# SCIENCE NEWS OF THE WEEK

## California Tectonics: Bits and Pieces

No wonder California attracts the restless — the land itself is constantly on the move. Like passing trains stuck in the same tunnel, the east and west halves of the state lurch and shudder past each other along the giant seam of the San Andreas fault.

Until now, the north-bound "train" — that sliver of land west of the San Andreas that runs from Baja California in the south to Eureka, Calif., in the north — was thought to have journeyed only about 650 kilometers in the past 100 million years or so. But a collection of papers presented at the recent meeting in San Francisco of the American Geophysical Union suggest that that piece — or pieces — of real estate may have been more like a rush-hour express, moving farther and faster than anyone imagined.

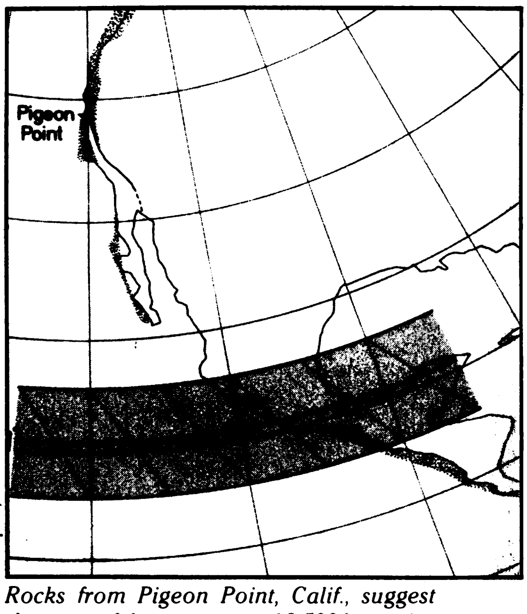
The emerging picture of California's assembly from fast-moving and far-flung pieces is startling. Drawn by Duane Champion, David G. Howell and others at the U.S. Geological Survey in Menlo Park, Calif., and Bradley Erskine and Monte Marshall of San Diego State University, it shows some segments cruising northward as much as 2,500 km in 70 million years, shoving aside earlier arrivals, and other pieces twirling and zooming — compared to present rates of motion — into place in only 15 million years. Considering its radical departure from present notions, the image is a hard one for some researchers to digest.

This portrait is the product of a relatively new field called paleomagnetism. This technique depends on the fact that certain rocks — particularly volcanic rocks — contain bits of magnetic material that line up parallel to the earth's magnetic field when the rocks are still molten and that "freeze" in that position when the rocks cool. Because the direction of the field is slightly different everywhere on the globe, a rock that has moved from its original position will have a different magnetism than would be expected from its current location. From this deviation, and taking into account the position of the pole at the time the rock formed, the amount of north or south movement and the degree of rotation of the rock can be determined. The original longitude cannot, however, be discerned, because the direction of the field is constant across a given longitude.

Using this method, Champion, Howell and Sherman Gromme examined 70 million-year-old rocks from Pigeon Point, Calif., about 40 miles south of San Francisco, and found that the region appears to have moved at least 2,500 km from the south. Earlier work by Howell and others, which matched the geology of the region with that of other areas to the south, estimated a northward trek of, "at the wildest," 1,000 km. Moreover, Champion says that Pigeon Point and the geologically coherent Salinian block on which it sits appear to have made most of their expedition before 50 million years ago and to have moved only about 250 km in the last 20 million years.

With Hugh McLean and J. G. Vedder, Howell takes this idea even further, suggesting that regions of southern California, based on their similarity to the Salinian block, hitched a ride on that fantastic voyage. Matching this welded block to a geologic "hole" near Acapulco, Mexico, Howell suggests that these chunks broke off the Mexican coast, swept northward with the Pacific plate, beached in southern California, scooted over the existing terrain and created mountains. This scenario requires that this sutured block moved about 7 to 8 centimeters per year, a speed with which most geologists are comfortable.

Many are not so comfortable with the speed envisioned for another chunk of California by Bradley Erskine, now at the University of California at Berkeley, and Monte Marshall. Erskine and Marshall examined rock samples from a block that extends from Riverside, Calif., to Baja California. Their results indicate that this segment traveled a total distance of possibly 1,300 km, putting San Diego 100 million years ago where Mazatlan, Mexico, is now. The voyage had two very different legs, Erskine notes: Between 90 and 15 million years ago, the parcel of land rotated about 42° clockwise but moved north only 120 to 500 km. Beginning about 15 million years ago, however, the rocks tell of a 700- to 1,200-km-long journey, suggesting that the block moved at tectonically breakneck speeds. Some geologists voice doubt about that amount of movement in only 15 million years, but Erskine maintains that similar results "keep popping up" from rocks in other regions. "I can't believe we'd keep seeing these same numbers if there weren't something there," he says. "It's a lot of movement, but it may work out."




Champion, et al. USGS

*Rocks from Pigeon Point, Calif., suggest that part of the state moved 2,500 km, twice as far as previously thought. Shaded portion is possible zone of origin.*

All the researchers agree there is much left to be done before California's piecemeal portrait is completed. Champion and Howell plan to take paleomagnetic samples from the San Gabriel mountains, for example, to see if that region was indeed a fellow traveler of the Salinian block. Whatever the outcome, California tectonics will never be the same. As Champion says, "It's part of a new picture. Everything is moving, everything is mobile. Our scale of perception is changing quickly." □

## A plasma laser, not a laser plasma

It seems as if almost anything can be made into a laser. Such is one of the impressions recorded by Theodore H. Maiman as he reviewed the 20 years since the invention of the laser in a keynote speech at the International Conference on Lasers '80 held last week in New Orleans. Maiman's first laser used a ruby rod. When his success became public knowledge, as he says, nearly everybody with a crystal in his laboratory tried putting mirrors on the ends of it to see if it would lase. The surprising thing is that many did.

A large number of substances and different states of matter have been used as the active element in lasers. Now it is the turn of what is sometimes called the fourth state of matter — plasma — in the form of ionized metal vapors. W. T. Silfvast of Bell Telephone Laboratories describes "a new laser we've [E.O.R. Wood II and others] been working on." It makes use of the radiation generated as an ionized gas recombines — that is, as the ions recapture the electrons they have lost and neutralize themselves.

Silfvast describes this as "the simplest laser anyone could make." He says it gives gas lasers some of the desirable properties of solid state lasers. It also shows promise of providing laser radiation in the vacuum ultraviolet part of the spectrum.

The electrons that are undergoing this process of capture lose energy by dropping through a series of quantum energy states (provided they do not undergo collisions and lose energy that way). The conditions imposed on the design of such a plasma laser — a segmented plasma excitation and recombination (SPER) laser, as the developers call it — are thus quite stringent. The plasma has first to be made in such a way that a large number of electrons are in the highest possible energy states. That means making the plasma at high density. The plasma must then be immediately cooled to induce recombination. That must be done in such a way as to minimize interference by collisions, which can deexcite the electrons in unwanted ways. This means cooling by expansion against the background gas.

There is a second form of assurance against collisional deexcitation of the electrons — choosing substances that have a large gap in the series of their quantum steps. It is harder for the dynamic conditions of a random collision to match a large and specific energy gap, and so trigger release of energy, than it is for them to match one of a series of small steps. This condition means rejecting ordinary gases like hydrogen, which do not have a large gap, in favor of certain metals, such as indium or cadmium, which do.

It turns out also that the plasma cools best if it is segmented; it should be formed in small balls so that all of the balls can expand in three dimensions within a vessel of background gas.

Satisfying all these conditions, the basic element of the laser comes out quite simple nevertheless. It consists of a substrate strip to which pieces of thin metal film are attached, "pieces of metal on glass with sticky tape," Silfvast says. The gaps between the metal pieces are where the action takes place.

The way to make a plasma with this kind of set up is to fire a pulse of electric current and make sparks that cross the gaps between the metal pieces. The electric arcs pull atoms off the metal pieces and ionize them, forming little puffs of plasma in each gap.

The whole arrangement is located in a glass tube full of some background gas. The little plasma balls expand against the gas, cool and recombine. Recombination yields the desired light. Mirrors at the end of the tubes set up the feedback and coherence conditions, and the laser pulse is on its way.

The arrangement is naturally a pulsed laser. However, the experimenters have run it at rates of thousands of pulses a second, and they want to see whether they can work up to continuous-wave conditions. Such a laser has a certain lifetime. The arcing gradually erodes the metal pieces, and when they disappear, so does the laser. Silfvast believes the lifetime will be reasonably long. So far the largest number of repetitions with a single laser is on the order of 100,000, and that seems nowhere near the limit.

At the moment the operating SPER lasers all work in the near infrared. "The next stage is shorter wavelengths," Silfvast says. The design principle permits a kind of scaling. Series of metals have similar patterns of energy levels, but the patterns shift to higher and higher absolute energies as the atomic number of the metal rises. Higher absolute energies means shorter-wavelength radiations. By climbing such a scale the experimenters hope to reach their goal of a vacuum-ultraviolet laser. Of course, says Silfvast, the visible infrared and ordinary ultraviolet possibilities both stand on their own merits. □

# Brain transplants: A growing success

Parkinson's disease, stroke, senility, brain damage due to tumor or accidents, and perhaps even genetic brain disorders like Huntington's chorea may be treated in the future with what is essentially a brain transplant. That is a conclusion being drawn from two recent findings: the ability of young mammalian nerves in the central nervous system to repair themselves if damaged, and the ability of transplanted young nerves to correct central nerve disorders in the adult mammalian brain.

In 1979, Katherine Kalil and Thomas Reh of the University of Wisconsin at Madison reported that severed central nerves in baby hamsters could not only regenerate but regenerate in a useful way, contrary to previous findings (SN: 9/22/79, p. 199). Last spring, Richard Jed Wyatt of the National Institute of Mental Health and colleagues reported that they had implanted fetal nerve cells from the substantia nigra area of the brain into the brains of nine adult rats with damaged substantia nigra nerves (and resulting Parkinson disease-like tremors) and that the implanted nerves grew correctly in the brains and improved the condition (SN: 5/12/79, p. 308). At a Dec. 8 news conference held by the American Psychiatric Association, Wyatt said that he and his team have extended the same findings to 75 rats. And now, in the Dec. 19 SCIENCE, Don Gash, John R. Sladek Jr. and Celia D. Sladek of the University of Rochester School of Medicine and Dentistry report that an inherited diabetic defect in the brains of adult rats has been improved, in some cases, by fetal nerve cell transplants.

The researchers performed their experiments on adult rats with diabetes insipidus, an inherited condition in which nerves in the hypothalamus fail to make the water-conserving hormone vasopressin. The researchers took hypothalamic nerves that make vasopressin from rat fetuses and implanted them in the hypothalami of 40 adult diabetic rats. Another group of diabetic rats served as one form of control: They received transplants of central nerves from the occipital cortex of rat fetuses. Still a third group of the rats acted as a second form of control: They only got an injection of saline. Although both control groups showed some improvement, it was not nearly as good as that experienced by nine of the 40 rats that got the vasopressin neuron transplants.

Gash et al./Univ. of Rochester

*Vasopressin-containing neurons can be seen in the hypothalamic tissue transplants that the diabetic rats received and that helped ameliorate their diabetes.*

The nine experimental animals with positive responses to the nerve transplants were then sacrificed, and their hypothalamic transplants were found to contain nerves that secrete vasopressin. These nerves could also be seen hooking up to blood vessels in the hosts' brains. This evidence, the investigators conclude, suggests that "the axons of the grafted fetal neurons made appropriate and functional connections," and that the neurons improved the animals' diabetes.

These results, Gash explains, do not have practical implications for human diabetics because diabetes insipidus is rare in humans (occurring after head trauma) and can be treated successfully with a vasopressin nasal spray. However, these findings, along with those reported by Kalil and Reh and Wyatt and his group, have important implications for adult patients suffering from Parkinson's disease, stroke, senility, brain damage, Huntington's chorea and other central nerve disorders, Gash points out, because they suggest that transplanted fetal central nerves might help to correct such deficiencies.

Once such experiments are ready to be tried on human patients, of course, they might raise some ethical questions if transplanted nerves come from aborted or even miscarried human fetuses. On the other hand, transplanted central nerves might be obtained from some part of a patient's own body. In fact, Wyatt points out that he and his colleagues have taken central nerve tissue from the adrenal gland of a rat with Parkinson-like disease and have transplanted it into the rat's damaged brain. The transplanted adrenal gland nerves seem to be correcting the disease. □