ShakeAlert: Earthquake Early Warning System

Narration from [www.iris.edu](http://www.iris.edu) animation:

5.1 seconds after the magnitude-six Napa earthquake, ShakeAlert test users in San Francisco received warning that the strongest ground shaking would arrive in eight seconds, vital time to get to safety. How does ShakeAlert work and how can it be used? When an earthquake occurs, two types of seismic waves carry energy away from the hypocenter. P waves, similar to sound waves, have a velocity of about six kilometers per second in rock. S waves, are slower at four kilometers per second, but they have larger amplitude and are generally much more damaging than P waves. ShakeAlert works by detecting P waves arriving at seismometers closest to the earthquake, sending those signals at the speed of light to a computer system that determines earthquake location and travel times of both P and S waves to your location, then alerts you how much time remains before potentially damaging S waves will arrive. You can “Drop, Cover, and Hold On” with just a few seconds of warning. Unfortunately, if you are too close to the earthquake, you may be in a blind zone that cannot receive a warning. ShakeAlert does not predict when or where an earthquake will occur. Instead, when an earthquake does occur, ShakeAlert warns you how much time you have before the strongest ground shaking will arrive at your location. If the initial earthquake triggers an ongoing rupture with continuing release of seismic waves, the system recognizes that the magnitude has increased and warns that shaking will be greater than initially predicted. To more fully appreciate the importance of ShakeAlert during major earthquakes, we’ll examine the scenario for a hypothetical magnitude 7.8 Earthquake on the southern San Andreas fault. A similar earthquake will happen some time in the future. We just can’t predict when or where. Abrupt movement of rock across a fault starts at the hypocenter, directly below the epicenter location. This ShakeAlert example is aimed to highlight the maximum warning for Los Angeles. ShakeAlert subscribers closer to the hypocenter will be alerted at the same time, but will receive a shorter early warning before the nearby shaking arrives. Within seconds of the earthquake, P waves arrive at nearby seismometers. ShakeAlert estimates the magnitude as 7.0 and issues 70 seconds of warning to Los Angeles residents that S waves from the initial rupture will produce weak ground shaking. Five seconds later, the rupture, shown as the bold pink line along San Andreas Fault, has grown dramatically so the magnitude estimate is increased to M7.8 and the expected intensity in L.A. climbs to moderate. Whereas the magnitude estimate remains at 7.8, notice that the expected intensity of the largest S waves in LA continues to climb. This is because seismic energy is continually released at the rupture front that is rapidly approaching LA. Twenty two seconds before small-amplitude S waves from the initial rupture reach LA, the expected intensity of the largest S waves released by the approaching rupture is increased to strong. If we look at an oblique view of the Los Angeles basin, we can watch the waves arrive from the southeast. Four seconds before it reaches LA, the expected intensity is increased to Very Strong. Notice that the first S waves arriving from the initial rupture are small, but S waves released from the rupture front closer to LA arrive seconds later and produce much stronger ground shaking. Besides providing alerts to “Drop, Cover, and Hold On”, ShakeAlert gives time to: get away from dangerous machines or chemicals; shut down gas and electric supply lines; stop rail and road traffic; halt airport takeoffs and landings; stop surgeries; and get emergency personnel ready to respond. Along with: construction of earthquake resistant buildings and infrastructure, coordinated emergency management, and public education, Earthquake early warning can help us achieve an earthquake resilient society.