Earth Sciences

Stefi Weisburd reports from Austin, Tex., at the meeting of the Seismological Society of America

Visible waves are viable

A number of people who have experienced earthquakes firsthand have reported seeing waves or bulges in the solid earth — from centimeters to tens of meters tall — plow past them like leisurely ocean waves shortly after the rapid shaking of the quake had ceased. But over the years, such claims of "visible waves" have been eyed with skepticism by many seismologists.

However, one seismologist, Rene Rodriguez at the University of Kentucky in Lexington, says he has been convinced of the waves' existence after seeing one follow an earthquake in Japan 18 years ago. Since then he has collected reports made by other seismologists who saw ground waves in connection with 26 quakes around the world. What's more, he and a co-worker have recently improved and expanded calculations, first done in 1967 by another researcher, to test the viability of large surface waves and have found them to be theoretically possible.

In Rodriguez's model, which he says is more realistic than its predecessor, the earth's surface is represented as two layers. The topmost layer is more elastic than its underlying companion. The researchers showed that surface waves of the type reported could be generated if the ratio of the two layers' elasticities fell within a certain range. This criterion, it turns out, is met if, for example, the top layer is made of clay and the bottom of limestone or granite. And this is very much like the makeup of sedimentary basins, in which visible waves were reported for all 26 earthquakes.

Rodriguez argues that surface waves would explain a number of phenomena that cannot be explained by the rapid ground shaking of quakes alone. For instance, a large-amplitude wave could have applied stresses to some floors of a hospital in San Fernando, Calif., in 1971, causing them to collapse into others that had remained unperturbed. The most dramatic example, he says, are adobe walls built by Mayas in Guatemala; a wall parallel to the direction of seismic wave travel has been imprinted with a wavelike pattern on the top, where adobe crumbled, while walls lying perpendicular to wave motion remained unscathed.

When forcing fluids makes quakes

Since the 1940s, petroleum companies have routinely enhanced oil recovery by injecting fluids into rocks surrounding reservoirs. This so-called hydraulic fracturing — which cracks the rocks and creates pathways for oil flow — is used in 27,000 wells every year.

Sometimes the injection or withdrawal of fluids causes earthquakes. And because there are detailed public records of fluid pressures in most wells, some scientists believe that oil and gas fields are ideal places to learn about the crustal stresses that induce seismicity. Wayne Pennington and Scott Davis, both at the University of Texas at Austin, used these field records to reconstruct histories of fluid pressures in a number of Texas fields, some of which had experienced quakes. They found that the pressures that triggered earthquakes were not what conventional thinking predicts.

According to Pennington, traditional models say that earthquakes are produced because injected fluids raise fluid pressure and weaken faults, which then slip. But those models predict that hundreds of Texas fields are seismic when in reality only about a dozen have earthquakes. "What we're beginning to conclude is that high fluid pressure in areas where there are weak stresses probably leads to fault creep [aseismic smooth sliding of a fault] and not earthquakes," he says. The researchers believe that earthquakes result instead from very specific patterns of fluid injection and occur in regions of low fluid pressure that are suddenly overwhelmed with high stresses that migrate from nearby fluid injection spots. Pennington says the traditional theory is still valid for regions of high stress, but thinks their model is better for low-stress regions.

Physical Sciences

From Austin, Tex., at a meeting of the Acoustical Society of America

The timing of syllables

Difficulties with rhythm may be a major reason why non-native speakers of English are hard to understand, say Z.S. Bond and Joann Fokes of Ohio University in Athens. One aspect of this problem is the timing of syllables. In sets of words like stick, sticky, sticking, sticker, stickily and stickiness, U.S. speakers of English consistently shorten the duration of the base word (stick) as the number of syllables in the suffix increases. Non-native speakers from a variety of backgrounds, they found, compress the base word the same amount regardless of the number of syllables in the suffix. These individuals are also less consistent in how much the base word is compressed.

Programming an artificial ear

Hearing aids precisely fitted to meet a particular person's needs may be available within the next few years, says electrical engineer David P. Egolf of the University of Wyoming in Laramie. The missing element, however, is a way of measuring exactly what's happening to sound inside the ear canal between the hearing aid and the eardrum. Clinicians would need this kind of information in order to adjust a hearing aid to fit the specific amplification requirements of a hard-of-hearing patient.

Inserting a miniature microphone into the ear canal to make these measurements is dangerous because of possible damage to the eardrum, says Egolf, and the microphone itself disturbs the air-pressure patterns in the canal. Alternatively, commercially available "artificial ears," designed to simulate the characteristics of an "average" adult human ear and often used for testing products like stereo headphones and telephone receivers, don't adequately take account of individual variations. The answer, says Egolf, is an artificial ear that can be altered easily to match a particular person's ear.

Recently, Egolf and graduate student William A. Kennedy developed such a programmable artificial ear. In their system, a microphone (acting like an eardrum) at one end of a brass, cylindrical cavity, detects the signals sent by a hearing aid at the other end. These measurements are sent to a computer where a program automatically adjusts them according to data already collected and stored on the size and shape of an individual's ear canal. This makes it possible to predict the loudness of sounds at various frequencies that a hearing aid delivers to an eardrum.

The sound of air bubbles

To human ears, the tune may be inaudible, but an underwater air bubble jolted by a burst of intense light will "ring," radiating sound waves into the surrounding liquid. This effect is set off by the push that reflected light gives to a surface from which it bounces. Thus, a bubble, which reflects a large amount of the light that strikes it, is initially compressed. The bubble begins to expand and contract, vibrating rapidly at its resonance frequency until the oscillations die away.

The hard part is ensuring that the vibrations are strong enough to produce detectable sound waves, says physicist Philip L. Marston of Washington State University in Pullman. Marston and graduate student Bruce T. Unger were the first to observe this effect. To detect it, the researchers illuminated tiny, individual gas bubbles with green light from an argon-ion laser, and the resulting sound waves were focused onto a microphone designed to operate in water.

Typically, an illuminated bubble, 0.1 millimeter in diameter, naturally rings at close to 30,000 cycles per second, a frequency the human ear can't hear. Larger bubbles oscillate at lower frequencies. The researchers found that by sending the light in pulses at a rate that matches a bubble's resonance frequency, they amplified the oscillations, making the resulting sound waves even "louder."