Earth Science

Richard Monastersky reports from San Francisco at the fall meeting of the American Geophysical Union

Little-known fault poses quake risk

Many residents of the San Francisco Bay area immediately recognize the names San Andreas and Hayward as the two major faults framing the Bay. But recent geologic studies suggest that a more obscure fault to the north may pose the greatest immediate risk to Bay area residents.

Researchers from the U.S. Geological Survey (USGS) in Menlo Park, Calif., recognized several years ago that this fracture, the Rodgers Creek fault, warranted concern. They have now gathered evidence that the fault may be nearing a magnitude 7 earthquake. "Of all the segments in the area, this fault is probably closest to failure," says USGS geologist David P. Schwartz. He and his co-workers found evidence of three prior earthquakes when they dug trenches across the Rodgers Creek fault between San Pablo Bay and Santa Rosa. Carbon-14 dating suggests that the shocks occurred every 300 years or so, with the last earthquake dating to approximately 1700.

If the Rodgers Creek fault does rupture regularly, it should produce another shock in the next few decades, Schwartz says. He warns, however, that the limited data currently available make it difficult to tell how regularly the fault generates quakes.

Fifth force sunk in ocean experiments

After creating a splash among physicists in the mid-1980s, the hypothesized "fifth force" now appears washed up. A set of extremely accurate gravity measurements made in the Pacific Ocean shows no evidence of the extra force, confirming the results of laboratory experiments that have also failed to detect this would-be addition to the family of four universal forces.

Scientists raised the idea of a fifth force in 1986 after finding hints that the gravity inside an Australian mine shaft did not follow Newton's inverse square law. They theorized that a previously unrecognized force — acting over distances of tens to thousands of meters — had altered the attraction between the gravity meter and the rock around the shaft.

Geophysicists from the Scripps Institution of Oceanography in La Jolla, Calif., and elsewhere have now tested this hypothesis by measuring gravity while ascending in a submersible through 5 kilometers of water off the coast of California. Carefully surveying the seafloor, the sea level and other variables, the scientists determined the gravitational constant G to an accuracy of 2 parts in 1,000. These are the most precise gravity measurements made in a large-scale field experiment, says John A. Hildebrand of Scripps.

Laboratory tests have found no sign of a fifth force but these experiments could not test for the force acting over great distances. If a fifth force did manifest itself over 1,000 meters, the recent gravity measurements near the seafloor should have differed from those several kilometers above the seafloor — a distance presumably out of the range of the hypothetical force. But the scientists found no appreciable variation.

Earth burps and magnetic flips

Like an unruly child, Earth's magnetic field displays some pretty erratic behavior. Throughout the planet's history, the field has flipped its orientation thousands of times, sometimes pointing toward the north and other times aiming in the opposite direction. But 123 million years ago, the field became remarkably stable, assuming a consistent orientation for a period of 40 million years.

Two geophysicists have now developed a theory to explain this magnetic "superchron" and other, shorter periods during which the field has remained well behaved. Roger L. Larson of the University of Rhode Island in Narragansett and Peter Olson of Johns Hopkins University in Baltimore suggest that the magnetic field stabilizes when the number of thermal plumes increases inside the planet. These plumes — the geologic equivalent of burps — are streams of rock that rise from the deep mantle and erupt at the surface as basalt volcanoes, creating such features as the Hawaiian Islands and submerged oceanic plateaus. As evidence for their theory linking field stability with plumes, Larson and Olson report that the superchron period was a time of tremendous basaltic eruptions from rising plumes.

Geoscientists believe the magnetic field arises from convecting currents of liquid iron within Earth's outer core. Plumes are thought to originate from a boundary layer that separates the core from the overlying rocky mantle.

In Larson and Olson's model, the surge in plume development 123 million years ago thinned that boundary layer, allowing more heat to escape into the mantle and enhancing convection within the outer core. The vigorous convection stabilized the magnetic field, preventing it from reversing its orientation. Later, when the convection died down, the field began its reversals again.

New date resets geologic clocks

What if someone discovered that a day lasts 25.8 hours instead of 24? That's precisely the kind of revision scientists are now facing, after finding age problems with one of the more familiar yardsticks in Earth's history.

Researchers often use prominent changes in the planet's magnetic field as reference points for dating rocks. For more than a decade, they have considered the last major change as occurring 730,000 years ago, between the Brunhes and Matuyama geomagnetic periods. But recent experiments suggest this transition occurred 50,000 years earlier — a finding that could substantially alter ideas about the past.

Geophysicist Michael McWilliams of Stanford University dated the Brunhes-Matuyama transition at 780,000 years ago using the argon-argon technique, a variation of the standard potassium-argon dating method. His finding confirms results reported last year by oceanographers who redated the transition using an entirely different technique, based on counting the number of Earth's orbital oscillations in ocean sediments. The previous age of 730,000 was determined from conventional potassium-argon dating, which can yield inaccurate results when used with certain types of rocks, McWilliams says.

He notes that the new age would solve some problems confronting scientists studying the San Andreas fault. Precise measurements across the fault suggest that the Pacific plate moves past North America at a rate of 48 millimeters per year. But a different type of estimate, based on magnetic lineations in the ocean, puts that speed at 51 millimeters per year. Redating the Brunhes-Matuyama transition eliminates the discrepancy, McWilliams says.

Pinatubo begins its ozone assault

Balloon flights over Boulder, Colo., early last month measured the lowest December ozone values ever recorded at this site. The unusual readings came on the same day that a patch of Mt. Pinatubo's volcanic cloud passed overhead, and may in part reflect ozone destruction catalyzed by sulfuric acid particles in the cloud, says David J. Hofmann of the National Oceanic and Atmospheric Administration in Boulder.

Soon after the eruption, scientists predicted that the particles could dramatically accelerate ozone destruction around the world. To determine the extent of ozone loss over the northern midlatitudes, experts must wait a month or more until the full cloud reaches this region. Hofmann predicts that when the cloud travels to the far south, it may generate an "extra" ozone hole during the Antarctic fall. The "usual" ozone hole appears during Antarctica's spring.