History of the USGS Earthquake Hazards Program

By Susan C. Wells

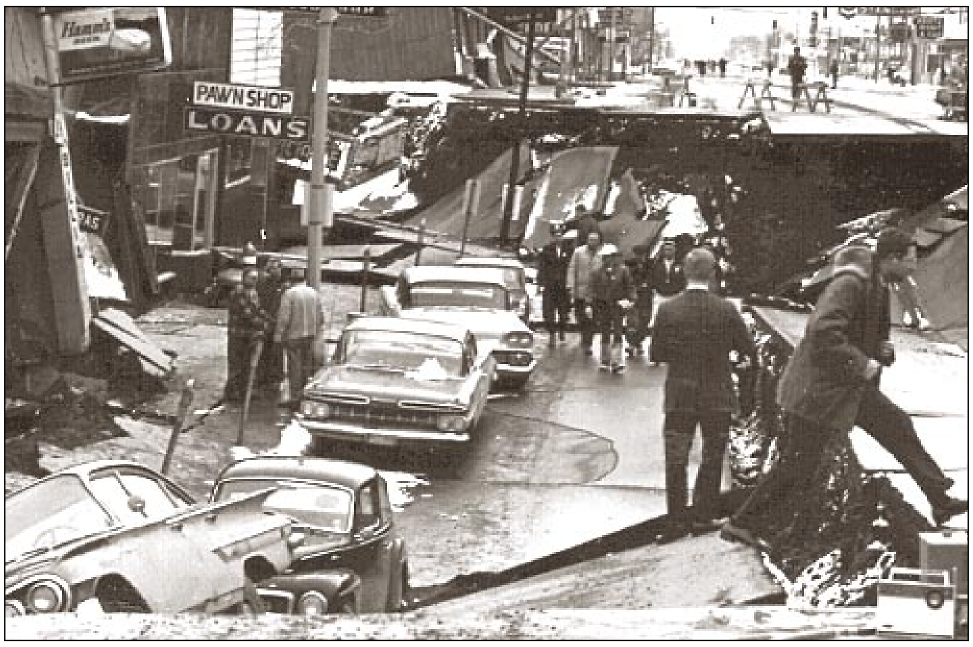
Scientific study of earthquakes in the United States arose from three seismic events that occurred in the eastern, central, and western parts of the country beginning in the early 1800s. In the winter of 1811–1812, three magnitude-8.0 earthquakes shocked New Madrid, Mo.; a magnitude-7.3 earthquake devastated Charleston, SC, in 1886; and in 1906, the magnitude-7.9 earthquake struck San Francisco. Although Charleston's event was thought to be an anomaly because no surface evidence showed that faults had triggered the earthquake, scientists had begun to recognize a direct link between faults — or seeming breaks in the earth's surface — and earthquakes. In 1895, geologist A.C. Lawson at the University of California at Berkeley studied a fault south of San Francisco and named it the San Andreas Fault. At the time he didn't realize the small fault was part of a vast system of faults along the western edge of California. After the great San Francisco earthquake, scientific research revealed its true extent and scientists began speculating that energy building up along these fissures eventually released and shook the earth.

In the 1950s, a permanent USGS site in seismically-active California was established in Menlo Park, 30 miles south of San Francisco. Its focus was primarily geologic and topographic mapping; but seismology was beginning to take root with little fanfare and little funding. Two events soon propelled seismology into the national spotlight, one was due to the nature of human relations and the other to the dynamic nature of the Earth.

The Nuclear Connection

Scientist emeritus John Filson, a former chief of the Earthquake Hazards Program, recalls that early advancements in the field of seismology were closely tied to nuclear energy, both in monitoring nuclear arms testing and in developing seismic safety standards for nuclear reactors. To avoid global catastrophe from radioactive contamination, a treaty prohibiting nuclear testing in the atmosphere, in outer space and underwater, was signed in 1963. However, it did not prohibit underground testing.

As a result, the Department of Defense began to support a broad-based program in basic and applied seismic research. This program included the development of the Worldwide Standardized Seismograph Network. During the 1960s, data from this network was used to establish the theory of plate tectonics, an essential element of modern understanding of earthquake causes and occurrences. The drive toward seismic safety standards for nuclear reactors helped improve seismic hazard analyses, particularly in the eastern part of the United States.



The 1964 Alaska earthquake released perhaps twice as much energy as the 1906 San Francisco Earthquake, was felt over an area of almost 500,000 square miles and triggered a tsunami that traveled along the coast from Alaska to California. The next year, the USGS Center for Earthquake Research was established.

The Great Alaska Earthquake

The biggest boost in earthquake awareness in the United States occurred in the aftermath of the great Alaskan earthquake of 1964. This magnitude-9.2 earthquake killed 15 people in Alaska and spawned a tsunami that took more than 100 lives along the Pacific Coast from Alaska to California.

By placing instrumentation far beneath the Earth's surface, the San Andreas Fault Observatory at Depth marks a major advance in the pursuit of understanding earthquakes.

The next year, the USGS Center for Earthquake Research was established in Menlo Park, hailed as one of the largest centers for study of the earth sciences in the world. Scientists became crusaders with a quest: earthquake prediction. Jim Devine, USGS Senior Advisor for Science Applications, recalls how everyone felt that muscle and brains could make it happen, but even now, 40 years later, earthquake prediction remains the "Holy Grail" of seismology.

Consolidation of Earthquake Studies

The U.S. Coastal and Geodetic Survey, part of the National Oceanic and Atmospheric Administration (NOAA), had been involved since 1900 in earthquake monitoring and research. By 1972, a network of nearly 600 strong-motion seismographs was installed throughout the United States and Central and South America. In 1973, the U.S. Coastal and Geodetic Survey was merged with USGS seismological studies. The U.S. Coastal and Geodetic Survey's National Earthquake Information Center, in Golden, Colo., was transferred to the USGS. [See page 14.]

National Earthquake Hazards Reduction Program

The Disaster Relief Act of 1974, referred to as the Stafford Act, gave the USGS authority to issue geologic-related hazard warnings — including earthquakes — with the caveat that "predictions of the precise location, time and magnitude of specific earthquakes cannot generally be made now." It did allow that broad-scale estimates of earthquake susceptibility were available for various regions of the United States, principally California.

As a result of this legislation, the USGS National Seismic Hazards Mapping Project sprang to life, providing connections between earthquake research and hazards mitigation. Hazard maps have become the basis for the seismic sections of model building codes such as the Uniform Building Code. [See "Building Safer" page 26.]

In 1976, the National Science Foundation and the USGS developed a report titled *Earthquake Prediction and Hazard Mitigation: Options for USGS and NSF Programs*, referred to as the "Newmark-Stever Report," that combined needs assessments, state of knowledge reviews, and recommended provided programs and budgets on which to base a national earthquake hazards reduction program.

In 1977, Congress enacted the Earthquake Hazards Reduction Act, recognizing the important role of scientific research in the mitigation process, and establishing the National Earthquake Hazards Reduction Program (NEHRP), a multi-agency effort that includes the USGS earthquake monitoring and research programs.

A year later, the USGS Earthquake Hazards Program was established to carry out the mandates of NEHRP. The USGS, with the most extensive seismic monitoring and response system in the nation, joined forces with other agencies and universities to advance understanding of the causes and effects of earthquakes. Work also began in conjunction with emergency-response agencies to address public safety and hazards mitigation.

The Loma Prieta Earthquake

In 1989, the magnitude-6.9 Loma Prieta earthquake caused significant damage in an extended area around San Francisco.

"I remember answering more than 2,000 phone calls in the week after the Loma Prieta earthquake of 1989," says Earthquake Hazards Program assistant Joyce Costello, who has been with the USGS earthquake program for 33 years. "Callers wanted to know if this was 'the big one' — an earthquake equal to or greater than the 1906 San Francisco earthquake. It wasn't."

A curious bit of wisdom from Loma Prieta was the increased awareness that emergency responders can also be immobilized in an earthquake. In some cases, firehouses had been shaken off kilter with their doors jammed shut and trucks trapped inside. Hazards emphasis shifted from predicting the occurrence of earthquakes to predicting and mitigating their effects.

Advanced National Seismic System

In 1997, Congress reauthorized NEHRP with a specific request for development of a "real-time seismic hazard warning system." This paved the way for development of the Advanced National Seismic System. [See page 22.] Begun in 2000, the system has helped integrate, modernize, and expand earthquake monitoring and notification nationwide.

Parkfield Prediction

Between 1857 and 1966, six magnitude-6.0 earthquakes occurred at intervals of approximately 22 years along the San Andreas Fault near Parkfield, Calif. In 1985, USGS scientists took advantage of the seeming regularity of these earthquakes and set up extensive research instrumentation in the area. They boldly predicted the next sizable earthquake would occur in 1988, 22 years after the last one. Instead, it arrived in September 2004, after providing a wealth of valuable research data.

In 2004, the USGS and the National Science Foundation, as part of the EarthScope science initiative, went even further and began drilling a deep hole to install instruments directly within the San Andreas Fault near the point of the previous magnitude-6.0 earthquakes, forming the San Andreas Fault Observatory at Depth (SAFOD).

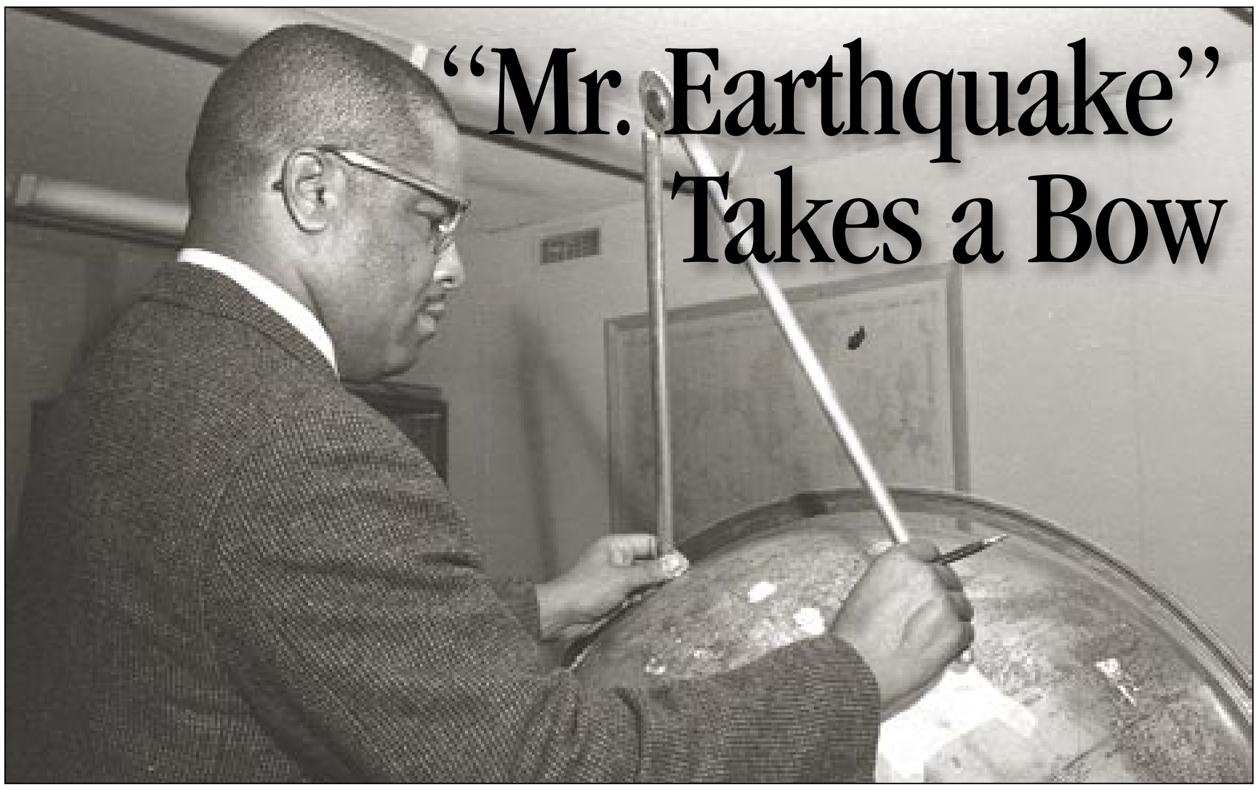
USGS Senior Advisor for Science Applications Jim Devine recalls that improvements in earthquake monitoring and advances in seismology and geomagnetism made the 1950s and 1960s a very exciting time for scientists. "Nothing has matched it since," he says.

SAFOD is providing direct information on the composition and mechanical properties of rocks in the fault zone, the nature of stresses responsible for earthquakes, the role of fluids in controlling faulting and earthquake recurrence, and the physics of earthquake initiation and rupture. By observing earthquakes "up close," SAFOD marks a major advance in the pursuit of a rigorous scientific basis for assessing earthquake hazards and predicting earthquakes. This work ties in with the National Earthquake Hazard Reduction Program's efforts to protect lives and property from earthquake hazards.

The Future

"Short-term prediction is still in the future," says Senior Science Advisor for Earthquake and Geologic Hazards David Applegate, "but we are making great strides at minimizing loss of life and property right now by providing assessments of hazard zones and delivering rapid post-event information for first responders and emergency managers."

The USGS continues to improve existing earthquake monitoring, assessment and research activities with the ultimate goal of providing the nation with a new generation of earthquake products to improve earthquake mitigation and response. On the horizon is an extensive, coordinated seismic-monitoring network that will instantly register ground motion and signal an alarm if an earthquake occurs near a populated area — automatically opening the firehouse doors seconds or minutes before the tremblors arrive.



"Mr. Earthquake" Takes a Bow

Waverly Person uses the technology of the day to locate earthquakes.

By David Hebert and Heidi Koontz

After 51 years of educating audiences around the globe about earthquakes, USGS scientist Waverly Person called it quits on Feb. 3, 2006. Person is well known among media circles as *the* person to call when an earthquake happens anywhere in the world. Known by many as "Mr. Earthquake," he is a fixture both in classrooms and on television sets.

Before becoming a government scientist, he served in both World War II and the Korean War with the U.S. Army. He then took his bachelor's in mathematics to a position as a science technician with the Department of Commerce, which oversaw federal seismic monitoring in the 1950s.

Person was literally thrown in front of the media spotlight in 1964 following the magnitude-9.2 earthquake that hit Anchorage, Alaska.

In the lobby of the Commerce Building in Washington, D.C., was a seismograph; and the ink used to create seismograms was spilled everywhere because of the machine's drastic response to the huge quake. The lobby was full of curious people, some with microphones and cameras, asking questions about the situation. Person saw what was happening and told his supervisor, "Somebody needs to talk to those people."

"Well, there's nobody else here," the supervisor responded. "You've got to talk to them."

And that's exactly what he did. Media, citizens, students — anyone who asked a question about earthquakes, he answered. Some notable names of inquirers over the years include Tom Brokaw, Dan Rather and Matt Lauer.

Of course, Person is a natural when it comes to talking to people.

"It's one of the things I enjoy most of all," he says. "I've always tried to put news to the general public in a way they can understand it — to get the message to the vast majority. When there's an earthquake, people are frightened. If you relate the information to them so that they understand, they calm down."

Behind the public view, Person has some historical feats to boast. He marched alongside Dr. Martin Luther King, Jr., and has been coined the nation's first black earthquake seismologist.

"I've learned a lot along the way," said Person. "And the path hasn't always been kind."

He feels lucky to be a noticeable face to younger generations and to have the opportunity to persuade minority students to pursue science. Thus, Person will continue educating this demographic about seismology through speaking at inner-city classrooms.

Last year, U.S. Rep. Bob Beauprez (Colo.) recognized Person's 50 years of government service at a ceremony honoring his career.

"You want economic advice, you go to Alan Greenspan. You want to know anything about seismic activity, you see if you can get Waverly Person on the line," said Rep. Beauprez in a *Denver Post* article commemorating Person's 50th anniversary.

So who will fill Person's shoes?

"Waverly is a hard act to follow — not only because of his calm under fire, but also his incredible encyclopedic mind for earthquake history," said Jill McCarthy, director of the USGS Geologic Hazards Team in Golden, Colo. "For the past few years, we've been training other scientists to deal with media inquiries, and we've been developing earthquake databases and computer programs that attempt to replicate what Waverly knows intuitively from decades of hands-on experience. Even still, we realize that things just won't be the same without Waverly."

And they haven't been.

"People still call and ask to talk with Waverly about rumblings they've felt," said John Bellini, a geophysicist who was hired by Person 7 years ago. "We tell them he's retired, and a bit of shock ensues."

Person, a long-time Boulder, Colo., resident, and his wife, Sarah, plan to enjoy each other's company and travel around the country to visit family. And since he is now a scientist emeritus, you might just see him in the background the next time a "big one" hits.