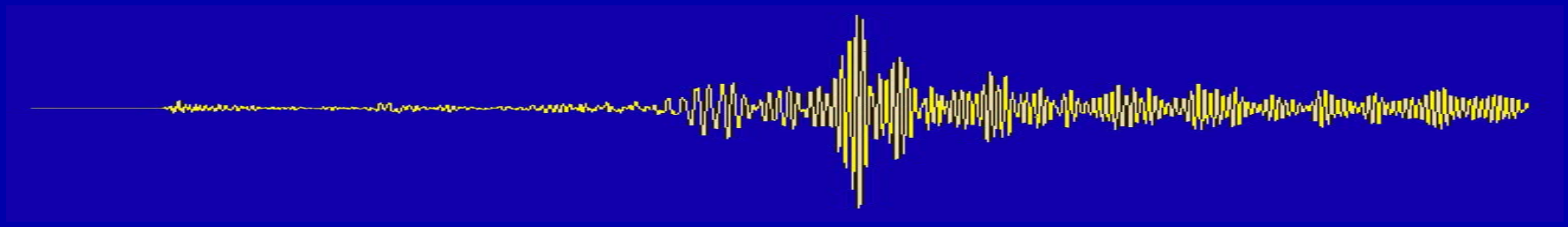
12.103

Strange Bedfellows: The Science and Policy of Natural Hazards

Module 2

Earthquakes



Spring 2008

Natural phenomenon

Natural hazard

Natural hazard

Natural catastrophe

Izmit, Turkey, 17/08/1999, M 7.6 (XI)

>17,000 fatalities; 50,000 injured; $6,500M damage

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Courtesy National Information Service for Earthquake Engineering, University of California, Berkeley

Izmit, Turkey, 17/08/1999, M 7.6 (XI)

Image courtesy of NSF-Sponsored Geotechnical Extreme Event Reconnaissance (GEER). Used with permission.

Adapazari, Turkey, 1999

Niigata, Japan, 1964 (M=7.5)

Image courtesy of NOAA.

Banda Aceh, Indonesia, Dec 2004

Niigata Prefecture, Japan, 2004

Image courtesy of USGS.

Santa Tecla, El Salvador, Jan 14, 2001 (M=7.6)

Image courtesy of USGS.

Earthquakes as a hazard

Type of Hazard	No of Events
Drought	782
Earthquake	899
Extreme temperature	240
Famine	77
Flood	2389
Landslide	448
Strom surge	18
Tornadoes (non-US)	84
Tornadoes (US)*	9476
Tsunami	986
Tropical ctyclone	1337
Volcano	168
Wind (other)	793
Wild fire	269

** for F2-F5 Tornadoes 1950 - 995*

Figure by MIT OpenCourseWare.

Bryant, 2005

Earthquakes as a hazard

Type of Hazard	Deaths	Injuries	Homeless	Largest Death Toll Event and Date	Death Toll
Avalanches, Landslides, Mud flows	60,501	8,071	3,759,329	Soviet Union, 1949	12,000
Cold wave	6,807	1,307	17,340	India, Dec 1982	400
Extra-tropical stroms	36,681	117,925	12,606,891	Northen Europe, Feb 1953	4,000
Earthquakes	1,846,119	1,147,676	8,953,296	Tangshan, China, July 1976	242,000
Fires	2,503	1,658	140,776	USA, Oct 1918	1,000
Floods	6,851,740	1,033,572	123,009,662	China, July 1931	3,700,000
Heat wave	14,732	1,364	0	India, May 1998	2,541
Tornado	7,917	27,887	575,511	Bangladesh, Apr 1989	800
Tsunami	10,754	789	-	Sanriku Japan, Mar 1933	3,000
Tropical cyclones	1,147,877	906,311	34,272,470	Bangladesh, Now 1970	300,000
Volcano	96,770	11,154	197,790	Martinique, May 1902	30,000
Total	**10,052,401**	**3,257,714**	**183,533,065**		

Figure by MIT OpenCourseWare.

Bryant, 2005

Earthquakes as a hazard

Type	Cost
Cold wave	$9,555,000,000
Drought	$16,800,000,000
Earthquake	$248,624,900,000
Flood	$206,639,800,000
Heat wave	$5,450,000,000
Tropical strom	$80,077,700,000
Wild fire	$20,212,800,000
Wind strom	$43,890,000,000
Total	**$631,250,200,000**

Figure by MIT OpenCourseWare.

Bryant, 2005

Earthquakes

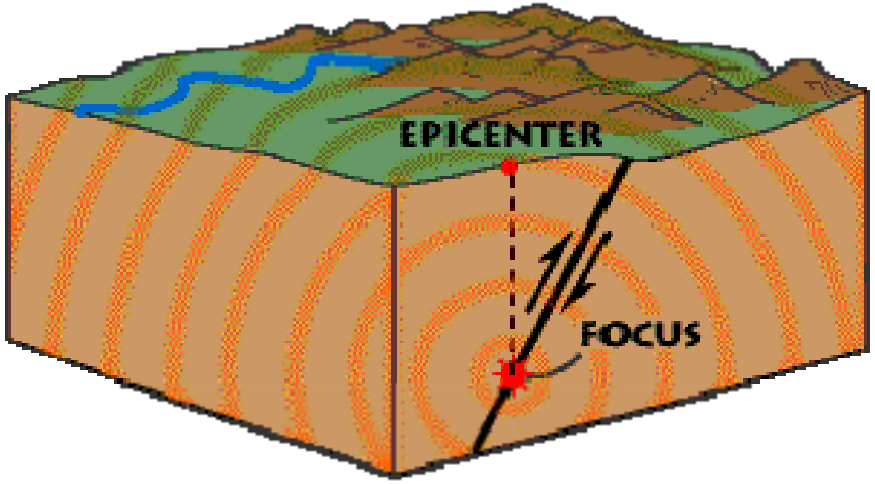


Image courtesy of USGS.

Definition: The term earthquake is used to describe both the mechanism that causes a sudden stress release within the earth and the resulting ground shaking.

Image courtesy of USGS.

Earthquakes

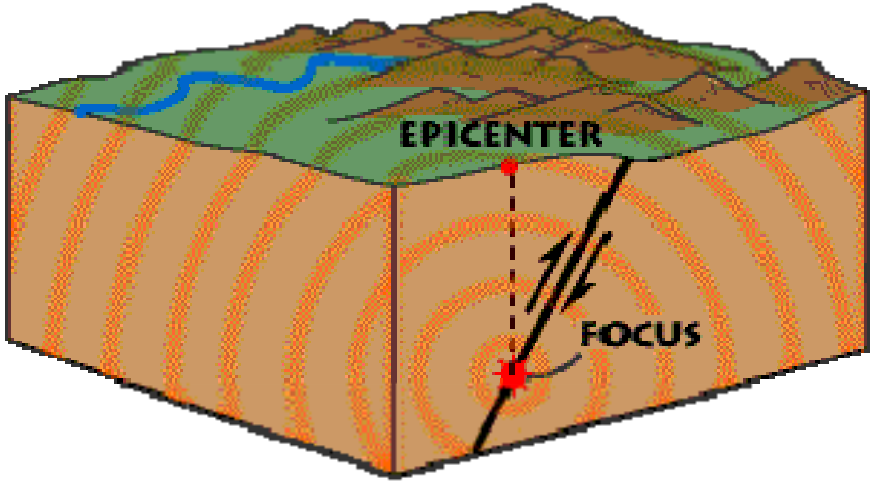


Image courtesy of USGS.

Hypocenter: is the point within the earth where an earthquake rupture starts - also termed focus (lat, lon, depth).

Epicenter: is the surface projection of the hypocenter (lat, lon).

Earthquakes

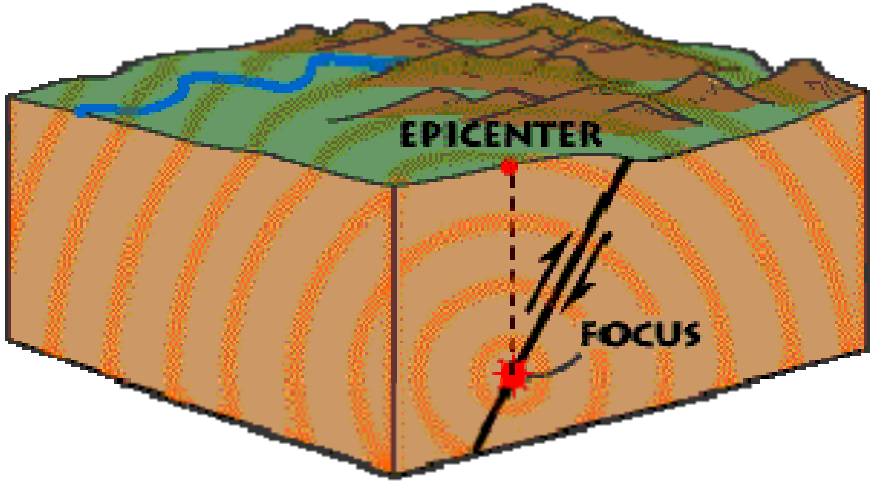


Image courtesy of USGS.

Magnitude: is a number that characterize the relative size of an earthquake and is based on measurements of the maximum motion recorded at a seismograph (various scales, most empirically derived).

Earthquakes

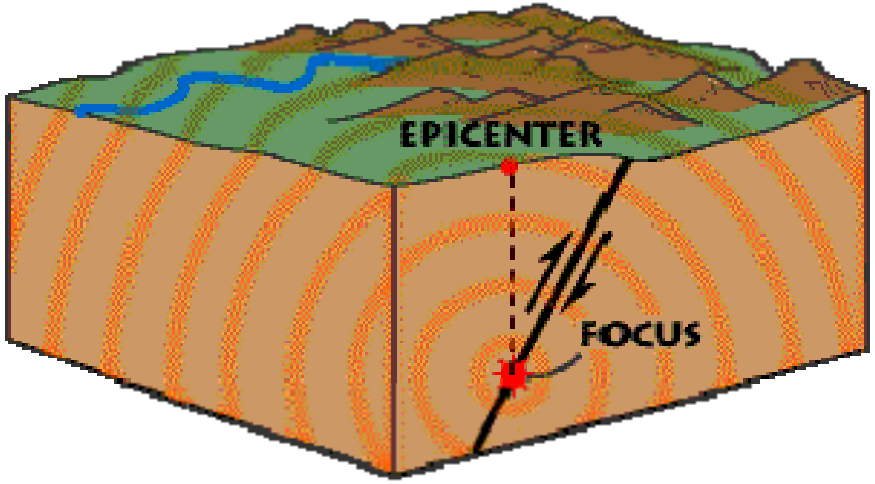
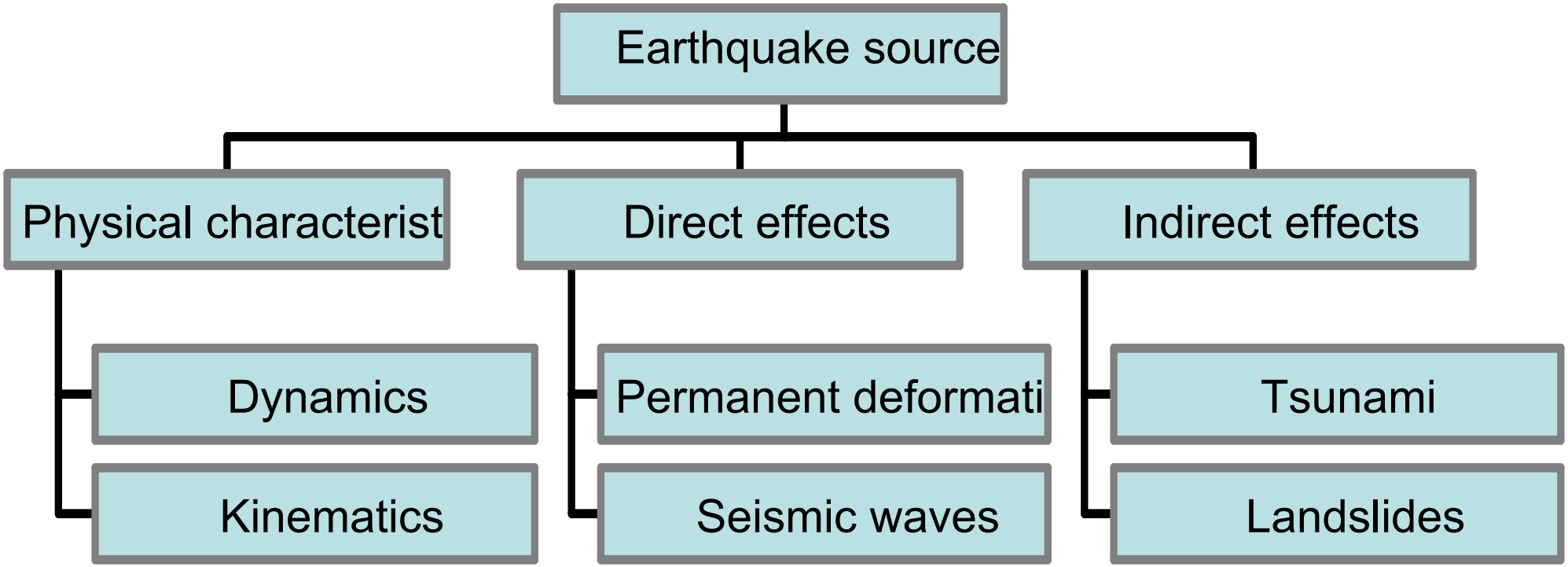


Image courtesy of USGS.

Intensity: is a number (written in Roman numeral) describing the severity of an earthquake based on qualitative assessment of its effects on the earth's surface and on humans and their structures.

Modified Mercalli Intensity Scale

MMI	M	description
I	1-2	Not felt except by a very few under especially favorable conditions.
II	2-3	Felt only by a few persons at rest, especially on upper floors of buildings.
III	3-4	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	4	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	4-5	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	5-6	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	6	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	6-7	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	7	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	7-8	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	8	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	>8	Damage total. Lines of sight and level are distorted. Objects thrown into the air.


Earthquake source
Physical characterist
Direct effects
Indirect effects
Dynamics
Kinematics
Permanent deformati
Seismic waves
Tsunami
Landslides

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Spring 2010