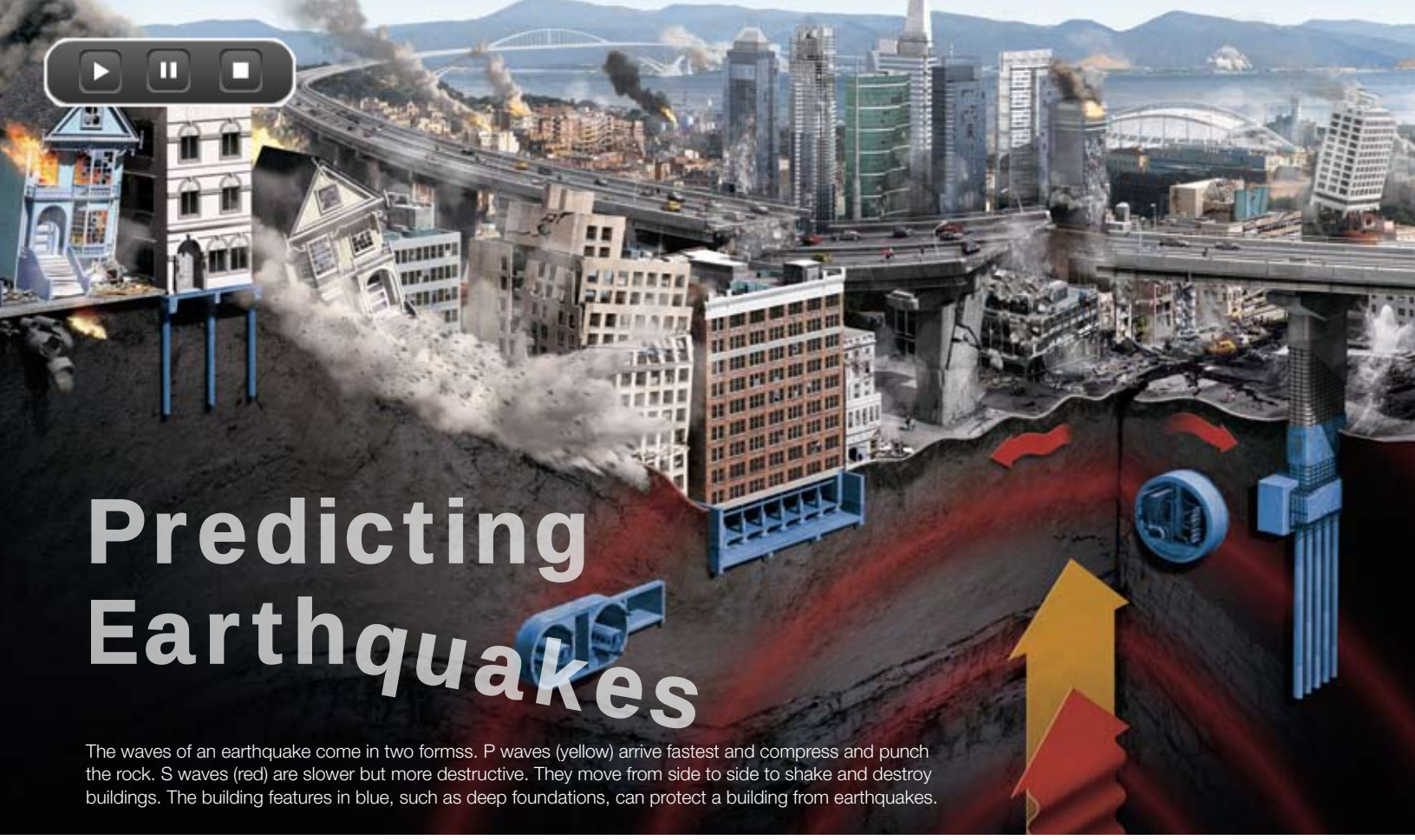


# Predicting Earthquakes

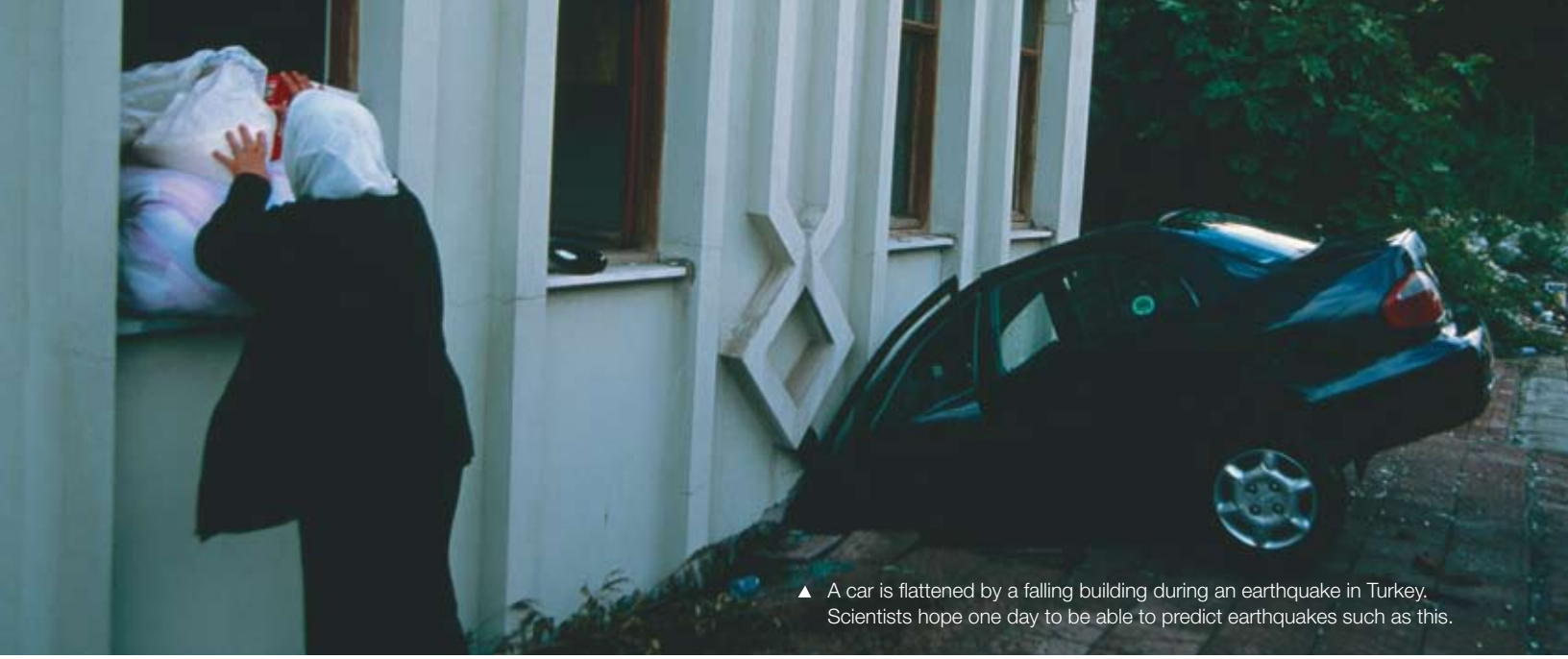
The waves of an earthquake come in two formss. P waves (yellow) arrive fastest and compress and punch the rock. S waves (red) are slower but more destructive. They move from side to side to shake and destroy buildings. The building features in blue, such as deep foundations, can protect a building from earthquakes.

Never before have so many people packed into cities—places such as Los Angeles, Istanbul, Tokyo, and Lima—that are regularly affected by earthquakes. Located near the edge of Earth's huge, shifting plates, these cities face the risk of death and economic disaster from large quakes—and from the tsunamis, fires, and other destruction they often cause.

We understand earthquakes better than we did a century ago. Now scientists would like to predict them, but is this possible? Today some of the simplest questions about earthquakes are still difficult to answer: Why do they start? What makes them stop? Perhaps the most important question scientists need to answer is this: Are there clear patterns in earthquakes, or are they basically random and impossible to predict?

In Japan, government scientists say they have an answer to the question. "We believe that earthquake prediction is possible," says Koshun Yamaoka, a scientist at the Earthquake Research Institute at the University of Tokyo. Earthquakes follow a pattern; they have observable signs, Yamaoka believes. In fact, Japan has already predicted where its next great earthquake will be: Tokai, a region along the Pacific coast about 161 kilometers (100 miles) southwest of Tokyo. Here, two plate boundaries have generated huge earthquakes every 100 to 150 years. But the section along Tokai hasn't had a major quake since 1854. The theory is that strain[1] is building up in this region and that it's time for this zone to reduce its stress. Unfortunately, this is more a forecast than a prediction. It's one thing to say that an earthquake is likely to happen in a high-risk area. It's another to predict exactly where and when the quake will occur.

The desire for a precise prediction of time and place has lead to another theory: the idea of "pre-slip." Naoyuki Kato, a scientist at the Earthquake Research Institute, says his laboratory experiments show that before a fault in the Earth's crust finally breaks and causes an earthquake, it slips[2] just a little. If we can detect these early slips taking place deep in the Earth's crust, we may be able to predict the next big quake.



▲ A car is flattened by a falling building during an earthquake in Turkey. Scientists hope one day to be able to predict earthquakes such as this.

Scientists working in Parkfield, California, in the U.S. are also trying to see if predicting earthquakes is possible. They've chosen the town of Parkfield not only because the San Andreas Fault runs through it, but because it's known for having earthquakes quite regularly—approximately every 22 years. In the late 1980s, scientists in Parkfield decided to study the fault to see if there were any warning signs prior to a quake. To do this, they drilled deep into the fault and set up equipment to register activity. Then they waited for the quake.

Year after year, nothing happened. When a quake did finally hit on September 28, 2004, it was years off schedule, but most disappointing were the lack of warning signs. Scientists reviewed the data but could find no evidence of anything unusual preceding the September 28th quake. It led many to believe that perhaps earthquakes really are random events. Instead of giving up, though, scientists in Parkfield dug deeper into the ground. By late summer 2005, they had reached the fault's final depth of three kilometers (two miles), where they continued collecting data, hoping to find a clue.

And then they found something. In an article published in the July 2008 journal *Nature*, the researchers in Parkfield claimed to have detected small changes in the fault shortly before an earthquake hit. What had they noticed? Just before a quake, the cracks in the fault had widened slightly. Scientists registered the first changes ten hours before a 3.0 quake hit; they identified identical signs two hours before a 1.0 quake—demonstrating that perhaps the "pre-slip" theory is correct. In other words, it may in fact be possible to predict an earthquake.

Although there is still a long way to go, it appears from the research being done all over the world that earthquakes are not entirely random. If this is so, in the future we may be able to track the Earth's movements and design early-warning systems that allow us to predict when a quake will happen and, in doing so, prevent the loss of life.

◀ The San Andreas Fault cuts through the desert of southern California.