port that they have identified an active fault that may explain not only the 1356 earthquake but two earlier ones as well. The finding provides the first indication of how frequently such events shake the upper Rhine graben, the rift valley system to which Basel and its environs belong.

Unlike the San Andreas fault in California, European faults responsible for earthquakes are hard to identify, says Domenico Giardini, director of the Swiss Seismological Service and a co-author of the report. That's because small earthquakes leave little trace on the surface, and major earthquakes are too rare to have left much of a historical record.

With a magnitude estimated at between 6 and 6.5, however, the 1356 quake should have been big enough to leave a visible mark, says Mustapha Meghraoui, a geologist at the University of Strasbourg, France. Meghraoui and colleagues Bertrand Delouis and Matthieu Ferry of the Swiss Federal Institute of Technology in Zürich set out to find it. After poring over aerial and satellite photographs and topographic maps, they zeroed in on a 50-meter-high escarpment that runs for 8 kilometers along the western side of the Birs valley in Reinach, south of the city of Basel. Something had obviously happened there—but was the feature really due to an earthquake, or just to erosion or landslides?

Searching for clues, the researchers visited an archaeological dig in the area. There, in the wall of a trench, they spotted signs of movement along a fault: a sharp contact between a very young sediment and an old sediment. The team crossed the road and started trenching at the base of the scarp, using geophysical evidence such as differences in the electrical resistivity of the ground to pinpoint the most promising sites.

"Before you open the trench, you cannot be 100% certain that you will find the earthquake," says Delouis, a seismologist, who says he followed close behind the digging machine. To date, eight trenches have been opened. Painstaking examination of the wall contents have revealed blocks of sand and clay clearly separated on a steep diagonal—the trace of so-called normal faulting, in which extensional (or pull-apart) forces cause blocks of crust to slide up and down relative to each other along a rupture. In the fourth trench, carbon-14 dating confirmed that three earthquakes had nudged the earth upward a total of 1.8 meters over the past 8500 years.

The new findings suggest that the fault unleashes a 1356-type earthquake every 1500 to 2500 years on average. That may not seem like much to worry about. But averages say little about when the next quake will strike, Meghraoui points out. Besides, he says, the Rhine graben probably harbors other faults capable of rattling the area: "The challenge is to find them and build a realistic seismic hazard assessment."

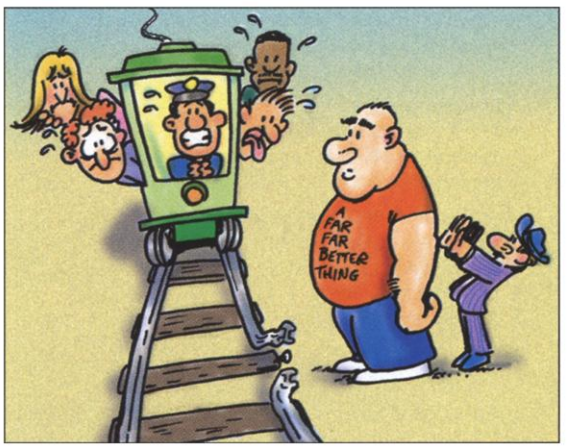
Donat Fäh, a geophysicist with the Swiss Seismological Service, says that data from this and future studies will go into regional earthquake catalogs to help develop building codes, especially for critical facilities such as chemical and nuclear power plants and long-lived features such as artificial lakes. **–GISELLE WEISS**

Giselle Weiss is a writer based in Allschwil, Switzerland.

COGNITIVE NEUROSCIENCE

Moral Reasoning Relies on Emotion

Suppose, in a classical moral dilemma, you see a trolley with five frightened people in it headed for certain disaster. They can be saved from plunging off a cliff if you hit a switch and send the trolley onto another track where, tragically, another person is standing who would be killed by the trolley. What to do? Most people say that it's worth sacrificing one life to save five others.



Right or wrong? Sometimes saving a net four lives just feels wrong.

But suppose the doomed trolley can only be saved if you push a bulky person onto the tracks, where his body would stop the trolley but, alas, he would be killed. Although faced with the same trade-off of five lives for one, most people say it would be wrong to stop the trolley this way. Paradoxes such as this mean job security for philosophers. They've been debating them for decades but have been unable to come up with a logical reason why sometimes

ScienceScope

Patent Fight The Institut Curie in Paris this week said it will formally oppose a European patent for a breast cancer test awarded in January to the biotech firm Myriad Genetics, based in Salt Lake City, Utah. The test detects mutations in the *BRCA1* gene, which are responsible for more than half of all hereditary breast cancers.

Earlier this year, Curie had threatened to file the protest with the European Patent Office in Munich after discovering a mutation in *BRCA1* that is not detected by Myriad's test (*Science*, 8 June, p. 1818). The institute claims that the Myriad patent is too broad and would block the use of other genetically based tests. "Such a monopoly will put the brakes on the development of research," says Curie geneticist Dominique Stoppa-Lyonnet. Myriad executives were not available for comment.

French research minister Roger-Gérard Schwartzenberg has supported the action. Last week he said the government would extend to diagnostic tests an existing law that forces biomedical firms to grant licenses to their products if their patents are "exploited under conditions contrary to the interests of public health."

Cash Prize Hoping to stem the flow of blue-chip graduate students to prestigious U.S. institutions, the University of Toronto will become the first Canadian university to guarantee minimum financial stipends for all doctoral candidates. Starting this fall, the school's roughly 4000 Ph.D. students will each receive at least $11,000 to cover tuition, fees, and living expenses.

The funds will give a boost to students in the oft-neglected social sciences and humanities, who typically must pay their own way, while reducing the need for students to take part-time jobs that could interfere with their studies, says vice provost of students Ian Orchard. The stipends should also help science departments compete with U.S. institutions, Orchard adds. U.S. schools give students an average of $7800 annually—nearly 50% more than under Toronto's former policy, according to a university task force.

Orchard predicts Toronto's move will put pressure on other Canadian universities to sweeten the pot, too. But while University of Alberta provost Douglas Owram applauds Toronto's initiative, he says his school doesn't "have the resources right now" to keep up.

Contributors: David Malakoff, Josh Gewolb, Michael Balter, Wayne Kondro

ILLUSTRATION: JOE SUTLIFF

it's OK to kill one person to save five, whereas other times it's not.

Now, an interdisiplinary team has offered its philosopher colleagues a helping hand. According to a brain imaging study presented on page 2105, even if an ethical problem is posed in strictly rational terms, people's emotional responses guide their solutions. The study, says cognitive neuroscientist Martha Farah of the University of Pennsylvania in Philadelphia, "pushes outward on the boundaries" of cognitive neuroscience. Rather than studying how people perform relatively simple tasks such as movements, the team is exploring "something quintessentially a form of higher human thought."

Intrigued by the dilemma of the moral dilemmas, a team led by Joshua Greene, a philosophy grad student at Princeton University in New Jersey, used functional magnetic resonance imaging to spy on people's brains while they read and reasoned their way through a number of scenarios. Some resembled the "switch tracks" dilemma, others the "push body," and some had no apparent moral component, such as deciding whether to take a bus or train to some destination.

While the people were deliberating the body-pushing set of moral dilemmas—but not the other scenarios—emotion areas of their brains lit up, the team found. These areas, the medial frontal gyrus, posterior cingulate gyrus, and angular gyrus, have been shown to be active when someone is sad, frightened, or otherwise upset. The team's scan didn't register parts of the frontal lobes that are strongly associated with emotions and judgment, so "it's not the prettiest picture," says Farah. Even so, she says it's still clear that some dilemmas activate emotion areas of the brain and others don't.

"From a utilitarian point of view, these situations are identical," says psychologist Jon Haidt of the University of Virginia in Charlottesville; "they differ only in that one of them feels wrong." Greene points out that the study doesn't resolve whether it's right or wrong to push someone into the path of a runaway trolley, but it does begin to answer a related question: how people decide what's right and wrong.

The findings are bad news for the majority of moral philosophers and ethicists, who maintain that moral decisions must be based on pure reason, says philosopher Stephen Stich of Rutgers University in New Brunswick, New Jersey. After all, he says, people in the scanner are "thinking of abstract, hypothetical problems, of the sort philosophers have been reflecting on for decades." Instead of discounting emotion, Stich says, his colleagues should treat it as an important part of people's moral reasoning. –LAURA HELMUTH

NEW FACILITIES

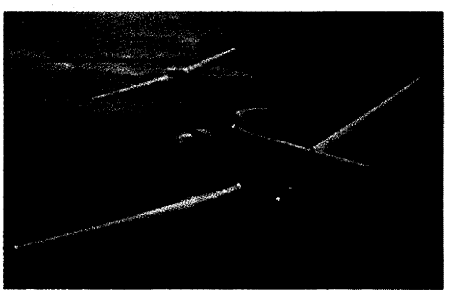
Congress Grills NSF on Selection Process

Michael Marx wants to understand why there's so much more matter than antimatter in the universe, making possible the world as we know it. Before probing this mystery, however, the particle physicist must struggle with another, more earthly puzzle—understanding how the U.S. National Science Foundation (NSF) ranks competing big-ticket projects like Marx's.

Marx thought he had the NSF part of the equation solved last October. That's when the National Science Board (NSB), which oversees the agency, approved a $120 million accelerator experiment at Brookhaven National Laboratory in Upton, New York, that would allow him and a team of scientists from around the world to measure a phenomenon, called charge-parity violation, that provides a glimpse into the first few moments after the big bang. However, Marx's excitement cooled in April when he looked at NSF's 2002 budget request and couldn't find a $25 million downpayment for the two detectors that make up the Rare Symmetry Violating Processes (RSVP) experiment. "I was shocked," he recalls. "They told us that we were on the very fastest track." Two months later, his disappointment turned to anger when he learned that an influential member of Congress was planning to put money into NSF's budget for another facility—a neutrino detector dubbed Ice Cube at the South Pole—also approved by the science board but not requested by NSF (*Science*, 27 July, p. 586).

Testifying last week before the House Science Committee's research subcommittee, NSF director Rita Colwell and NSB vice president Anita Jones offered a glimpse into how the agency selects such projects as RSVP and Ice Cube from a pool of contenders. The hearing, prodded by a report from NSF's inspector general that faulted the agency's management of large facilities under construction, also featured the first public listing of projects approved by the science board (see table).

One revelation was that the science board does not prioritize its choices after screening for scientific merit. "Our job is to [whittle them down] from a huge list to a small number of projects," explained Jones, a computer scientist at the University of Virginia, Charlottesville. "The board expects them all to go forward, budget permitting." Representative Nick Smith (R–MI), who chaired the hearing, expressed dismay that the board doesn't rank them. "Do we really want OMB [the Office of Management and Budget] to make that decision and then leave it to politicians to decide what to fund?" he asked.



En route. This Gulfstream V will become a research plane, one of several new facilities funded by NSF.

WHAT'S IN THE NSF PIPELINE

Under construction
- Atacama Large Millimeter Array (ALMA, design phase)
- HIAPER (high-altitude research plane)
- South Pole Station modernization
- Network for Earthquake Engineering Simulation
- Terascale computing systems

Unfunded requests
- ALMA (construction phase)
- EarthScope (USArray and San Andreas observatory)
- National Ecological Observatory Network

Board approved, not yet requested
- EarthScope II (Plate Boundary Observatory)
- Ice Cube neutrino detector
- Ocean observatories
- Rare Symmetry Violating Processes

Jones defended the board's neutrality, saying it provided NSF with greater flexibility. Colwell added that her top priority is completing projects that have already received some funding, after accounting for balance across disciplines and the readiness of individual projects. Each fall NSF hashes out the list with OMB, which this year created a logjam by ordering no new starts.

That explanation wasn't much solace for RSVP's supporters, however. At the hearing, Representative Felix Grucci (R–NY), whose district includes Brookhaven, pressed Colwell for information about the status of the project. She dodged his question, saying that he'd have to wait until the Bush Administration's 2003 budget is unveiled in February.

However, Colwell was more forthcoming on how NSF plans to handle future big projects. She announced the formation of an office for large facilities to try to ensure that every project is built on time and on budget. "We want to bring in some expertise that hasn't been resident here," says Tom Cooley, NSF's chief financial officer, about a new

SOURCE: NSF