PALEOSEISMOLOGY

Earthquakes are a bane to society, which gets adversely impacted, by the havoc caused by the seismic upheaval. The proposition to study it for foreseeing earthquake occurrence is still at infancy. However, efforts are on all over the world to get a grip on its timing.

One important way in which this objective can be achieved is by finding out when an earthquake had hit a particular region in the past. Since the instrumented records do not stretch a long time back, the timing of the occurrence need to be ascertained by some other valid methods. One such method is to search for the seismic signals that are embedded in the soft sediments. The deformities caused by previous earthquake/s can be radiometrically, as well as magnetically, dated. These dates can then be used to calculate the recurrence time of earthquake/s in a particular region. These studies cannot be carried out any place desired. The likelihood of occurrence of deformed structures is more in soft and unconsolidated sediments which are amenable to relative motion of grains within the formation. Such sediments occur in limited areas and finding them is always a tricky proposition. It needs lot of hard work, trenching and travelling. IIG has carried out such studies in the north, northeastern Himalayan belt and in the Deccan traps near Killari (Latur) earthquake area.

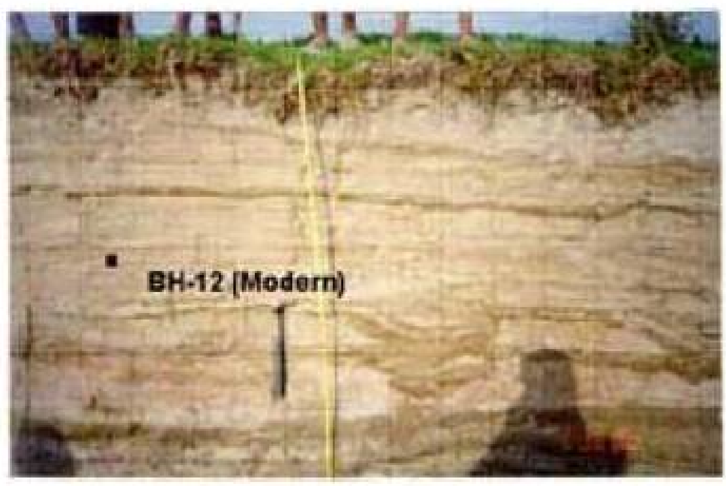
Knowledge of when, where, howbig, and how often large earthquakes occur is crucial for evaluating the seismic hazards of a region and forms the main body of paleoseismological studies. In simple terms, it investigates past geological record forany signs of earthquakes to decipher thenature of large earthquakes that occurred along faults or a swath of regions. The record could go back over hundreds to tens of thousands of years. This record is very essential since it complements historical and instrumental records.

Major seismic events generally manifest themselves in deformational features like fractures, faults, folds, change in sedimentation pattern in lakes, landslides, shift in river course direction, and liquefaction. These features are called seismites. Paleoseismology involves identification of seismites, collection of relevant organic material for carbon-14 dating, inorganic for thermoluminiscence, palaeomagnetic and magnetostratigraphic dating; and also cataloguing of stratigraphic sequences. Thereafter, radiometric and magnetic dates are related to the geological signatures to arrive at the occurrence time of seismic events. Thus, the use of absolute and relative dates makes it easier to correspond deformed and undeformed features, with before, during and after earthquake times to help estimate recurrence time interval for major seismic events. Besides establishing timing of the seismic event, the study involves estimation of probable magnitude of the event on the basis of empirical relations. The information ultimately helps in estimating the natural hazard due to earthquakes in the past in a given area, which otherwise has to be based on instrumented records. However, dating of prehistoric earthquakes usually presents a challenge because of the nature of the depositional material associated with these events. At best, a paleoliquefaction event can be constrained in time to have occurred between the dates of layers stratigraphically bounding the surface at the time of the event.

Palaeoseismic research, through the integration of geological, seismological, archaeological, historical, and tectonic information, provides data and criteria for (a) quantifying rates of ongoing tectonic activity in a region, (b) understanding the influence of this activity on the local landscape and (c) constraining structural and seismological models of fault behavior and growth.

Paleoseismic evidence is either primary or secondary. The former is produced by tectonic deformation resulting from coseismic slip along a fault plane, and the latter is produced by earthquake shaking, or by erosional and depositional responses to shaking and coseismic elevation changes.

Some seismites, like vertical offset, flexuring, warping, flame like features were identified in meizoseismal area of 1993 Latur earthquake along Tirna and Manjira rivers. The age of deformation was radiocarbonically constrained which revealed this region experience earthquake activity around 2000 years ago.Bihar –Nepal region is affected by many earthquakes and the palaeoliquefaction features provided evidence for two prehistoric seismic events that occurred: (1) during 1700 to 5300 years BP, besides the well documented 1934 and 1833 seismic events. The paleoseismological study in the Shillong plateau has provided geological evidences for earthquakes and recurrence period. Trenching along the Krishnai river, a tributary of river Brahmaputra, has unraveled very conspicuous and significant earthquake induced signatures in the alluvial deposits of the valley. The geological evidence includes: (1) paleoliquefaction features, like sand dykes and sand blows; (2) deformational features like tilted beds; (3) fractures and syndepositional deformational features, like flame structures caused by coeval seismic events. The radiocarbon dating of organic material associated with the deformed horizon indicate the Shillong Plateau has been struck by large/major earthquakes around 500±150; 1100±150 and 1500±150 yr BP in addition to the well-known great seismic event of 1897. This radiocarbon dates indicate a recurrence period of the order of 500 yr for the large earthquakes in the Shillong Plateau.



A 4.5 m deep cross-section at Benibad village about 40 km from Muzaffarpur on Muzaffarpur–Darbhanga highway depicts a 2.8 m high and 4–5 cm wide sand dyke oriented in N15^{0}E direction. Top 1.7 m of the section is occupied by alternate layers of sand and silt underlain by older and younger alluvium side by side. The sand dyke has a lower bound of 6130 ± 280 years BP as dated using shell samples **(left)**.

Photograph showing the flexured and disrupted silty sand strata at a depth of 0.7 m subsequent deposition over the disturbed beds had a similar alternating depositional succession as below it. Flexured and disrupted strata is an indication of seismic shaking. The sample BH-12 (^{14}C date ‘Modern’) represents the upper bound for the seismic event, possibly the year 1934 **(right)**.

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