

ACTIVITY 5— LESSENING EARTHQUAKE DAMAGE

Background Information

Destructive earthquakes occur frequently in the United States and around the world (see pages 161 – 162 in the Student Book). The hazards or effects of earthquakes can be divided into those directly related to the fault movement and passing waves and those hazards or effects that are triggered by the passing waves. Hazards caused directly by the passing waves and fault movement include ground shaking, fault rupture, ground subsidence, and tsunamis. Hazards triggered by the passing waves include fire, soil liquefaction, and Earth movements like landslides, mudflows, and rockfalls. Each of these hazards and the damage they cause is described below.

Ground shaking is caused by seismic waves as they travel along the Earth's surface. When body waves reach the surface they generate two kinds of surface waves. Damage from ground shaking is the most widespread and pervasive of all earthquake damage (Bolt, 1988). Ground shaking can destroy buildings, bridges, and other structures and disrupt water, sewer, and utility lines. Additional damage from ground shaking results from objects falling from shelves and tables.

Fault rupture is caused by the propagation of the fault plane to the surface. Depending on the orientation and sense of movement on the fault, the rupture may manifest itself as

ground cracks or fault scarps. A fault scarp is a steep slope or cliff formed directly by movement along a fault before modification by erosion or weathering. Many of the steeper topographic features in the western United States, like the Grand Teton Mountains, are fault scarps. Numerous recent geologic events have caused ground cracking and fault rupture. For example, the 1906 San Francisco earthquake caused features to be offset by as much as 3 m.

Ground subsidence is a lowering of the ground surface due to shifting of fault blocks, gravitational slumping, or landsliding. In Hawaii, the coastline was submerged 3.5 m during a magnitude 7.1 earthquake in 1975.

A tsunami is a sea wave produced by a large disturbance of the ocean floor. A tsunami can be triggered by a large earthquake, or by a large landslide or volcanic eruption. In 1946, an earthquake off the coast of Alaska triggered a tsunami that later arrived in Hawaii and produced waves 16 m high. The 1964 Alaska earthquake generated a tsunami that killed seven people in Crescent City, California, the most recent tsunami on the Pacific coast of the United States. For large earthquakes in the Pacific Ocean basin the earthquakes are located and tsunami warnings are issued to distant areas. Tsunamis move at about the speed of a jet airplane and can take up to 24 hours to travel from one corner of the Pacific to the other. Unfortunately, some earthquakes are located close to land and, if they trigger a tsunami, it arrives onshore very quickly with no time for a warning. In 1896, a locally generated tsunami in Japan killed 26,000 people.

Secondary earthquake hazards include fire, soil liquefaction, and landslides, mudflows, and rockfalls.

Fires are often caused by the disruption of natural gas pipelines. Water lines are also broken, which makes fighting the fires difficult. Following the 1906 San Francisco earthquake, fires burned for three days and caused ten times more damage than the earthquake itself. New building codes have reduced the likelihood of large fires during California earthquakes.

Soil liquefaction is in “cohesionless soil, the transformation from a solid to a liquid state as a result of increased pore pressure and reduced effective stress” (Bates and Jackson, 1980, p. 362). Soils and other soft geologic materials (ash, sand) with very high water content are also susceptible to seismically induced landsliding. Liquefaction has caused spectacular damage. During the 1964 earthquake in Niigata, Japan, large apartment buildings remained intact but toppled on their sides. Liquefaction of clay-rich soils during the 1964 earthquake in Alaska cut 300 m inland and 2800 m along the coast.

A landslide is a “general term covering a wide variety of mass-movement landforms and processes involving the downslope transport, under gravitational influence, of

soil and rock material en masse” (Bates and Jackson, 1980, p. 349). A mudflow is a “general term for a mass-movement landform or process characterized by a flowing mass of predominantly fine-grained earth material possessing a high degree of fluidity during movement” (Bates and Jackson, 1980, p. 413). A rock fall is the “relatively free falling or precipitous movement of a newly detached segment of bedrock (usually massive, homogeneous, or jointed) of any size from a cliff or other very steep slope; it is the fastest form of mass movement...” (Bates and Jackson, 1980). Landslides were numerous during the 1994 Loma Prieta earthquake in California. Landslides during the 1998 earthquake in Afghanistan destroyed entire villages, killing hundreds of people. Landslides also disrupt transportation routes, making disaster relief more difficult.

The *EarthComm* web site www.agiweb.org/earthcomm contains a variety of links to web sites that will help you to deepen your understanding of content and prepare you to teach this activity. Many of the sites also contain images which can be downloaded and made into overheads for later incorporation into class discussions.