The Advanced National Seismic System: A Sure Bet for a Shaky Nation

By David Hebert

If you were to learn that in 1886, a major U.S. city was ravaged by a magnitude-7.3 earthquake in which 60 people were killed and millions of dollars of damage done, where would you guess it had happened — Los Angeles? San Francisco? Anchorage?

Try Charleston, S.C.

In fact, damaging earthquakes have rocked several U.S. cities far from Alaska or California — Boston, Memphis and Salt Lake City, to name a few. Chances are, they will again, and those at risk need to be ready.

That's where the Advanced National Seismic System (ANSS) comes in.

The ANSS is a proposed nationwide earthquake-monitoring system designed to provide accurate and timely data and information products for seismic events, including their effects on buildings and structures.

"The ultimate goal of the ANSS is to save lives, ensure public safety and reduce economic losses," said Bill Leith, a USGS scientist and coordinator of the ANSS. "Rapid, accurate information about earthquake location and shaking, now available in parts of California, Washington and Utah, is generated by data from a dense network of seismic-monitoring instruments installed in high-risk urban areas. The information has revolutionized the response time of emergency managers to an earthquake in these areas, but its success depends on further deployment of instruments in other vulnerable cities across the United States."

Although the frequency of earthquakes on the West Coast is higher than other areas of the contiguous United States, the geologic characteristics nationwide mean that research and monitoring are necessary everywhere.

"When people think of faults and earthquakes, they tend to think of the San Andreas Fault, but earthquakes in the eastern United States might be different," said Eugene Schweig, a USGS geologist in Memphis, Tenn. "Assuming buildings will shake the same in the East as they do in California is probably not valid."

ANSS network instruments are already at work in many areas and are planned for other earthquake-prone regions nationwide, including Northern and Southern California, the Pacific Northwest, Alaska, Salt Lake City, the New Madrid Seismic Zone, and along the Atlantic Coast in South Carolina, New York and Massachusetts.

The ANSS, when fully implemented, will integrate all regional and national networks with 7,000 new seismic instruments, including 6,000 strong-motion sensors in 26 at-risk urban areas. (See map for a list of these areas.)

Boston is one of those urban areas — indeed, it has experienced damaging earthquakes before. In 1755, an earthquake centered near Cape Ann, Mass., caused building damage and chimney collapses in Boston. The buildup of the city since then would likely make matters much worse if such an earthquake were to happen there today.

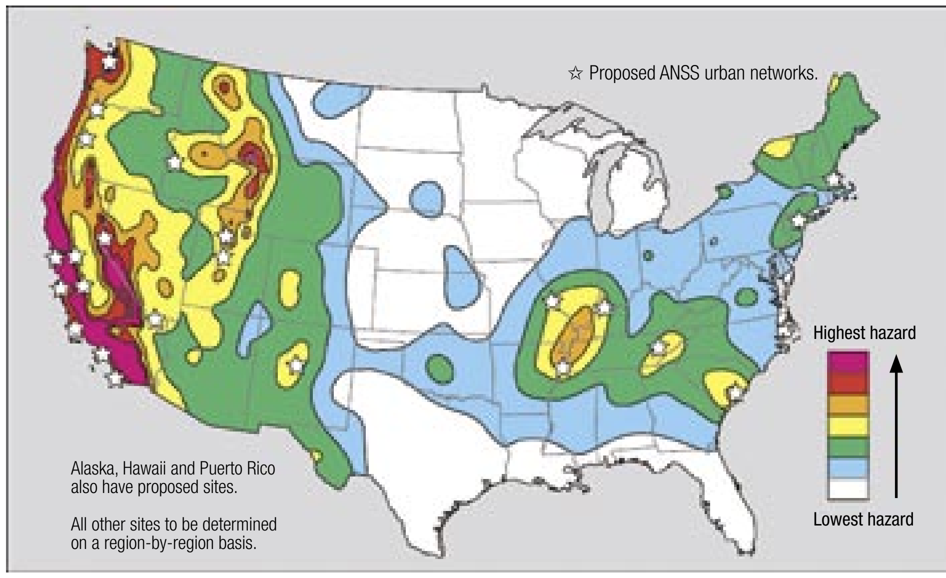
John Ebel, a professor of geophysics at Boston College and northeast coordinator for ANSS implementation, estimates that damaging earthquakes (magnitude 5 or greater) happen in New England every 50 to 60 years. In 1940, there was a magnitude-5.5 quake in New England, and the clock is ticking.

"I talk to people all the time who ask, 'Earthquakes don't really happen here, do they?' " Ebel said. "And I answer, 'Yes, they do.' "

Although the frequency of earthquakes is much greater in the West, the damaging effects of a quake in the East travel farther.

"The 1994 magnitude-6.7 Northridge,

Twenty-six U.S. urban areas, identified in the map at right, are at risk of significant seismic activity:



The earthquake hazards map of the conterminous United States shows the areas of highest seismic hazard in red and lowest seismic hazard in grey. The stars indicate urban areas where dense urban monitoring networks are proposed. The regional networks (not shown) will be concentrated in the areas of highest risk, and the national networks (not shown) will have sites evenly distributed throughout the country.

- Albuquerque, N.M.
- Anchorage, Alaska
- Boise, Idaho
- Boston, Mass.
- Charleston, S.C.
- Chattanooga-Knoxville, Tenn.
- Eugene-Springfield, Ore.
- Evansville, Ind.
- Fresno, Calif.
- Las Vegas, Nev.
- Los Angeles, Calif.
- Memphis, Tenn.
- New York, N.Y.
- Portland, Ore.
- Provo-Orem, Utah
- Reno, Nev.
- Sacramento, Calif.
- St. Louis, Mo.
- Salinas, Calif.
- Salt Lake City, Utah
- San Diego, Calif.
- San Francisco-Oakland, Calif.
- San Juan, P.R.
- Santa Barbara, Calif.
- Seattle, Wash.
- Stockton-Lodi, Calif.

USGS Earthquake Scientists — A Nationwide Notion of Pride

By David Hebert

USGS scientists from across the country have been part of many incredible and memorable earthquake experiences. With that in mind, several of them were asked, **"What has been your proudest, most exciting or most noteworthy moment in USGS earthquake science?"**

The answers are as different as the scientists themselves.

Susan Hough

Title: Geophysicist/Seismologist

Location: Pasadena, Calif.

Length of service with the USGS: 14 years

In April of 1992, less than two months after joining the USGS office in Pasadena, Calif., I led the deployment of portable seismometers after the magnitude-6.1 "Joshua Tree" earthquake struck the Southern California desert near Palm Springs. My colleagues and I were able to keep these instruments running for the next few months, recording many thousands of aftershocks.

On the morning of June 28, 1992, the magnitude-7.3 Landers earthquake struck just to the north of where the Joshua Tree event had occurred. The portable seismometers — instruments developed by the USGS in Menlo Park — operated faithfully, recording invaluable close-in seismograms of the largest earthquake in California in 40 years.

Now, as in 1906, seismology remains a data-driven science: Our most important leaps in understanding have invariably come after large earthquakes not only strike but are recorded by increasingly sophisticated instrumentation. Earthquakes do not, however, record themselves. Long- and short-term monitoring requires ingenuity and commitment. The USGS has taken a leadership role with such efforts in the United States for nearly half a century. Looking back at my own career, I am proud of any number of accomplishments, but none more than the chance to contribute in a modest way to this tradition of excellence.

Calif., earthquake was not felt in San Francisco, less than 400 miles away," Ebel said. "If that same earthquake happened in Boston, it would be felt in Minneapolis-St. Paul, more than 1,000 miles away. There is potential for several metropolitan areas to be damaged by a single, large earthquake in the East."

In 1811 and 1812, a series of earthquakes, ranging in estimated magnitude from 7.5 to 8.0, started near New Madrid, Mo., and shook cities from St. Louis to Cincinnati. Although the probability for another 1811/1812-type sequence in the next 50 years is 7 to 10 percent, the probability for a magnitude-6 or greater during that same period is 25 to 40 percent.

"Based on paleoseismic work, we know that 1811- and 1812-like events have happened two or three times in the past," said Mitch Withers, seismic networks director at the Center for Earthquake Research and Information at the University of Memphis. "So we know it's not a fluke and that they tend to come in sequences, where there are several events clustered together in time. From a hazard and recovery point of view, it's much more difficult if we have several in a row like that."

Earthquake hazard concerns stretch to the Mountain States as well, where several earthquakes since 1935 have caused more than 30 deaths in Idaho, Montana and Wyoming. The threat of such a quake happening in a mountain urban area means preparation and monitoring are vital in at-risk locations such as Salt Lake City.

"We haven't had our 1906 earthquake in Utah yet, but our partnership with the USGS under the ANSS has made us feel much better prepared to deal with it when it happens," said Gary Christenson, a geologist and manager of the Geologic Hazards Program at the Utah Geological Survey. "The USGS has been a partner in earthquake monitoring in Utah from the beginning, and implementation of the ANSS has been a major achievement in improving preparedness, response and scientific/engineering data gathering."

The variety of earthquake hazard concerns that are both unique to and shared by urban areas nationwide illustrates the need for a consolidated, cooperative approach to information gathering and mitigation.

"The ANSS is working toward development and implementation of integrated software and human resources to more effectively use these with existing hardware resources to provide timely and valuable information to the public," Withers said.

Timely and valuable information is a key ingredient to effective mitigation. A possibility USGS scientists have been keenly aware of throughout the development of ANSS is that an early warning of even a few seconds would give schoolchildren enough time to get under their desks and would allow managers time to stop trains and subways, shut off pipelines and suspend medical procedures.

These sorts of warnings can only be accomplished through national cooperation, so a nationwide network of science and civic partners is working to make the ANSS a reality.

"The USGS and its regional partners combine resources to augment ANSS-funded stations to operate regional seismic networks," Withers said.

These partners include state geological surveys, university researchers, emergency managers, engineering organizations and more. The USGS works to unify perspectives and efforts to create a single, national force with which to address earthquake concerns and provide timely information.

"To have the USGS as overseer and coordinator of the ANSS makes sense," Ebel said. "The USGS is nationally involved in earthquake research and monitoring and it has expertise in house."

The USGS is the only agency in the United States responsible for the routine monitoring and notification of earthquakes. The USGS fulfills this role by operating the U.S. National Seismograph Network, the National Earthquake Information Center, the National Strong Motion Program and by supporting 14 regional networks in areas of moderate to high seismic activity. All of these efforts are being integrated into the ANSS.

"The ANSS contributes to the infrastructure that enables monitoring to be much more cooperative and integrated, allowing information to the public that combines data from all regional partners," Withers said.

The goal of USGS earthquake monitoring is to mitigate risk — using better instruments to understand the damage caused by shaking and to help engineers create stronger and sounder structures that ensure vital infrastructures, utility, water and communication networks can keep operating safely and efficiently.

The ANSS comprises several products that work to engage and inform the public, emergency managers and decision makers:

- **Recent Earthquakes** — Automatic maps and event information are available within minutes online at the USGS Earthquake Hazards Program Web site, which displays earthquake locations nationwide.
- **Did You Feel It?** – This is a citizen science Web page where shaking intensity maps are created by the people who felt the earthquake. [See page 33.]
- **ShakeMap** – A rapidly generated computer map that shows the location, severity and extent of strong ground shaking within minutes after an earthquake. Fast information on strong shaking in urban areas helps get emergency response to the right places.
- **Hazard Maps** – Hazard maps identify the areas of the country that are mostly likely to experience strong shaking in the future. ZIP code or latitude-longitude lookup is available. [See pages 26, 30, 31.]
- **Earthquake Notification** – Automated notifications of earthquakes are available through e-mail, pager or cell phone. This provides rapid information and updates to first responders and resources for media and local government.
- **Earthquake Catalog and Data** – Users can search an online catalog and download information and technical data.
- **Real-time Waveforms** – Real-time waveform displays from 60 stations, showing the movement of seismic waves, are available online 24 hours a day.
- **Regional Earthquake Info** – Information about earthquake hazards, historical seismicity, faults and more is available for different regions of the country and by state.
- **Movies of Structures Shaking** – These are Quicktime movies created from the recordings of fully instrumented structures during earthquakes.

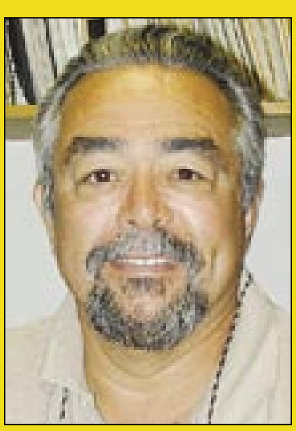
"USGS and ANSS support allows for much better monitoring than we would otherwise have," Withers said. "By making use of ANSS tools, we are able to provide rapid notification, recent earthquakes, ShakeMap, real-time data exchange, technical expertise exchange, etc."

Rapid and reliable information on the location, magnitude and effects of an earthquake is needed to guide emergency response, save lives, reduce economic losses and speed recovery. ANSS can offer these benefits if resources and efforts are continuously devoted to it.

"These things play out over decades to hundreds to thousands of years, so implementations and improvements have to be done year in and year out," Ebel said. "ANSS is a down-payment investment on future earthquake monitoring."

> **"The ultimate goal of the ANSS is to save lives, ensure public safety and reduce economic losses."**
>
> **— Bill Leith**

USGS Earthquake Scientists — A Nationwide Notion of Pride



Roberto J. Anima

Title: Geologist

Location: Menlo Park, Calif.

Length of service with the USGS: 33 years

For the past six or seven years, I have had the opportunity to report, both locally and internationally, to the Spanish-speaking public on both television and radio, about earthquakes, tsunamis and other natural disasters. I feel that this is important because much of the information reported in English was not being reported to the Spanish-speaking community. Because we live in an earthquake-prone area — the entire West Coast of North, Central and South America — these communities need to be made aware of the potential hazards that surround us and them. As part of these assumed duties, I have also helped in translating two fact sheets concerning earthquakes and tsunamis.

In 2001, I was asked to be part of the Tsunami Response Team that was invited to Peru in response to a series of tsunamis that occurred along the coast of Camana, Peru, as a result of a magnitude-8.4 earthquake off the coast of southern Peru. The study focused on tsunami deposits on the beaches between Ocoña and Mejia, Peru. I am currently working on mapping the rift valley of the San Andreas Fault, Tomales Bay. I am also mapping the continental shelf along the central California coast.

Ken Rukstales

Title: IT Specialist

Location: Golden, Colo.

Length of service with the USGS: 21 years

Along with Art Frankel and E.V. Leyendecker, we have produced seismic building-design maps that are the basis for the seismic design provisions of the International Building Code and the International Residential Code. These maps are the most significant product to ensure that buildings, bridges and other structures are designed to withstand expected levels of ground shaking caused by earthquakes. Properly designed, earthquake-resistant structures greatly reduce the loss of life and property from earthquakes.