ABOUT EARTHQUAKE

Sikkim Earthquake 2011, India

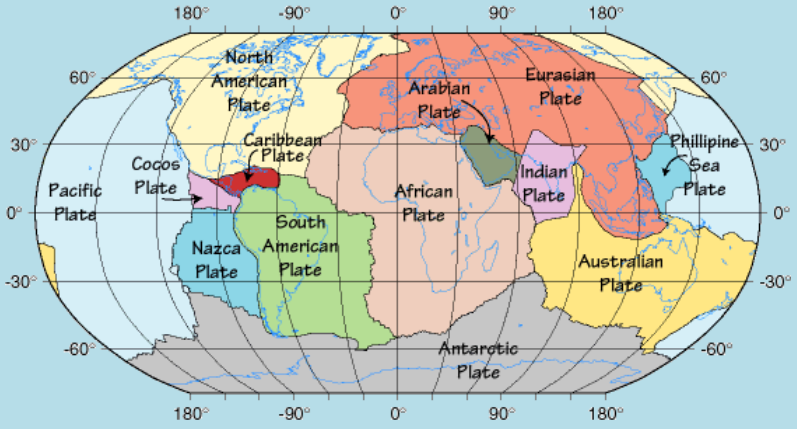
Source:http://sikkimnews.blogspot.in/2011/09/villagers-evacuated-by-helicopter-from.html

Earthquake, a geological disaster, is a phenomenon of sudden shaking of earth's curst due to natural causes (rock displacements, landslide, avalanche, volacanic eruption, meteoritic impact, sub-marine sea faulting, etc). Apart from the natural causes, this disaster can also occur due to human activities such as, explosions due to chemical blasts or nuclear blasts or rock burst due to mining activities, and reservoir induced earthquakes[1]. Earthquakes result from crustal strain, volcanism, landslides, and collapse of caverns. Stress accumulates in response to tectonic forces until it exceeds the strength of the rock. The rock then breaks along a preexisting or new fracture called a fault. The rupture extends outward in all directions along the fault plane from its point of origin (focus). The rupture travels in an irregular manner until the stress is relatively equalized. If the rupture disturbs the surface, it produces a visible fault on the surface. Earthquakes are recorded by seismograph consisted of seismometer, a shaking detector and a data recorder. The moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude, with magnitude 3 or lower earthquakes being mostly imperceptible and magnitude 7 causing serious damage over large areas. Intensity of shaking is measured on the modified Mercalli scale. In India Medvedev-Sponheuer-Karnik scale, also known as the MSK or MSK-64, which is a macroseismic intensity scale, is used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence. Due to earthquake seismic waves are generated and measurements of their speed of travel are recorded by seismographs located around the planet.

Causes of Earthquakes

Earthquakes may last only a few seconds or may continue for up to several minutes[2]. They can occur at any time of the day or night and at any time of the year. They are caused by stress that builds up over time as blocks of crust attempt to move but are held in place by friction along a fault. (The Earth's crust is divided into large plates that continually move over, under, alongside, or apart from one another atop the partly molten outer layer of the Earth's core.) When the pressure to move becomes stronger than the friction holding them together, adjoining blocks of crust can suddenly slip, rupturing the fault and creating an earthquake.
No part of Earth's surface is free from earthquakes, but some regions experience them more frequently[3]. They are most common at tectonic plate boundaries where different plates meet. The largest events usually happen where two plates are colliding, or colliding and sliding past one another.

The earth has four major layers: the inner core, outer core, mantle and crust. The crust and the top of the mantle make up a thin skin on the surface of our planet. But this skin is not all in one piece – it is made up of many pieces like a puzzle covering the surface of the earth. Not only that, but these puzzle pieces keep slowly moving around, sliding past one another and bumping into each other. We call these puzzle pieces tectonic plates, and the edges of the plates are called the plate boundaries. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstuck on one of the faults and there is an earthquake[4].



Major plates of earth

Source:http://eqseis.geosc.psu.edu/~cammon/HTML/Classes/IntroQuakes/Notes/plate_tect01.html

Plate Tectonics Theory[5]

The plate tectonics theory is a starting point for understanding the forces within the Earth that cause earthquakes. Plates are thick slabs of rock that make up the outermost 100 kilometers or so of the Earth. Geologists use the term "tectonics" to describe deformation of the Earth's crust, the forces producing such deformation, and the geologic and structural features that result.

Earthquakes occur only in the outer, brittle portions of these plates, where temperatures in the rock are relatively low. Deep in the Earth's interior, convection of the rocks, caused by temperature variations in the Earth, induces stresses that result in movement of the overlying plates. The rates of plate movements range from about 2 to 12 centimeters per year and can now be measured by precise surveying techniques. The stresses from convection can also deform the brittle portions of overlying plates, thereby storing tremendous energy within the plates. If the accumulating stress exceeds the strength of the rocks comprising these brittle zones, the rocks can break suddenly, releasing the stored elastic energy as an earthquake.

Three major types of plate boundaries are recognized. These are called spreading, convergent, or transform, depending on whether the plates move away from, toward, or laterally past one another, respectively. Subduction occurs where one plate converges toward another plate, moves beneath it, and plunges as much as several hundred kilometers into the Earth's interior. The Juan de Fuca plate off the coasts of Washington and Oregon is subducting beneath North America.

Ninety percent of the world's earthquakes occur along plate boundaries where the rocks are usually weaker and yield more readily to stress than do the rocks within a plate. The remaining 10 percent occur in areas away from present plate boundaries -- like the great New Madrid, Missouri, earthquakes of 1811 and 1812, felt over at least 3.2 million square kilometers, which occurred in a region of southeast Missouri that continues to show seismic activity today.

Types of Earthquake

Classification of earthquake is based on several parameters. Based on scale of magnitude (M), earthquake may be of Micro (M < 3.5) or macro (M > 3.5) type. Depending up on the extent of energy released and strength of the ground shaking it may be of several types, like moderate strong, very strong, great and very great earthquake. Depending up on the scale of damage, the earthquake may be of various types, such as less damaging earthquake, Moderate damaging earthquake, and catastrophic earthquake. Depending up on the focal depth (h) of the event, it could be shallow earthquake (d< 70 km); intermediate depth earthquake (70 < h < 300 km); the deep earthquake (300 < h < 700 km).

Depending up on the location of events in different tectonic settings, earthquake may be of intra-plate, inter-plate, and sub-oceanic earthquake[1]. Depending up on involvement of other agencies / phenomena with earthquake genesis, it may be of several types, such as Reservoir induced; Fluid-driven earthquake; Tsunamigenic earthquake, and volcanic earthquake. Depending up on the type of faulting involved during earthquake genesis, earthquake may be categorized into several categories, such as normal faulting, reverse faulting, thrust faulting, and mega-thrust earthquake. Depending up on the frequency content, the earthquake may be of Low-Frequency tremors or high – Frequency tremors. Depending up on the epicenter distance (distance between earthquake main shock and the recording stations), the earthquake may be classified into Local, Regional and Global earthquake.

Earthquakes Prediction [1, 6]

With the present state of knowledge of science, it is not possible to predict earthquakes. It is so because the physics involved in earthquake genesis is very complex. The mechanism of earthquake generating processes is still not adequately understood us because of involvement of multi-component parameters in earthquake genesis.

Earthquake forecasting and prediction is an active topic of geological research. Geoscientists are able to identify particular areas of risk and, if there is sufficient information, to make probabilistic forecasts about the likelihood of earthquakes happening in a specified area over a specified period. These forecasts are based on data gathered through global seismic monitoring networks, high-density local monitoring in knowing risk areas, and geological field work, as well as from historical records. Forecasts are improved as our theoretical understanding of earthquakes grows, and geological models are tested against observation. Long-term forecasts (years to decades) are currently much more reliable than short to medium-term forecasts (days to months).

It is not currently possible to make deterministic predictions of when and where earthquakes will happen. For this to be possible, it would be necessary to identify a „diagnostic precursor" – a characteristic pattern of seismic activity or some other physical, chemical or biological change, which would indicate a high probability of an earthquake happening in a small window of space and time. So far, the search for diagnostic precursors has been unsuccessful. Most Geoscientists do not believe that there is a realistic prospect of accurate prediction in the foreseeable future, and the principal focus of research is on improving the forecasting of earthquakes.

Some Significant Earthquakes in World (1900-2013)[1, 7]

Date	Country	Disaster		Number	
		Type	Subtype	Killed	Affected
17 March 1906	China	Earthquake (seismic activity)	Earthquake (ground shaking)	1266	
21 Oct 1907	China	Earthquake (seismic activity)	Earthquake (ground shaking)	12000	
28 Dec 1908	Italy	Earthquake (seismic activity)	Earthquake (ground shaking)	75000	150000
16 Dec 1920	China	Earthquake (seismic activity)	Earthquake (ground shaking)	180000	
1 Sept. 1923	Japan	Earthquake (seismic activity)	Earthquake (ground shaking)	143000	203733
2 Dec 1924	Indonesia	Earthquake (seismic activity)	Earthquake (ground shaking)	727	11250
5 Oct 1948	Turkmenistan, Soviet Union	Earthquake (seismic activity)	Earthquake (ground shaking)	110000	
4 Feb 1976	Gautemala	Earthquake (seismic activity)	Earthquake (ground shaking)	23000	4993000
23 Nov 1980	Italy	Earthquake (seismic activity)	Earthquake (ground shaking)	4689	407700

6 Nov 1988	China	Earthquake (seismic activity)	Earthquake (ground shaking)	939	1270364
12 July 1993	Japan	Earthquake (seismic activity)	Tsunami	239	7355
17 Jan 1995	Japan	Earthquake (seismic activity)	Earthquake (ground shaking)	5297	541636
4 Feb 1998	Afghanistan	Earthquake (seismic activity)	Earthquake (ground shaking)	2323	32818
30 May 1998	Afghanistan	Earthquake (seismic activity)	Earthquake (ground shaking)	4700	116935
26 Dec 2004	Indonesia	Earthquake (seismic activity)	Tsunami	165708	532898
8 Oct 2005	Pakistan	Earthquake (seismic activity)	Earthquake (ground shaking)	73338	5128000
12 Jan 2010	Haiti	Earthquake (seismic activity)	Earthquake (ground shaking)	222570	3700000
24 Oct 2010	Indonesia	Earthquake (seismic activity)	Tsunami	530	11864
11 March 2011	Japan	Earthquake (seismic activity)	Tsunami	19846	368820
20 April 2013	China	Earthquake (seismic activity)	Earthquake (ground shaking)	198	2198785
15 Oct 2013	Philippines	Earthquake (seismic activity)	Earthquake (ground shaking)	230	3222224

Some Significant Earthquakes in India (1900-2013)[1, 7, 8]

Date	Location	Disaster		Number	
		Type	Subtype	Killed	Affected
04 April 1905	Kangra, HP	Earthquake (seismic activity)	Earthquake (ground shaking)	20000	
15 Jan 1934	Bihar- Nepal Border	Earthquake (seismic activity)	Earthquake (ground shaking)	600	
15 Aug 1950	Arunachal Pradesh- China Border	Earthquake (seismic activity)	Earthquake (ground shaking)	1500	
21 July 1956	Anjar, Gujarat	Earthquake (seismic activity)	Earthquake (ground shaking)	113	219
10 Dec 1967	Koyna, Maharastra	Earthquake (seismic activity)	Earthquake (ground shaking)	117	52272
24 Aug 1980	Jammu	Earthquake (seismic activity)	Earthquake (ground shaking)	13	40
20 Nov 1980	Sikkim, Gangtok Region	Earthquake (seismic activity)	Earthquake (ground shaking)		8
31 Dec 1984	Cachar district (Assam)	Earthquake (seismic activity)	Earthquake (ground shaking)	20	10900
26 April 1986	Dharmsala	Earthquake (seismic activity)	Earthquake (ground shaking)	6	30
06 Aug 1988	Manipur-Myanmar Border	Earthquake (seismic activity)	Earthquake (ground shaking)	2	12
21 Aug 1988	Bihar- Nepal Border	Earthquake (seismic activity)	Earthquake (ground shaking)	382	20003766
20 Oct 1991	Uttarkhashi, Uttarakhand	Earthquake (seismic activity)	Earthquake (ground shaking)	1500	54383

30 Sept 1993	Latur- Osmanabad, Maharshtra	Earthquake (seismic activity)	Earthquake (ground shaking)	9748	30000
22 May 1997	Jabalpur, MP	Earthquake (seismic activity)	Earthquake (ground shaking)	43	156500
29 Mar 1999	Chamoli Dist, UK	Earthquake (seismic activity)	Earthquake (ground shaking)	100	477894
26 Jan 2001	Bhuj, Gujarat	Earthquake (seismic activity)	Earthquake (ground shaking)	20005	6321812
26 Dec 2004	Tamil Nadu, Andaman & Nicobar Island, Andhra Pradesh, Kerala	Earthquake (seismic activity)	Tsunami	16389	654512
08 Oct 2005	Kashmir	Earthquake (seismic activity)	Earthquake (ground shaking)	1309	156622
18 Sept. 2011	Sikkim	Earthquake (seismic activity)	Earthquake (ground shaking)	112	575200
01 May 2013	Doda district (J&K)	Earthquake (seismic activity)	Earthquake (ground shaking)	3	59350

References

[1] http://www.saarc-sadkn.org/earthquake.aspx

[2] http://www.fema.gov/earthquake/why-earthquakes-occur

[3] http://www.ga.gov.au/scientific-topics/hazards/earthquake/basics/where

[4] http://earthquake.usgs.gov/learn/kids/eqscience.php

[5] http://www.uic.edu/classes/psych/psych353/role/description_plate_tectonics.html

[6] http://www.geolsoc.org.uk/Education-and-Careers/Resources/Field-Work-Resources/Gower-Field-Guide/The-structure-of-Gower-five-guided-tours/~/~/link.aspx?_id=01717E64-6124-4AFE-B50E-B131712902E8&_z=z

[7] http://www.emdat.be/database

[8] Disaster management in India, Ministry of Home Affairs, Government of India