the resulting debris.

The SARS-receptor molecule latched on to three proteins, but only one of these, angiotensin-converting enzyme 2 (ACE2), is typically found on the surface of mammalian cells.

Several subsequent experiments, reported in the Nov. 27 *Nature*, make the case that the human form of ACE2 is a SARS-virus receptor. First, human-kidney cells engineered to produce ACE2 fuse with cells engineered to make the SARS virus' surface molecule. Second, cells engineered to mass-produce ACE2 were more readily infected by the SARS virus than were normal cells. Third, an antibody to ACE2 slowed the replication of the virus in cells bearing the enzyme.

"We nailed it. It's lock-solid" that ACE2 is a receptor for the SARS virus, says Farzan.

Another virologist trying to identify the receptor agrees. The results are "very convincing," says Dimitar S. Dimitrov of the National Cancer Institute in Frederick,

Md. "It's absolutely amazing how quickly they did this."

Until now, ACE2 has largely interested cardiologists. Several decades ago, physicians began using inhibitors of a similar enzyme, ACE, to treat high blood pressure and heart disease. A few years ago, scientists discovered ACE2 and began to look for compounds that block its activities. There's a good correspondence between tissues that make ACE2—the heart, lungs, and kidneys, for example—and ones affected by the SARS virus, notes Farzan.

He and his colleagues are now looking into whether known ACE2 inhibitors block the SARS virus from cells. It's possible that these inhibitors may thwart ACE2's function but still allow the virus to grab onto the enzyme, cautions Farzan.

Gary Nabel, director of the National Institutes of Health Vaccine Research Center in Bethesda, Md., calls the new work a "fascinating discovery" but notes that the SARS virus may exploit proteins other than ACE2 as receptors. —J. TRAVIS

Electronic Thread

Fiber transistor may lead to woven circuits

Someday, the very fabric of your shirt might contain flexible electronic devices that monitor your vital signs or enable you to dial in the color or pattern you want to wear that day. Futuristic clothing of this sort may be closer to your closet now that researchers have developed a type of transistor-on-a-fiber.

Josephine B. Lee and Vivek Subramanian of the University of California, Berkeley say that the perpendicular arrangement of a fabric's fibers should make it possible to wire transistors such as these new fiber ones into sensing devices, wearable displays, and other electronic devices. Conductive wires among the fabric's threads would provide the transistor-to-transistor links.

Unlike conventional transistor fabrication, which takes place at elevated temperatures and requires high precision and ultraclean conditions, making fiber transistors is "totally compatible with the weaving process," says Lee. She's slated to present this new work at an international meeting on electronic devices next month in Washington, D.C.

The two researchers make their new transistors by coating hair-thin strands of aluminum with an electrically insulating film. Doing that requires oven temperatures, but the step is completed before weaving takes place. Atop the insulating film, the researchers deposit a layer of pentacene, an organic chemical that behaves as a semiconductor.

In the lab, the researchers have demonstrated another important step in making fiber-based circuits: By positioning threads across the fiber transistors, the Berkeley team can deposit thin films of gold on the fibers except in the tiny areas where the overlying thread masks incoming gold vapor. This process breaks the fibers into discrete transistor regions, each of which can be contacted individually with thin, metallic wires during the weaving process.

"Using the fibers of the textile as shadow masks points to a possibly inexpensive way of making transistors on fabric," comments Sigurd Wagner of Princeton University. On the other hand, pentacene transistors will require additional protective coatings to prevent degradation by moisture or exposure to the air, he notes.

For tasks such as sensing body temperature, even damaged transistors might work well enough, Lee says. She and Subramanian are now at work on the next step: weaving circuit-laden cloth from the new fibers. —P. WEISS

The Next MTBE

Contamination from fuel additives could spread

The recent political debates on the use of two common gasoline additives, methyl *tert*-butyl ether (MTBE) and ethanol, suggest that refiners may have to rely more on alternative chemicals for oxygenating gas and reducing smog.

A University of California, Los Angeles (UCLA) research group has compared the in-ground behavior of MTBE, four alternatives, and basic gasoline constituents, such as benzene. The researchers analyzed data on more than 850 leaking underground fuel tanks in the Los Angeles area, as well as measurements of those contaminants in groundwater at various distances from the tanks. They conclude that

at their present concentrations in gasoline, the alternative additives aren't as environmentally prevalent as MTBE, but that reformulations with higher concentrations could create problems comparable to those already caused by MTBE.

To meet air-quality standards implemented in the 1990s, many petroleum processors began adding compounds called oxygenates—for the most part MTBE, with ethanol as a distant second—to gasoline. The additives reduce emissions from burning fuel, but they also have environmental drawbacks.

MTBE, which smells like turpentine, often escapes from leaking gas-storage tanks and spreads in underground plumes. The contaminant persists in groundwater for years and is difficult to remove (*SN*: 4/8/00, p. 229). Some states now prohibit manufacturers from adding MTBE to gasoline to minimize pollution.

Ethanol is less persistent than MTBE in the environment, but it appears to enhance the diffusion of benzene, a carcinogen and a major ingredient in gasoline, when ethanol-enriched gas leaks from tanks.

Several oxygenates other than ethanol could supplant MTBE as the gasoline additive of choice. They are frequent by-products of MTBE production and therefore already present at low concentrations in MTBE-enriched gasoline.

UCLA's Tom Shih and his colleagues detected MTBE in the ground at 83 percent of the leaking tanks, making it nearly as prevalent as benzene. The oxygenate *tert*-butyl alcohol occurred at 61 percent of the sites, and the other three oxygenates—all ethers similar in structure to MTBE—turned up 9 percent to 24 percent of the time.

Half of the MTBE plumes exceeded 84 meters in length, while *tert*-butyl alcohol plumes were 61 m in median length. Typical plumes of the other ethers were 35 m to 58 m long. Shih and his colleagues report in an upcoming *Environmental Science and Technology*.

"All indications [nevertheless] suggest that the alternative ethers would pose groundwater contamination threats similar to MTBE if their scale of usage were expanded," Shih says.

The concentrations of alternative oxygenates found around leaking tanks in the new study are already surprisingly high, says environmental engineer Susan E. Powers of Clarkson University in Potsdam, N.Y. —B. HARDER

GOLD FINGERS The vertical threads of this tiny assembly contain the kinds of fiber-based electronic components that could one day become part of electronic textiles.