The Himalayan Physics *Vol. 6 & 7, April 2017* (86-91) *ISSN 2542-2545*

Siesmic Activity and its Periphery

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Abstract: *Earthquake is a series of vibrations within the earth's crust. It occurs when the earth's crust break due to geological forces on the rock and adjoining plate. Earthquake refers to a movement or tremor of the earth's crust that originates naturally and below the surface. An earthquake is a vibration or oscillation of the surface of the earth caused by a transient disturbance of the elastic or gravitational equilibrium of the rocks at or beneath the surface. There are two causes of earthquakes. One is religious concept and the other is modern concept. Earthquakes are of different types according to their place of origin and location. There are so many effects of earthquakes.*
Key words: Seismology, Seismograph, Seismic Waves, Faults, Tectonic plates, Richter scale, Hypocentre, Epicentre

1. INTRODUCTION

Why and how earthquake occurs is the most frequently asked question which cann't be answered till we don't know what is earthquake. An earthquake can be defined as a series of vibrations within the earth's crust that are caused by the rupture of its rocks. This rupture is due to gradual accumulation of elastic strain within the crust. Earthquakes are the manifestations of the slippage at a geological fault. The majority occur at tectonic plate boundaries .Earthquakes and volcanic activity are closely related, they often develop simultaneously, and both are fundamentally related to the margins of continental plates and to a mountain- building. There are different types of faults in the earth. Basically, the faults responsible for earthquakes are Parallel Fault, Normal Fault, Reverse Fault, Step Fault, Dip Fault and Tear Fault. Earthquake occurs when the earth's crust breaks due to geological forces on rocks and adjoining plates that cause physical and chemical changes.

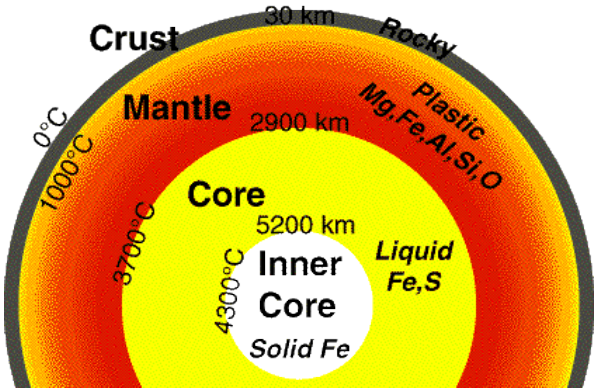

Fig. 1 Internal Structure of earth

Earthquakes usually begin deep in the ground. The point in the earth where the rocks first break is called the focus of the earthquake or hypocentre. The hypocentre of most earthquakes lies less than 70 km beneath the surface. The deepest known hypocentre has been found nearly 700 km below the surface of the earth. The point on the surface of the earth directly above the hypocentre is known as the epicentre of the earthquake. The strongest shaking of the earthquake is usually felt near the epicentre. When an earthquake occurs, the violent breaking of rock releases energy that travels through the earth in the form of vibrations called seismic waves. These seismic waves move out from the hypocentre in all directions and when they travel long distance from the hypocentre, they become weaker. Therefore, the ground generally shakes less farther away from the hypocentre.

2. MEASUREMENT OF EARTHQUAKE

The Richter magnitude scale assigns a magnitude number to quantify the energy released by an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph. Two types of scale are used to define the magnitude of earthquakes. In the logarithmic Richter scale each unit is ten times the intensity of the next lower on the scale. The intensity is recorded by seismographs. There is no upper limit but the greatest magnitude yet recorded is 8.9.

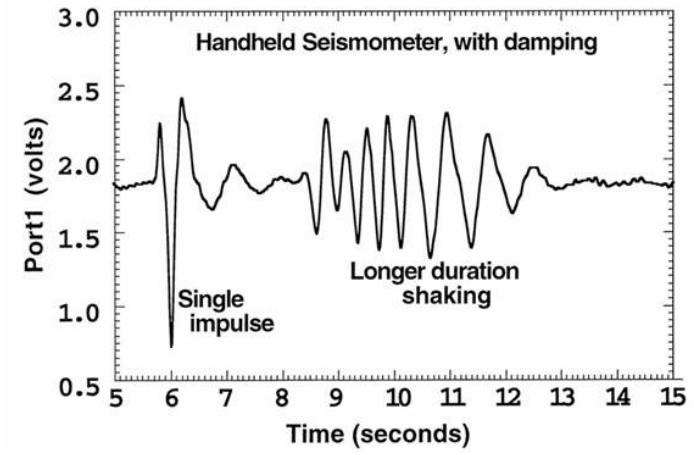

Fig. 2 Measurement of Earthquakes

The Modified Mercalli Earthquake Intensity Scale is in common use. It is based on the observed effects of an earthquake. At the lowest end, the numeral I means the shock is felt by only a few people under special circumstances. A shock felt generally, with minor breakages indoors is classed as V. The general alarm is equivalent to VIII and 'Panic' with varying categories of total destruction are graded IX to XII.

3. CAUSES OF EARTHQUAKE

What causes of earthquake is a matter of discussion this days and it can not be clearly explained scientifically with out any knowledge of physics. There are two causes of earthquake. According to religious concept, long ago, Great Spirit made a beautiful land that turtles carried on their backs in lakes and rivers. One day the turtles began to argue and started to move along different directions. Three of them swam east, the other three swam west. The earth shook and cracked. The turtles could not swim far because their load was heavy. So they made up. But once in a while, the turtles argue again. Each time, the earth shakes. Religion is a matter of faith and cannot be explained scientifically except a few aspects which have come to light. So, it will be futile to discuss the religious reasoning behind origin of earthquakes and find a scientific analogue to it.

According to modern concept, the plate tectonic theory gives the most convincing explanation for the cause of earthquakes. According to this theory, there are so many tectonic plates in the earth. When underground rocks or tectonic plates suddenly break along a fault in the earth's rocky outermost crust then sudden release of energy takes place. Actually all the tectonic plates are moving very slowly but they get stuck at their edges due to friction. So seismic waves are produced which make the ground shake.

Plate tectonics embodies the idea that the earth's surface is broken into several rigid plates, like a huge cracked sphere. The plates consist of portions of both continents and oceans and are moving in various directions. The new molten volcanic material from depth fills the void created by their separation where the plates are pulling apart. The continental rocks are often squeezed and buckled into mountain where the plates come together eventually one plate descends under the other and is absorbed back inside the earth.

4. TECTONIC PLATES

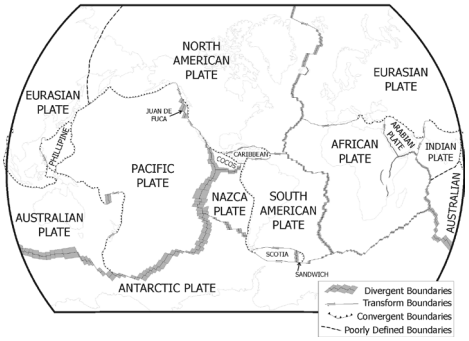

Fig 3 Tectonics Plate

The exact number of plates is unknown but at least seven large ones and several small ones have been identified. The largest plate is the Pacific Plate whose area is 103300000 km^2 and carries most of the Pacific Ocean. The North American Plate consists of that continent and the western half of the Atlantic Ocean whose area is 75900000 km^2 and the entire unit is moving to the west where it is colliding with the Pacific Plate. The eastern side of the Atlantic is part of the Eurasian Plate (area 67800000 km^2) which is moving in the opposite direction and colliding with the western edge of the Pacific Plate. Thus, the Atlantic Ocean is opening and the Pacific Ocean is closing. The size of African Plate is 61300000km^2. Similarly, the sizes of Antarctic Plate, Indo-Australian Plate, Australian Plate and South American Plate are 6090000 km^2, 58900000 km^2, 47000000 km^2, and 43600000 km^2 respectively. Since continental crust is composed of low-density materials and is more buoyant than ocean crust, it cannot be subducted. Consequently, the Pacific Plate, which is composed of oceanic crust, is descending under the North American and Eurasian Plates carrying continental crust,

and undergoes subduction into the deep sea trenches. The driving mechanism for plate movement is unknown but is still thought to involve huge convection currents of some sort.

5. FORMATION OF EARTHQUAKE

Most earthquakes occur along a fault; a fracture in the earth's rock where sections of rock repeatedly slide past each other. Faults occur in weak areas of the earth's rock. Most faults lie beneath the surface of the earth but some are visible on the surface. The stress on the earth causes large blocks of rocks along a fault to bend. The rocks break and snap into a new position, when the bending is too much, it results in shaking of the earth.

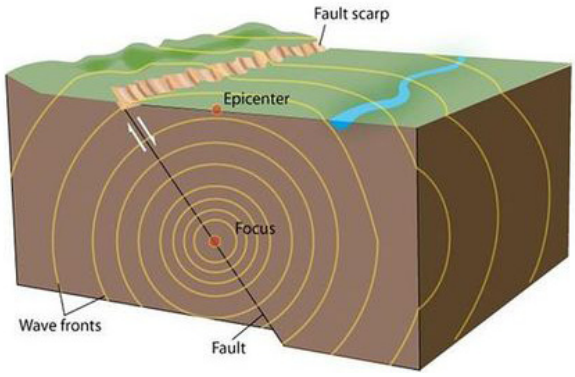

Fig 4 formation of earthquake

6. TYPES OF EARTHQUAKE

There are different types of earthquake depending upon their place of origin, location, movement and structure of the land surface. Earthquakes are relatively small vibratory movements of the earth's crust. Probably they are all initiated by the sudden displacement of the rocks along the fault line. According to their place of origin, there are three types of earthquakes. If the hypocentre lies below 50-70 km from the surface of the earth then that is called Normal Earthquakes. If the hypocentre lies below 70-250 km from the surface of the earth then that is called Intermediate Earthquakes. If the hypocentre lies below 250 km or greater than that from the surface of the earth then that is called Deep Earthquake.

According to their location, there are two types of earthquakes. They are- Continental Earthquakes and Oceanic Earthquakes. On the basis of their cause there are four types of Natural Earthquakes. They are-

a. Volcanic Earthquakes
b. Tectonic Earthquakes
c. Isostatic Earthquakes
d. Plutonic Earthquakes

On the basis of movement, there are two kinds of earthquakes. They are- horizontal quake and vertical quake. Horizontal quake is a to and fro or left and right movement of the earth. Vertical quake is the up and down movement of the earth.

Earthquakes occur when bombs are exploded on the earth's crust during the construction of roads, tunnels, etc. These types of earthquakes are called artificial earthquakes.

Depending on the structure of the land surface, there are two types of earthquake- Interplate and Intraplate. The earthquake that occurs between two adjoining megaplates is called interplate earthquake whereas the earthquake that occurs in the centre of the megaplate is called intraplate earthquake.

7. TYPES OF SEISMIC WAVES

Earthquakes generate three types of seismic waves. They are- Primary waves (P-waves), Secondary waves (S-waves) and Surface waves. Primary and secondary waves arrive at seismic recording stations one after another. Both primary and secondary waves penetrate the interior of the earth while surface waves do not. Due to this reason, primary and secondary waves are also known as body waves. The speed of P wave is 1.7 times the speed of S-wave. When these waves appear on the surface, another wave spread on the surface called surface wave or L-wave. This L wave damages human made properties.

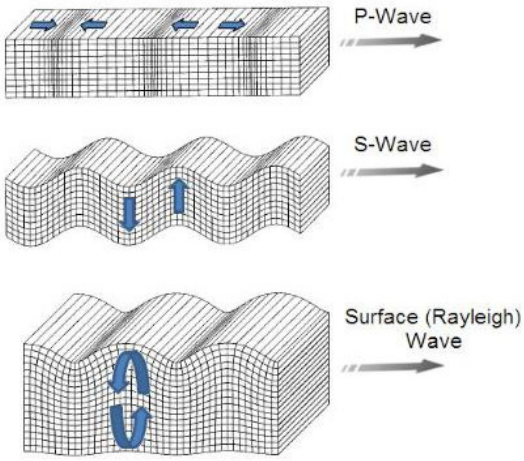

Fig 5 Formation of Seismic Waves

When an earthquake occurs, the seismic waves move out

in all directions from the hypocentre. These seismic waves cause ground motions. An instrument called seismograph is used to detect ground motion caused by seismic waves from both near and distant earthquakes. So, the strength and location of earthquake are determined by seismograph.

A large earthquake is generally followed by a series of other shocks. Aftershock is the vibration of the earth's crust after the main earthquake waves have passed. Aftershock originates at or near the same seismic focus, due to minor adjustments of the rocks after their main rupture. These shocks may go on for hours, days, months or even years.

8. REGIONS OF EARTHQUAKE OCCURRENCE:

Although there are so many regions, there are four basic regions of earthquake occurrence. One is along the mid-ocean ridges, where high heat flow and volcanic activity occur, caused by the stretching of the earth's surface. These mid-ocean earthquakes are usually shallow-focus, originating at depths of less than 70 km. Most volcanic and earthquake activity occurs in the vicinity of the deep sea trenches and island arcs. Both volcanism and earthquakes are now known to be direct by-products of plate movements and subductions. The second area of earthquake occurrence is along transform fault zones- where one section of the earth's crust is sliding by another- such as the San Andreas Fault in California or the Anatolian fault in Northern Turkey. Earthquakes here are also shallow but without associated volcanic activity. Third area of earthquake occurrence is a belt of shallow focus earthquakes which extends from the Himalayas to the Alps. It is apparently associated with the compressive forces responsible for the creation of these mountains. In general, shallow focus earthquakes pose the greatest danger to human populations, since they are most numerous and involve the greatest release of energy. The last earthquake area is the deep sea trenches and volcanic island arcs that surround the Pacific Ocean. Earthquake foci occurring in this region may be shallow, intermediate, or as deep as 700 km depending on their exact location in the subduction zone. The tracing of earthquake foci in these areas has revealed that the deeper earthquakes occur in an inclined zone that dips away from the deep sea trench. Therefore, by using a network of sensitive seismographs around the earth to locate the foci of these earthquakes, it is possible to establish the position and steepness of the subduction zone. Earthquakes do not occur below a depth of 700 km because the descending lithosphere becomes molten and behaves more like a plastic than a brittle solid.

9. ENVIRONMENTAL HAZARDS OF EARTHQUAKE

There are so many environment hazards of earthquake. Earthquake is the most damaging natural disaster. Buildings, bridges and other structures collapse due to earthquake. Various changes occur on the surface of the earth due to large earthquakes. Small mountains may convert into plains and plains may convert into small mountains due to deposition of rocks, soil, etc. Landslides and floods that occur due to earthquakes destroy agricultural land, forest, etc. The environmental hazards of earthquakes are those of ground-shaking, fault rupture, the creation of tsunamis (tidal wave) and the dislodgement of landslides, mud flows and avalanches. It sometimes causes a permanent change of level at the surface but generally the damage done by the shaking gives the only lasting visible effect. Secondary effects include falling debris from buildings and the ignition of fires caused by the disruption of fuel and electrical systems. The discussion here will be limited to ground shaking and fault rupture.

Fig 6 Environmental hazards

This is a list of earthquakes in Nepal. It includes those events with their epicentre in the country and those that occurred outside the country, but caused significant damage in Nepal.

Date	Place	Latitude	Longitude	Fatalities	Magnitude
1255, 7 June	Kathmandu	27.7	85.3	2,200	7.8
1260	Sagarmatha	27.1	86.8	100	7.1
1344	Mechi	27.5	87.5	100	7.9
1408 August	Near Nepal-Tibet Border, Bagmati zone	27.9	86.0	2,500	8.2
1505, 6 June	Near Saldang, Karnali zone	29.5	83.0	6,000	8.8
1681 January	Northern Koshi zone	27.6	87.1	4,500	8.0
1767 July	Northern Bagmati zone	28.0	85.5	4,000	7.9
1833, 26 August	Kathmandu/Bihar	27.9	85.5	6,500	8.0
1869, 7 July	Kathmandu	27.7	85.3	750	6.5
1916, 28 August	Nepal/Tibet	30.0	81.0	3,500	7.7
1934, 15 January	Nepal/India/Tibet	26.773	86.762	8,519	8.4
1966, 27 June	Nepal/India border	29.554	80.854	80	6.3
1980, 29 July	Nepal/Pithoragarh	29.598	81.092	200	6.5
2011, 18 September	Sikkim, India	27.33	88.62	111	6.9
2015, 25 April	Kathmandu/India/Tibet	28.147	84.708	8,922	7.8
2015, 12 May	Nepal/China/India	27.97	85.96	213	7.3

The shaking during earthquakes is caused by seismic waves created by the sudden displacement of the earth along a fault. This displacement may result in both vertical and horizontal movement of the ground with intense vibrations. Shaking of the ground is the single greatest hazard associated with earthquakes. The major danger in heavily populated areas comes from debris falling from damaged buildings, those constructed from rigid and unreinforced material such as concrete, masonry or adobe are particularly susceptible to earthquake damage. Wooden structures have the greatest resiliency. In Japan, Nepal, Chile, Peru and other countries where earthquakes have taken such a devastating toll in recent years, the typical house has a tile roof and adobe block walls veneered with plaster.

10. BENEFICIAL ASPECTS OF EARTHQUAKES

Although there are so many harmful effects of earthquake, there are also beneficial aspects of earthquake. The beneficial aspects of earthquakes are fewer than those of volcanoes, but seismic activity provides some benefits for man. Earthquakes are fundamentally related to the creation of initial relief and mountain building with all its ramifications. In addition, the vertical displacement of rock along fault zones exposes the rock, providing a view of what lies underground. This is particularly useful for the discovery and extraction of mineral deposits.

11. CONCLUSION

Earthquake occurs when the earth's crust breaks due to geological forces on rocks and adjoining plates that cause physical and chemical changes. When earthquake occur the violent breaking of rock releases energy that travels though the earth in the form of vibrations called seismic wave. Earthquake occurs as global plate motion. Some plate boundaries glide past each other smoothly while others are punctuated by catastrophic failures causing into earthquake. Some earthquakes stop only after a few hundred aftershocks. The Richter magnitude scale assigns a magnitude number to quantify the energy released by an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph.

An earthquake can be defined as a series of vibrations within the earth's crust that are caused by the rupture of its rocks. This rupture is due to gradual accumulation of elastic strain

within the crust. Fault zones and fault systems have a key role in the development of the earth's crust. They control the mechanics and fluid flow properties of the crust. A disturbance like an earthquake at any point on the earth will produce energetic waves called seismic waves. They travel through the earth in different ways and at different speeds.

New houses should be made based on the latest earthquake resisting technology and old houses should be renovated accordingly. Volunteers trained with earthquake knowledge should be prepared

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