جامعة الانبار - مركز دراسات الصحراء

الكلية	العلوم
القسم	الجيولوجيا التطبيقية
المادة باللغة الانجليزية	Seismic geology
المادة باللغة العربية	الجيولوجيا الزلزالية
المرحلة الدراسية	الرابعة
اسم التدريسي	سارة اسماعيل جياد
عنوان المحاضرة باللغة الانجليزية	**Location and Size of Earthquakes**
عنوان المحاضرة باللغة العربية	موقع و حجم الزلازل
رقم المحاضرة	الرابعة
المصادر والمراجع	

محتوى المحاضرة

Location and Size of Earthquakes

in the United States **Figure 1** shows the locations of all damaging earthquakes that have occurred in the United States since 1977. Note that only a few localities are relatively free of earthquakes. Most of the large earthquakes occur in the western states. Quakes in California, Nevada, Utah, Idaho, Montana,

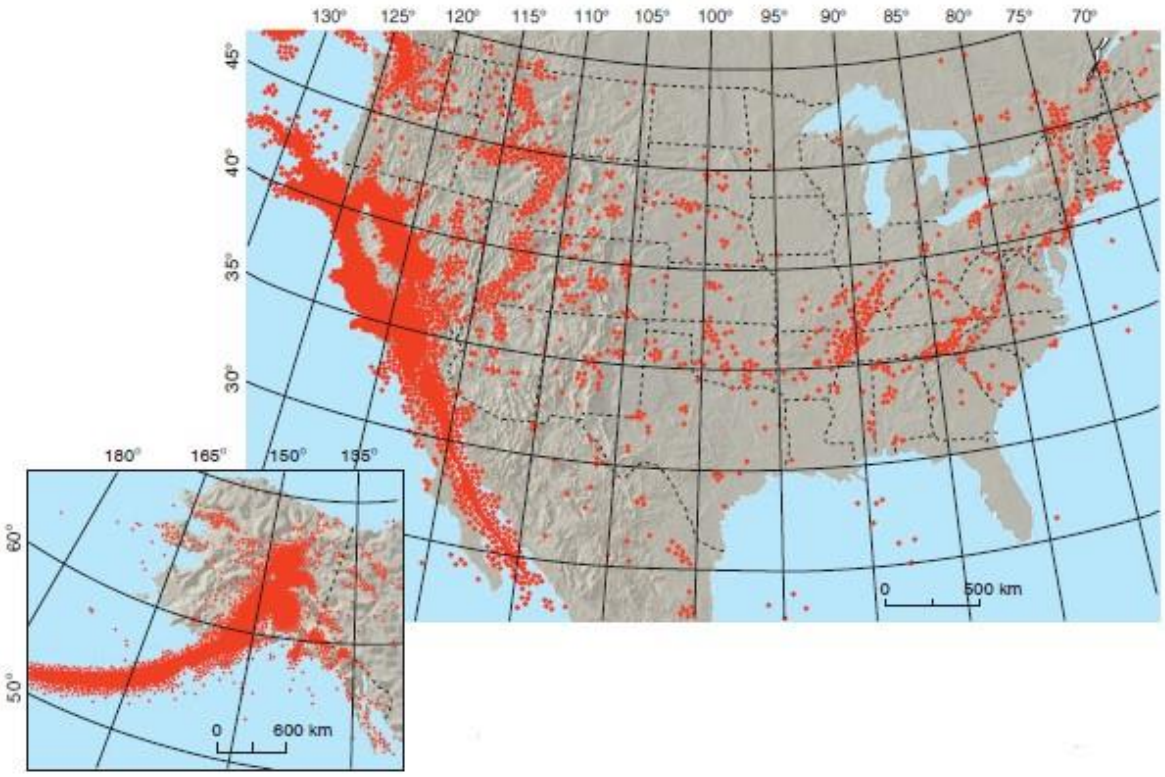

Figure 1 Locations of earthquakes that have occurred in the United States and southern Canada since 1977. *Source: U.S. Geological Survey (www.neic.cr.usgs.gov/neis/general/seismicity/us.html)*

Washington, and other western states are related to known faults and usually (but not always) involve surface rupture of the ground. Earthquakes in Alaska occur mainly below the Aleutian Islands, where the Pacific plate is converging with and being sub ducted beneath the North American plate.

Earthquakes east of the Rocky Mountains are rarer and generally smaller and deeper than earthquakes in the western United States.

They usually are not associated with surface rupture. The quakes may be occurring on the deeply buried, relatively inactive faults of old *divergent plate boundaries* and *failed rifts (aulacogens).*

Although large quakes are extremely rare in the central and eastern United States, when they do occur, they can be very destructive and widely felt, because Earth's crust is older, cooler, and more brittle in the east than in the west and seismic waves travel more efficiently. The Saint Lawrence River Valley along the Canadian border has had several intensity IX and X earthquakes, most recently in 1944. Plymouth, Massachusetts, had an intensity IX quake in 1638, and a quake of intensity VIII occurred in 1775 near Cambridge, Massachusetts. In 1929, in Attica, New York, an earthquake of intensity IX knocked over 250 chimneys. A series of quakes (intensity XI) that occurred near New Madrid, Missouri, in the winter of 1811–1812 were the most widely felt earthquakes to occur in North America in recorded history. The quakes knocked over chimneys as far away as Richmond, Virginia, and rang church bells in Boston, 700 kilometers (434 miles) away.

The 1886 quake in Charleston, South Carolina (intensity X) was felt throughout almost half the United States (figure 10) and killed sixty people; it was sharply felt in New York City. Moderate quakes hit southern Illinois in 2005, and again in 2008 and were felt throughout the Midwest damaging buildings in Louisville, Kentucky. In 2005, a 5.4-magnitude quake north of Quebec City was felt as far away as Indiana and Washington, D.C.

Geologists have mapped regions of seismic risk in the United States **(figure 2)** and elsewhere throughout the world, primarily on the assumption that large earthquakes will occur in the future in places where they have occurred in the past.

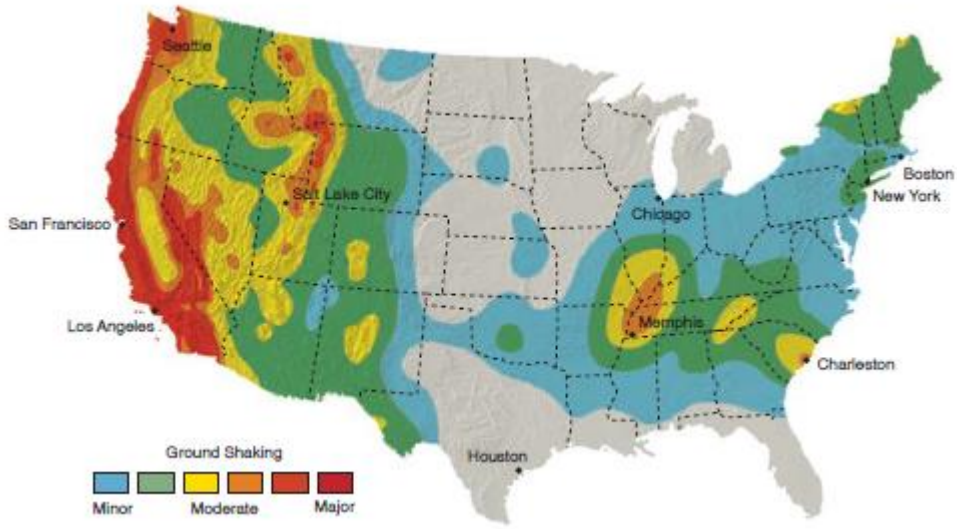

FIGURE 2 Map of seismic risk in the United States based on the expected amount of ground shaking and damage. *USGS-National Seismic Hazard Mapping Project*

EFFECTS OF EARTHQUAKES

Ground motion is the trembling and shaking of the land that can cause buildings to vibrate. During small quakes, windows and walls may crack from such vibration. In a very large quake, the ground motion may be visible. It can be strong enough to topple large structures such as bridges and office and apartment buildings (figure3). Most people injured or killed in an earthquake are hit by falling debris from buildings. Because proper building construction can greatly reduce the dangers, building codes need to be both strict and strictly enforced in earthquake-prone areas. Much of the damage and loss of life in the recent Turkey, India, and China earthquakes were due to poorly constructed buildings that did not meet building codes. As we have seen, the location of buildings also needs to be controlled; buildings built on soft sediment are damaged more than buildings on hard rock.

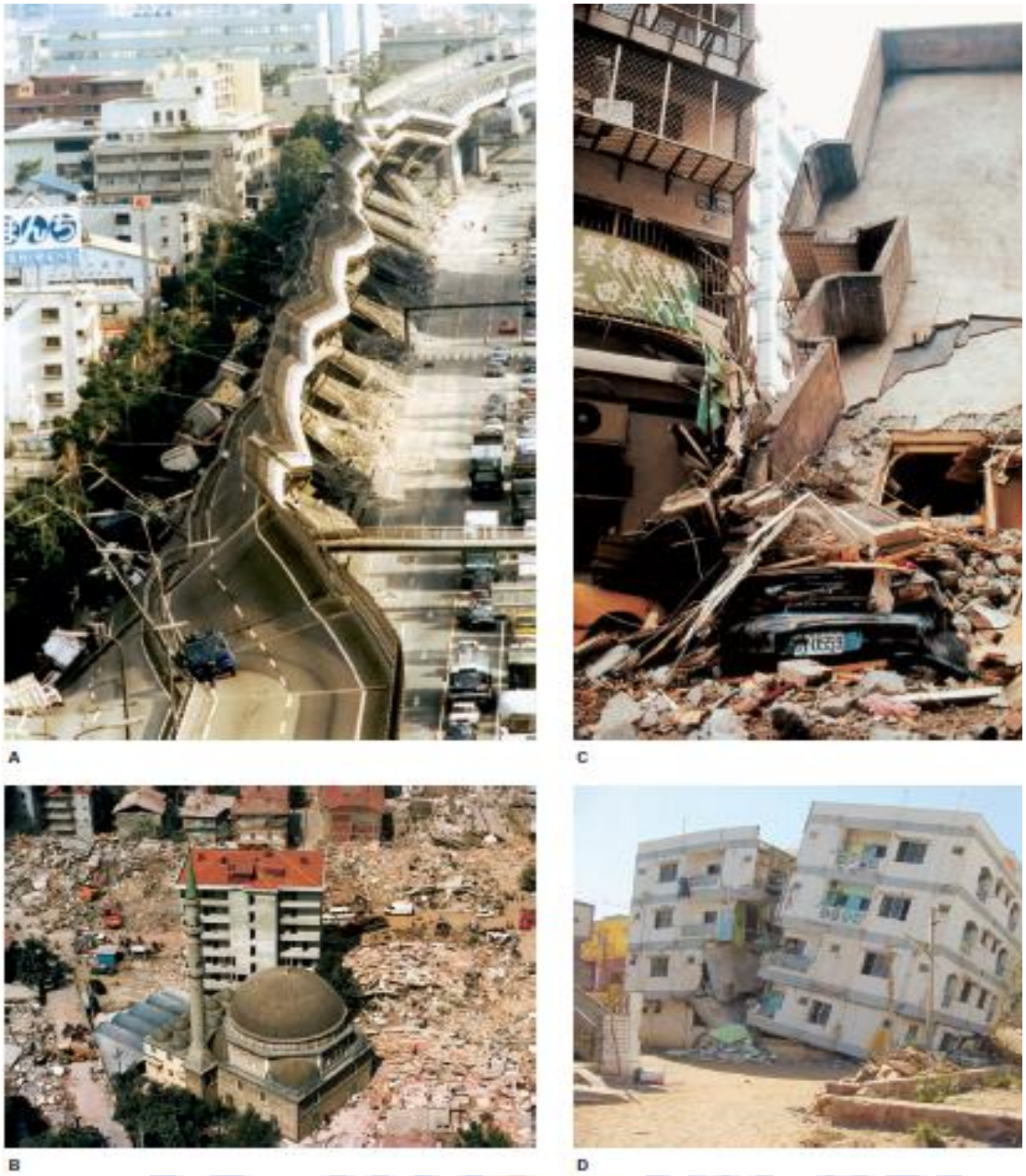

FIGURE 3 Earthquake damage to structures from recent major earthquakes throughout the world. (*A*) Elevated highway knocked over by a strong horizontal jolt during the 1995 Kobe, Japan, earthquake. Damage exceeded $400 billion and destroyed or severely damaged more than 88,000 buildings. (*B*) Poorly constructed buildings crumbled during the 1999 Izmit, Turkey, earthquake, while structures built to seismic code and old mosques were left standing. (*C*) Many high-rise buildings collapsed during the 1999 Taiwan earthquake. The M-7.6 quake was the largest to hit central Taiwan in the past 400 years, and damage exceeded $14 billion. (*D*) One of the many buildings damaged during the January 2001 Gujarat, India, earthquake that caused over $1.3 billion in damage. *Photo* A © *Reuter/Sankei/Shimbun; photo* B © *AP/Wide World Photo; photo* C © *Smith Glenn/SYGMA Corbis; photo* D © *Jaswant Arelekar/IITK, Kanpur, India*

Fire is a particularly serious problem just after an earthquake because of broken gas and water mains and fallen electrical wires (figure 4). Although fire was the cause of most of the damage to San Francisco in 1906, changes in building construction and improved fire-fighting methods have reduced (but not eliminated) the fire danger to modern cities. The stubborn Marina district fires in San Francisco in 1989 attest to modern dangers of broken gas and water mains.

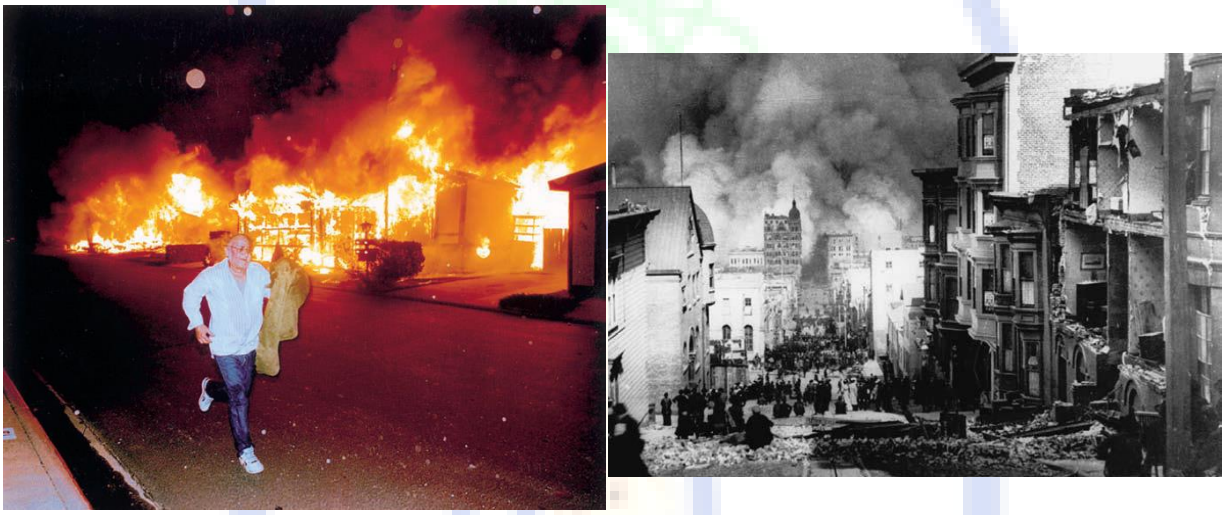

FIGURE 4 (*A*) Almost 100 homes burned at a Sylmar mobile-home park following the Northridge earthquake, southern California, 1994. (*B*) People on Sacramento Street watch the smoke rise from fires caused by the 1906 San Francisco earthquake; most of the damage from the earthquake was caused by fires that burned for days. *Photo* A © *Ken Lubas/Los Angeles Times; photo* B © *Arnold Genthe/AP/Wide World Photos*

Landslides can be triggered by the shaking of the ground (figure5). The 1959 Madison Canyon landslide in Montana was triggered by a nearby quake of magnitude 7.7. Landslides and subsidence caused extensive damage in downtown and suburban Anchorage during the 1964 Alaskan quake (magnitude 8.6). The 1970 Peruvian earthquake (magnitude 7.75) set off thousands of landslides in the steep Andes Mountains, burying more than 17,000 people (see box 13.1). In 1920 in China, over 100,000 people living in hollowed-out caves in cliffs of loess (described in chapter 18) were killed when

a quake collapsed the cliffs. The 2001 El Salvador quake resulted in nearly 500 landslides, the largest of which occurred in Santa Tecla where 1,200 people were missing after tons of soil and rock fell on a neighborhood. The 2008 Sichuan, China, earthquake occurred in a mountainous area and triggered numerous landslides that dammed rivers in steep canyons, causing 34 quake lakes to form. Because these landslide dams.

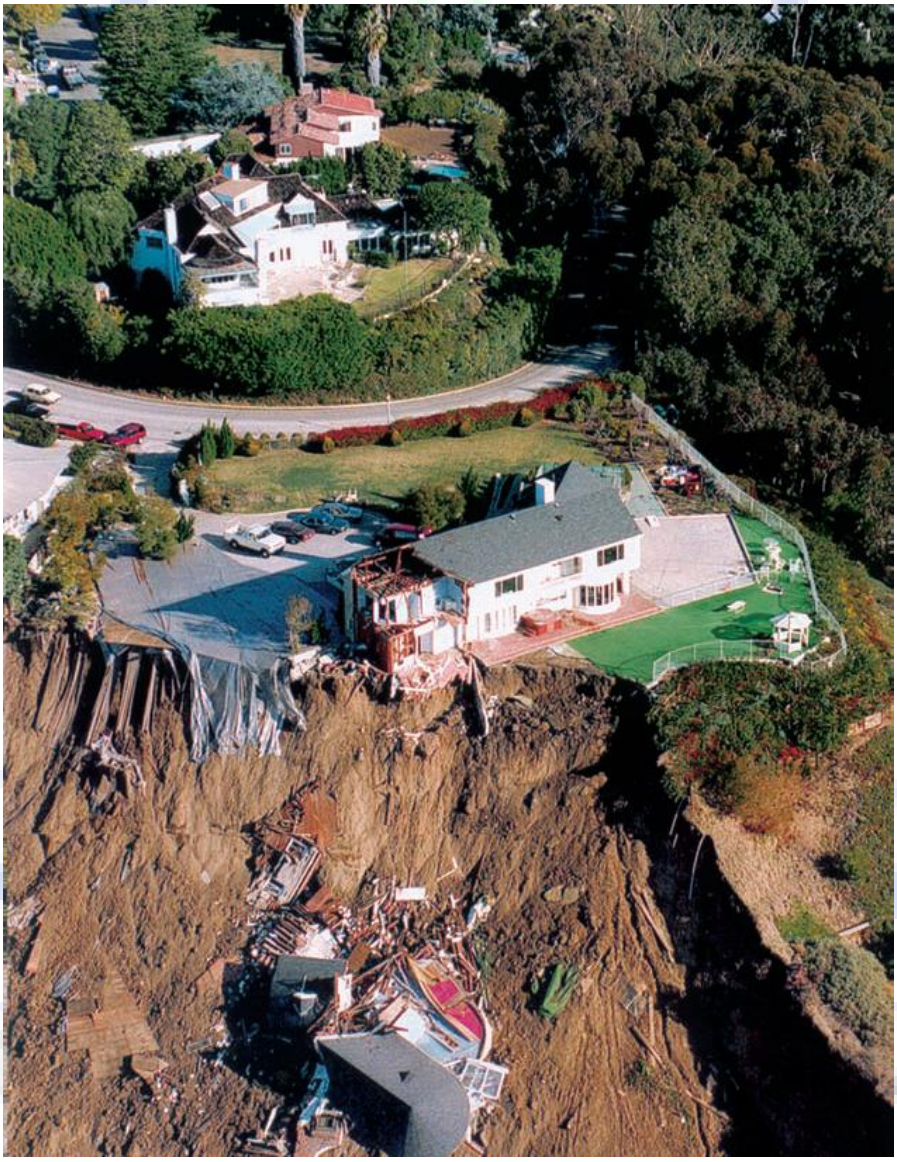

FIGURE 5 Landslide in Pacific Palisades triggered by the Northridge earthquake, 1994. © *Al Seib/Los Angeles Times*