ACTIVITY 1—AN EARTHQUAKE IN YOUR COMMUNITY

Background Information

The large-scale forces that act in the Earth's outer layer are transmitted over long distances through the rocks. The principle is the same as when you hold the ends of a long rod of wood or metal and try to pull the rod apart, or squeeze it together, or bend it. This results in local internal forces everywhere in the rod, called stresses. The stresses in rocks in the Earth can be compressional (tending to squeeze the material together), extensional (tending to pull the material apart), or shear (tending to cause sideways sliding in the material). The stresses cause the rock to change its shape (expanding, contracting, or bending). This change in shape is called deformation, or strain. As the rock is strained, energy is stored in the rock. Over time, stresses can build up to the point where they exceed the strength of the rock, causing it to break and releasing the stored energy in the form of an earthquake. The energy of strain can accumulate in rocks over decades, centuries, or millennia and be released in seconds or minutes. In this model of how rocks respond to stresses, the rocks deform elastically, in the sense that when the forces are relaxed by the breaking of the rock, the rock tends to spring back to its original shape. This phenomenon is called elastic rebound. The model of elastic rebound is widely accepted by geoscientists as accounting for the behavior of rocks during an earthquake.

In the model of elastic rebound, when the force exceeds the strength of the rock and the rock breaks, the rock masses on either side of the fracture surface slide past each other as they return to their original undeformed shape. The surface along which the sliding takes place is called a fault. As the rock masses slide past each other, the elastic energy that was stored within them is released in the form of waves, and also dissipated in the form of frictional heat. The motions of materials as these waves pass through them are what is felt as an earthquake. Faults vary in size from the size of a sand grain to hundreds of kilometers long. In general, the amount of energy released by an earthquake is proportional to the surface area of the fault along which the rocks move.

The body waves generated by an earthquake move outward in all directions away from the earthquake focus. To a first approximation, the wave fronts have a spherical shape in three dimensions, just as the ripples that are formed on a still water surface when a pebble is dropped into the water have a circular shape in two dimensions. For convenience in visualizing the travels of the waves, however, imaginary curves called rays are constructed to be everywhere perpendicular to the actual wave fronts. When geoscientists show diagrams of the passage of body waves through the Earth, they usually show the waves in the form of the rays rather than the wave fronts. If the speed of movement of the wave fronts were the same everywhere in the Earth, the rays would simply be straight lines extending in all directions from the earthquake focus. However, the speed of movement of the waves varies with depth in the Earth, generally increasing with depth. That causes the rays to be curved in such a way as to be generally concave upward. This phenomenon is known as refraction. If you need to explain this effect to your students, one good way is to have them picture a regular troop of marching persons. If the leader of the troop tells the people on the left to take small steps and the people on the right to take large steps, the path of the troop swings around to the left.

See the *EarthComm* web site www.agiweb.org/earthcomm for additional information.