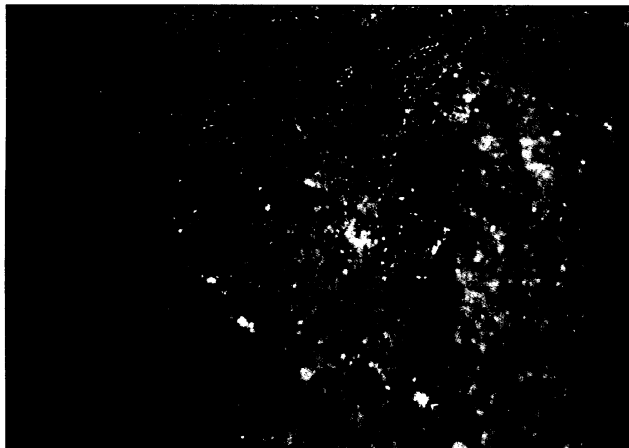


## TECTONICS

## A Deep Look Beneath Tall Mountains

Geologists are adept at scratching the surface, but they have trouble delving into deep mysteries. That's because they can only collect rocks from the topmost parts of the 40 kilometers of crust floating on the



**Relic from below.** Half-millimeter grains of diopside (green) contain signs of ascent from hundreds of kilometers down.

underlying mantle, and those surface rocks had seemed unlikely to reveal much about deep-seated geological processes. But now, mineralogists at the University of California, Riverside (UCR), have new evidence that a large chunk of rock high in the Alps may have originated hundreds of kilometers underground. If so, it may have brought some of those deep secrets to the surface.

The UCR researchers, Krassimir Bozhilov, Harry Green II, and Larissa Dobrzhinetskaya, base their conclusion on an analysis of the rock's mineral composition. As they report on page 128, it suggests that the rock rode to its current position on a geologic elevator from at least 250 kilometers down. "It's a strong case that these things come from deep in the mantle," says mineralogist Thomas Sharp of Arizona State University in Tempe. Confirmation that such deep minerals can rise to the surface, presumably during the upheavals sparked by colliding tectonic plates, would open up a new window on the mantle and how it participates in surface geology.

In the current work, the UCR researchers were pursuing a trail that Green and Dobrzhinetskaya picked up 3 years ago (*Science*, 29 March 1996, pp. 1811, 1841). While examining rock from the Alpe Arami massif, an 800-by-500-meter mass embedded in the mountains of southern Switzerland, they had found that the rock's magnesium-rich olivine contained 20-micrometer rods of the iron-titanium oxide mineral

called ilmenite. These crystals exhibited ordinary enough structures, but they were extremely rich in titanium and displayed an odd variety of low-pressure crystal structures. These strange features, the researchers realized, could be hallmarks of a rock that had risen from the depths: The ilmenite must have sweated out of the olivine and crystallized as the extreme pressures that had kept the iron and titanium dissolved in the olivine eased. Thus, the UCR group suggested that the Alpe Arami rock had once been 300 to 400 kilometers down.

That provocative conclusion has remained controversial, but Bozhilov and his UCR colleagues are now reporting the discovery of more persuasive relics of high pressures in Alpe Arami rock. When they took a look with a transmission electron microscope, they found thin plates of the mineral clinoenstatite that had been exuded by the surrounding mineral diopside. Within the clinoenstatite plates, which are some tens of nanometers wide, they could image what appear to be boundaries between crystal domains of subtly differing orientation. High-pressure lab studies have shown that such "antiphase boundaries" form when the high-pressure structure of a mineral relaxes to the low-pressure form. In the case of the Alpe Arami rock, that would have occurred at a depth of around 250 kilometers, the researchers concluded.

"I think the antiphase domains are reasonably good evidence" that high-pressure clinoenstatite gave rise to the present mineral, says mineralogist Charles Prewitt of the Geophysical Laboratory in Washington, D.C. However, to be certain that some fine-scale distortion seen in the clinoenstatite is not fooling them, both Prewitt and Sharp would like to see more study of antiphase boundaries created in clinoenstatite in the laboratory.

In the meantime, geophysicists are considering how a chunk of rock such as Alpe Arami could have risen from hundreds of kilometers down. Green invokes "the Ivory soap principle." It requires two colliding continents to drag buoyant continental crust to mantle depths, where it breaks free and bobs back to the surface, like a floating bar of soap, sometimes stealing a bit of the inherently dense mantle as it goes. If so, geologists could delve into very deep matters indeed.

—RICHARD A. KERR

## PHYSICS

## Laser Light From a Handful of Dust

Physicists have sparked laser action in a light-trapping powder, they reported last month in *Physical Review Letters*. They say the effect, which causes the powder to radiate intense light in all directions, might one day be used to brighten some kinds of flat-panel displays.

Conventional lasers use a pair of mirrors to bounce a light wave back and forth through a cavity containing a material or gas whose atoms are "pumped" into a higher energy state by an external light source. Each time a photon hits an excited atom, the atom falls back to a lower energy state while emitting a photon with the same wavelength and direction. When enough atoms in the laser cavity are excited, the process can sharply amplify a light beam.

A team led by Hui Cao from Northwestern University in Evanston, Illinois, has produced a similar effect in a finely ground semiconductor powder. In 1997, a team of Dutch and Italian scientists, including Ad Lagendijk of the University of Amsterdam and Roberto Righini of the European Laboratory for Non-Linear Spectroscopy in Florence, Italy, demonstrated that such a powder can trap or "localize" light. Because of its high refractive index, the powder strongly scatters light waves, bouncing photons back and forth like balls in a pinball machine.

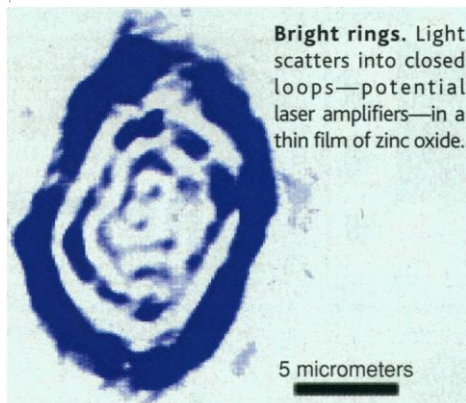
If the grains are close enough—less than the wavelength of the scattered light—the paths of the photons should form closed loops. "No matter which way [the waves] try to go, they will be scattered," explains Cao. "Depending on the local configuration of the scatterers, you have different probabilities for loops." As a result, the light passes many times through the same grains, just as an ordinary laser's light passes many times through the cavity between mirrors. "You can compare this with a cube made of six mirrors; a light wave will then run around continuously—just like in an optical cavity," says Lagendijk. If the atoms in the grains have been pumped to a higher energy state, the process could amplify light.

To test this idea, the team at Northwestern University prepared powder films of zinc oxide and gallium nitride, with particles of about 100 nanometers in diameter. They shined laser light onto the films to pump their atoms. Then they directed a probe beam at the sample and measured the total intensity of the scattered light. The team noticed that when the pump laser reached a certain power, the intensity of the light emitted by the sample increased sharply, by 10 to 100 times. They concluded that the light was

CREDIT: K. BOZHILOV ET AL./UCR

amplified; the powder had become a laser. "You are actually getting stimulated emission," says team member Eric Seelig. "Light travels in those loops, and each of these closed loops forms a cavity."

Righini says it's the first time researchers



have demonstrated that laser amplification can take place in a powder. "The paper is rather convincing," he says, predicting "this research will trigger more experiments." One way to exploit the phenomenon, says Cao, might be to shrink the phosphor grains that emit light in flat-panel field-emission displays. In these displays, each pixel consists of a tiny electron emitter placed in front of a tiny screen. The electron emitter, says Cao, excites the atoms of the phosphor; in small enough grains, it might spark laser amplification and brighten the pixels. "We are working on that," she says.

—ALEXANDER HELLEMANS

Alexander Hellemans is a writer in Naples, Italy.

## DENMARK

### University Cash Crisis Blocks Career Paths

**COPENHAGEN**—A bitter row has broken out at the University of Copenhagen, which has been forced to cut its scientific staff to close a yawning budget gap. The university science department decided in January that, instead of assessing who were its least productive researchers and firing them, it would simply not fill any junior tenured positions that became vacant—in effect blocking the career path of young tenure-track researchers. As the consequences of that policy have begun to bite, aspiring young scientists

say they now have little prospect of advancement and a whole generation of young researchers will either have to leave academic science or pursue a career abroad. "There is an atmosphere of hopelessness among students and postdocs whose possibilities for embarking on an academic career at the university now seem extremely limited," says plant molecular biologist Lars Østergaard, a postdoctoral fellow.

The crisis was precipitated late last year when the Danish government cut overall funding to Denmark's five universities. The science department at Copenhagen—the country's largest—was hit especially hard because it was already running a budget deficit. Forced to cut 15% of the tenured science positions—which translates into 70 people—the administration eliminated about 12 posts by offering early retirement to older faculty members and will cut the rest over time by not filling junior positions. "[It's] outrageous to prevent the necessary staff renewal and infusion of new ideas by forcing out young, talented, tenure-track scientists," says molecular biologist Olaf Nielsen, an associate professor.

The new policy is likely to exacerbate a simmering age problem in Danish universities. During the 1960s and '70s, the university system expanded rapidly and a large number of tenured positions were created. That generation of scientists is now approaching retirement age. "There will be an acute need for replacements when 30% to 40% of the currently tenured staff retire in 5 to 10 years," says associate professor of zoology Peter Arctander. "But because of what is happening now, there will be a lack of qualified young scientists."

Dean of science Henrik Jeppesen defends the policy. Although "it is sad that a number of young researchers have to leave," he says, "it would have created a very bad atmosphere to fire faculty members who have worked here for many years." This view is supported by university president Kjeld Møllgaard, who says it would be "an unfair personnel policy to simply get rid of the least productive as if it were a horse race." Jeppesen and Møllgaard both acknowledge, however, that the reaction of Denmark's powerful unions was a

**"[It's] outrageous to prevent the necessary staff renewal ... by forcing out young, talented, tenure-track scientists."**

—Olaf Nielsen

## ScienceScope

**2010 or Bust** With researchers expected to finish sequencing the *Arabidopsis* genome sometime next year, the National Science Foundation (NSF) is already contemplating a more challenging goal for the next decade—understanding the function of every one of the plant's 20,000 to 25,000 genes.

Extracting that information could lead to improved yields for crops and other commercially important plants. But it will cost "at least as much" as NSF's existing plant genome project, currently \$50 million a year, says Mary Clutter, the agency's biology chief. And a report due out soon from an NSF-funded workshop held last fall concludes that it will take a decade of research and training to do the job right.

Officials previewed the idea last week before the National Science Board, NSF's oversight body. They have dubbed the effort Project 2010 in preliminary talks on next year's budget request. Says Clutter: "This is something we definitely want to do. The only question is when."



**Data Dump** A new initiative may soon allow academics to sift through mountains of data collected by Canada's statistics agency. Currently, only employees of Statistics Canada have access to the trove of confidential surveys that the agency conducts in areas like health and education. To share this statistical wealth with university scientists and data-hungry policy-makers, the agency and Canada's Social Sciences and Humanities Research Council want the government to spend up to \$10 million a year to set up 10 centers where specially designated researchers could crunch the numbers.

The proposed Social Statistics Research System would give \$230,000 annually to interdisciplinary teams to produce reports on everything from health care to immigration. Such quantitative studies could help Canada "restructure our social policy," says J. Douglas Willms of the University of New Brunswick's Atlantic Centre for Policy Research. Before the keys to the data kingdom are handed out, however, the government must approve a funding plan, which will be submitted formally this fall.

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