tured] cells," says Ross. Particularly helpful, Bargmann notes, should be the "gain-of-function" mutants both teams have created, in which $G\alpha_o$ production is excessive. Gain-of-function mutants are "a powerful tool," she notes. "It's really nice" that they have such mutants.

The researchers plan to take advantage of their tool by inducing new mutations in the gain-of-function mutants, then screening for individuals whose behavior has been corrected by the mutations. The affected genes are likely to be acting downstream of $G\alpha_o$, because their inactivation blocks the excessive signaling. If all goes well, those genes could in turn be used to produce probes for tracking down comparable genes in mammalian cells.

"The interesting thing is that they can go beyond C. *elegans* to dissect the entire pathway," says Horvitz. Completing the work will probably take other approaches besides genetic studies in C. *elegans*, among them developing G protein knockouts in mice—an effort that is already under way in several labs—and continuing to study G proteins in cultured cells. In the end, though, G protein researchers should finally get some satisfaction from their growing wealth.

–Jean Marx

GEOPHYSICS

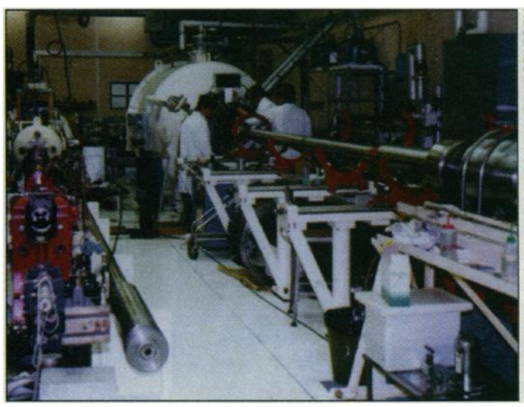
Shock Test Squeezes Core Temperature

Heat makes the world go around, or at least the world of geophysics. Heat drives the magnetic dynamo of Earth's liquid-iron core, it slowly churns the rocky mantle, and it drives plate tectonics and all its attendant phenomena from volcanoes to earthquakes to mountain building. But just how much heat Earth has in its deep interior and how it flows outward to shape the surface is a major unknown in geophysics—and one of its biggest bones of contention. One arena for the conflict is a new generation of lab experiments to probe the melting point of iron at the extreme pressures found in Earth's core. In 1987, these experiments came up with a temperature that was much higher than expected, and researchers have been working ever since to confirm—and explain—the startling result.

They have faced a big problem in trying to recreate the conditions in Earth's core in the lab, but refinements to the techniques used in 1987 have recently enabled several groups of researchers to come up with some new, independent estimates. To their relief, the predicted temperature of Earth's core has dropped down a notch. "No one would stick their neck out for the high temperatures [of 1987]," says Jean-Paul Poirier of the Institute of Physics of the Globe in Paris. But even these new results, from experimental work by Thomas Ahrens and his colleagues at the California Institute of Technology (Caltech) in Pasadena, still suggest an uncomfortably hot inner Earth.

The focus of the work is the temperature at the boundary between the solid-iron inner core and the molten outer core 5100 kilometers beneath the surface. This is the benchmark temperature of Earth's interior. The melting temperature of any material—the temperature at which solid and liquid coexist—has a fixed value for a given pressure, and as geophysicists know the pressure at the inner core/outer core boundary from the weight of material above it, by measuring the melting point of iron at that pressure they can determine the temperature at the boundary.

A landmark attempt to take the temperature of the inner core was reported in a 1987 *Science* paper describing two types of cutting-edge measurements of the melting point of iron. Quentin Williams of the University of California, Santa Cruz, then a student at the University of California, Berkeley, and Raymond Jeanloz of Berkeley reported melting-point measurements up to pressures of 100 gigapascals (GPa)—1 million times atmospheric pressure—created by squeezing a speck of iron between two diamonds while laser-heating it to 4000 K. The pressures in their diamond-anvil cell, at least a factor of 5 higher than in any similar iron-melting experiment, still fell far short of the 330 GPa in the Earth's inner core, however. To continue to higher pressures, Jay Bass of the University of Illinois, Urbana-Champaign, then visiting Caltech, Bob Svendsen of Caltech, and Ahrens melted iron between 200 and 300 GPa in high-pressure shock experiments in which the iron sample is blasted by a flat metallic "bullet" shot from a gas-powered gun at up to 7 kilometers per second.



THOMAS J. AHRENS/CALTECH SHOCK WAVE LABORATORY

Big guns. Shock waves produced in high-speed guns can melt iron under conditions of Earth's core.

The combined diamond-anvil and shock-melting results traced iron's rising melting point under increasing pressure. When these data were extrapolated a bit to the pressure of the inner core, they gave the stunningly high temperature of 7600 K. Even allowing for impurities in the core that might lower the melting point by 1000 K, this result was way above the textbook temperature for the inner core of around 4000 K.

Jeanloz, for one, was not fazed. He began work on a new view of Earth's interior, proposing a model in which the core still carries a hefty load of heat from its formation 4.5 billion years ago and contributes more than 20% of the heat flowing to the surface. Jeanloz's "hot Earth" model included a hot lower mantle to blanket the core and prevent heat from reaching the relatively cold upper mantle. This would also require a lower mantle rich in heavy elements to prevent mixing and enforce the stratification.

Because the hot Earth model specifies so many new characteristics of Earth's tectonic heat engine, most researchers remained skeptical. Among those was Reinhard Boehler of the Max Planck Institute for Chemistry in Mainz, Germany. He has been melting iron in a diamond-anvil cell since 1986, gradually making improvements on the pioneering work of Williams and Jeanloz and consistently coming up with figures 1000 K below their melting point at 100 GPa.

Why the results of the two diamond-anvil labs disagree is not yet understood, but Ahrens and George Chen of Caltech have modified the shock experiment so it can be used as a check on the lower pressure diamond-anvil results. They found that by preheating the iron sample, they could get it to melt with a lighter shock at pressures below 100 GPa. "We've done an independent set of experiments and we're very, very close to Boehler's data" below 100 GPa, says Ahrens.

Prompted by new doubts about his original shock experiments, Ahrens took another look at them as well. He and Kathleen Gallagher of Caltech began to look at the aluminum oxide casing, which holds the iron at high pressures during the critical few hundred nanoseconds of an experiment and acts as a window for the radiant energy emitted by the iron that tells the experimenter its temperature. If that window material were conducting less heat out of the iron than had been calculated from theory, the temperatures attributed to melting points would be too high.

Gallagher and Ahrens indeed found that the aluminum oxide was not behaving as their theoretical calculations had predicted. "That changes our ideas—our apparently mistaken ideas—about the behavior of materials at high temperature and pressure," says Ahrens. Gallagher and Ahrens estimate that the original 1987 shock temperatures from Caltech should be reduced by between 700 K and 800 K, bringing the melting point at 200 GPa down nearer Boehler's 4000 K. "My hunch is that Reinnie [Boehler] is closer" to the true melting point than the Berkeley group, says Dion Heinz of the University of Chicago, a former student of Jeanloz's. "If Tom's [Ahrens'] work is right, he's heading in that direction."

But even if Boehler is exactly right about the melting point at 200 GPa, it is still a long way to extrapolate to the inner core pressure of 330 GPa. Boehler's extrapolation from his diamond-anvil work that now reaches up to 200 GPa yields a melting point of 4850 K at inner core pressures, cool by recent standards but still hotter than thought a decade ago. The corrected Caltech shock melting point at 330 GPa is about 6500 K—a thousand degrees below the original report but still way above Boehler's figure. Boehler believes that Ahrens' results may be off because the shock may have temporarily heated the iron beyond its melting point.

Despite the recent refinements to their experiments, researchers in this field continue to be deeply concerned about the reliability of their methods. Other diamond-anvil studies, such as experiments aimed at exploring electrical conductivity in the deep mantle (*Science*, 29 November 1991, p. 1295), have already highlighted the difficulties with that technique, and shock experiments are also coming under close scrutiny. "It's a tricky problem experimentally," says Andrew Jephcoat of the University of Oxford, who has recently started working with iron in a diamond-anvil cell. "It will take several independent determinations to convince the community." Just how warm the hot Earth is remains to be seen. "We're now in the lower bracket," says Poirier. "It may be 1000 K wide, but it's the lower bracket." But even that reduction is unlikely to cool the debate.

–Richard A. Kerr

HISTORY OF SCIENCE

Keeping Alive the Spirit of Einstein

CAPUTH, GERMANY—When Albert Einstein pondered the nature of the universe six decades ago, he would sometimes slip into his sandals and wander into the quiet woods behind his summer home in this fishing village near Berlin. The pine forest and the house remain, but last month a roaring bulldozer cleared space for a parking lot near the spot where Einstein used to embark on his walks.

The new lot is intended to accommodate the cars of dozens of tourists who come every weekend to snoop around the former home of the twentieth century's most famous physicist. They are the sort of curious visitors that Einstein used to slip out the back door to avoid. Now, some Einstein advocates here find the visitors just as unwelcome, and they are trying to gain possession of the house to make it a center for scholars rather than for tourists.

It is the latest development in a complex ownership struggle that might confuse even the father of the theory of relativity. Built in 1929 with Einstein's life savings, the house fell into the hands of the now-defunct Prussian state after Adolf Hitler came to power in 1933. Einstein fled to the United States and never saw his home again. Nazi youth groups used the house for years; then the East German government leased it to families after the war ended. In 1979, it was turned over to the East German Academy of Sciences, which renovated it to honor the 100th anniversary of Einstein's birth, and prominent East German physicists used it as a retreat. When Germany reunified, the East German academy was dissolved and the state of Brandenburg took possession (*Science*, 29 March 1991, p. 1557). But a year later Caputh wrested control through a property court. The proud village has put up road signs to direct visitors to the house and included a color photo of it in a tourism brochure.

Caputh may have won a battle, but it has not yet won the war. On the other side are 11 heirs of Einstein's stepdaughter Margot—an unwieldy set of individuals and organizations ranging from the Hebrew University in Jerusalem to a New Jersey chapter of the Association for the Prevention of Cruelty to Animals. Since the fall of communist East Germany, some of the heirs have gone to a German court to press their own claims to the famous house. The court has not yet ruled.

PHOTOS BY ROBERT KOENIG

Meeting of minds. Einstein Forum Director Gary Smith wants Einstein's house to be a conference center, not a tourist trap.

The newest factor in this complex equation is the Einstein Forum, a Potsdam-based foundation that the state of Brandenburg established in 1992 to organize conferences and use the house in a way Einstein might approve of. Because Caputh does not have the money to maintain the building, the Einstein Forum pays maintenance and guard costs and in return gets use of the house on weekdays. Now it is working with some of the Einstein heirs to try to gain ownership if the German court rules against Caputh.

The Einstein Forum brings together prominent academics to "stimulate new forms of scholarly interaction" between the humanities and natural sciences, says Gary Smith, a native of Austin, Texas, who directs the forum. Over the past 2 years, the forum has organized interdisciplinary conferences, workshops, and research projects—on topics such as "variations of chaos" and the transmission of knowledge—that are important to scientists as well as other scholars. While his office is in Potsdam, Smith calls Einstein's house the forum's "central icon." He adds: "Our idea was to borrow the magic of this site."

But some of that magic is in danger of being lost. Smith, for one, thinks tourism—with some 200 visitors wandering through the house on weekends—is a "catastrophe" because it is damaging the structure. "It's a scandal that this summer house is being used in the winter. There already are signs of damage," including scarred floors.

Smith says he "can't get state money to renovate the house until we really own part of it," so he is trying to persuade the heirs to sell or give their claims to the forum. Recently, Smith says, Hebrew University officials in Jerusalem "agreed in principle to commit their 11.6% claim" to the forum and to help negotiate claims by other Jewish groups amounting to 17%. Smith hopes to resolve the ownership tangle by the year's end.

If the German court and the heirs cooperate, he says the forum may soon be able to rekindle the intellectual traditions remembered so fondly by Erika Britzke, a longtime caretaker of the Einstein House. Britzke likes to dwell on the glory days from 1929 to 1932, when dozens of famous visitors beat a path to Einstein's door, and the physicist wrote his renowned letters to Sigmund Freud about the nature of war. "It's a privilege to unlock the door each morning," she says. "For one of mankind's greatest minds spent so much time here, thinking and working."

–Robert Koenig

Robert Koenig is a journalist in Berlin.