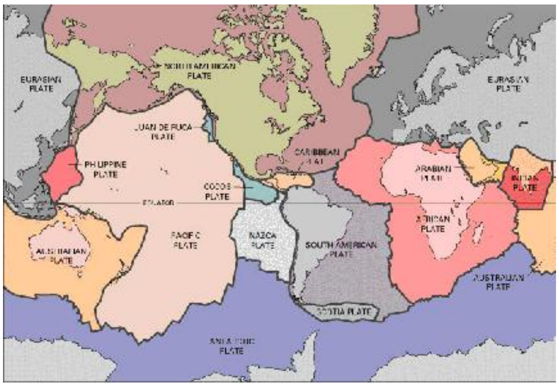
NEOTECTONIC ACTIVITY



Neotectonics is a sub-discipline of tectonics. It is the study of the motions and deformations of the Earth's crust (geological and geomorphological processes) which are current or recent in geologic time.

The term may also refer to the motions/deformations in question themselves. The corresponding time frame is referred to as the **neotectonic period**. Accordingly, the preceding time is referred to as **palaeotectonic period**

- The term is attributed to "recent tectonic movements occurred in the upper part of Tertiary (Neogene) and in the Quaternary, which played an essential role in the origin of the contemporary topography".
- Since then there has been a disagreement as to how far back in time "geologically recent" is, with the common meaning being that neotectonics is the youngest, not yet finished stage in Earth tectonics. Some authors consider neotectonics to be basically synonymous with **"active tectonics"**, while others start the neotectonic period from the middle Miocene.

- **10,000,000- 100,000,000 = Orogenic scale**

Our main scale of interest in this class

- **1,000-10,000 = Neotectonics**

- **1-10 = Active tectonics**

How do they compare?

- **"Neotectonics is the study of young tectonic events which have occurred or are still occurring in a given region after its orogeny or after its last significant tectonic set-up"**
- Neotectonics is also defined as "the study of geologically recent motions of the Earth's crust, particularly those produced by earthquakes, with the goals of understanding the physics of earthquake recurrence, the growth of mountains, and the seismic hazard embodied in these processes."

Neotectonic activity is manifested in the form of the following

- Earthquakes and associated strong ground motion
- Surface faulting
- Tsunamis
- Landslides along tectonic faults
- Liquefaction
- Volcanic activity
- Landform evolution

Important Landforms that develop as a result of Neotectonic activity are

- **River terraces**
- **Fault scarps**
- **Entrenched Meanders**
- **Incised valleys**
- **Triangular facets**
- **Skewed fans**
- **Knick points**
- **Stream piracy**
- Sag ponds
- Shutter ridges
- Pressure ridges
- Pull-apart basins
- Controlled drainage

The Himalaya originated as a result of continent–continent collision between India and Asia. The northward convergence of India resulted in crustal shortening of the northern margin of the Indian continent, accommodated by south-verging thrusts.

- ACTIVE faults are widely distributed in different sectors of the Himalaya and are important in that they provide signatures of the recurrent tectonic activity during the Quaternary and in particular the Holocene periods.
- The activity often resulted in destructive earthquakes, dislocation of old landforms and creation of new ones.

- The principal compressive stress field in the Himalayan orogeny, formed as a result of collision of the Indian and the Eurasian plates has changed from N-S to NE-SW during post-collisional times. Quaternary and Recent neotectonics have reactivated and transformed many of the thrust faults in the High Himalaya into strike-slip faults.
- The present-day ESE/*SE extension of the Indian subcontinent* has modified a number of pre-existing and newly formed fracture planes into normal faults.

The principal thrusts, namely the Main Central Thrust (MCT), the Main Boundary Thrust (MBT) and the Himalayan Frontal Thrust (HFT) show younging age and shallowing depth, suggesting southward migration of the main deformation front.

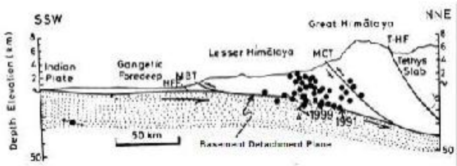


Figure 12. HFT traces the front of the Basement Detachment Thrust—the plane along which the Indian plate is sliding under the Himalaya. Movements of this plane generate earthquakes.

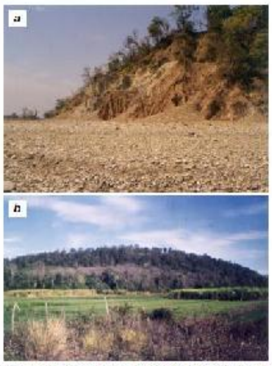
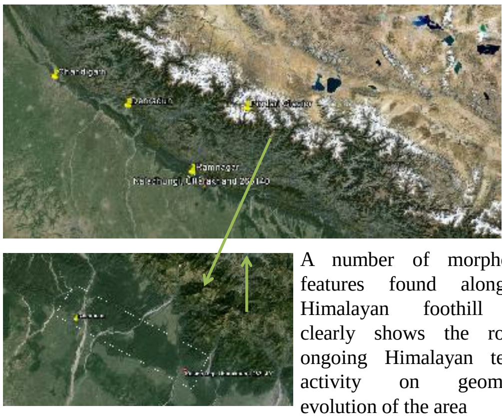
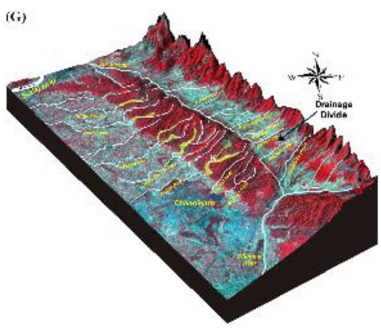


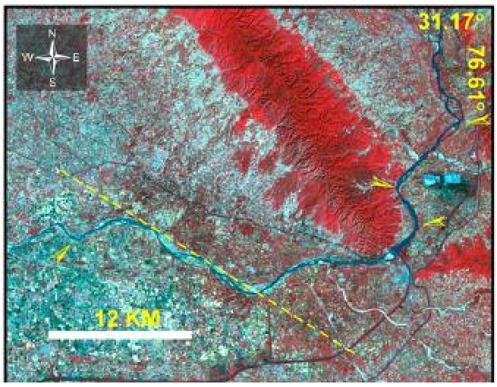
Figure 5. a, Triangular facets on the scarp face of the Siwalik related to the HFF, seen west of Mohand on the Dehradun–Roorkee road. b, Between Ramnagar and Kaladhungi in southcentral Kumaun, the 60 m high scarp exposing Late Pleistocene gravel deposit is a result of the reactivation of the HFF.

Neotectonic activity and active faulting related to the thrusts are observed on the surface in some restricted segments. The MCT remains largely inactive, except some reactivated segments showing lateral strike-slip movement as in Central Nepal.

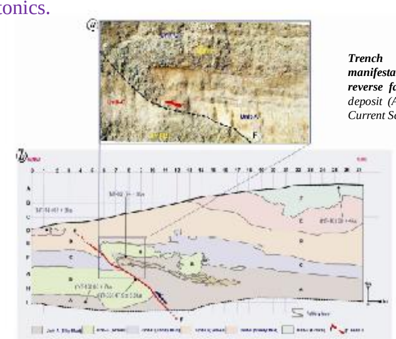


A number of morphotectic features found along the Himalayan foothill zone clearly shows the role of ongoing Himalayan tectonic activity on geomorphic evolution of the area





Systematic field surveys help in identifying various geomorphic features which have been formed or modified in response to active tectonics.



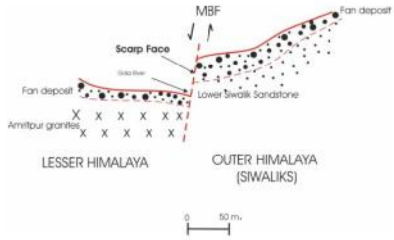
Trench wall showing the manifestation of folding and reverse faulting (F–F) in the fan deposit (After ***Philips et al. 2014****. Current Science)*

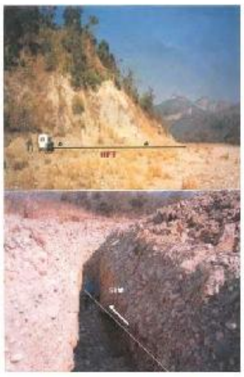
Trench wall log showing displaced Quaternary units along the active reverse fault *(F–F). OSL sample locations are marked with their ages (After* ***Philips et al. 2014****. Current Science)*

The MBT in certain localized areas exhibits neotectonic activity

The preliminary investigations suggest that the area is traversed by a number of recent faults that have resulted not only in the offsetting but also the skewing of the mountain front and several geomorphic features.

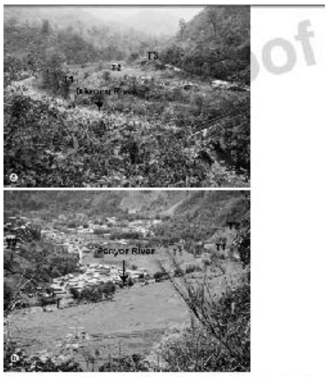
Fan Offsetting



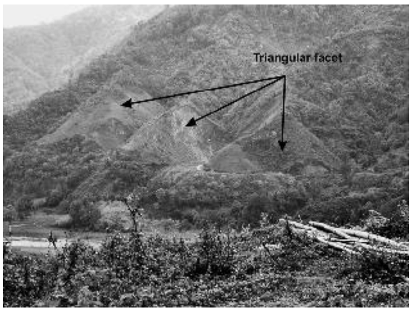


The Himalayan Frontal Fault (HFF) also referred to as the HFT, shows active faulting and associated uplift. The HFT represents a zone of active deformation between the Sub-Himalaya and the Indo Gangetic plain. It demarcates the principal present day tectonic displacement zone between the stable Indian continent and the Himalaya with a convergence rate of 10–15 mm/yr.

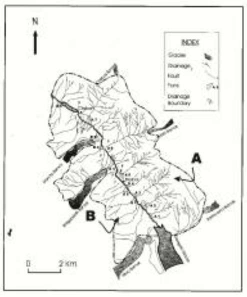
River terraces



Triangular Facets



Assymetrical drainage pattern



Drainage Anomaly

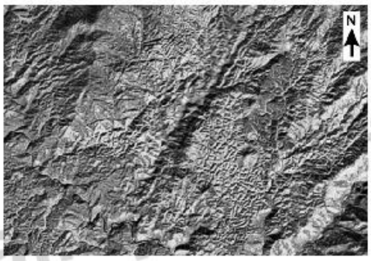
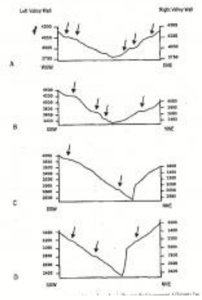
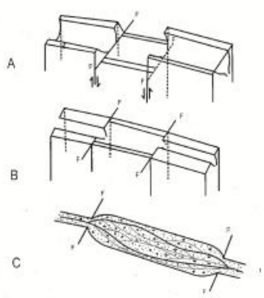
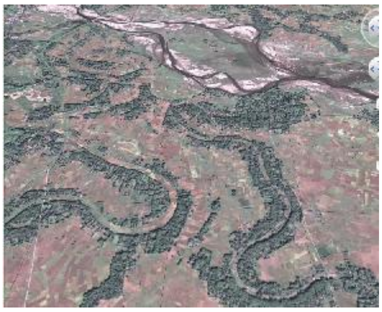


Fig.6 Higher drainage density of lower order streams as seen from high-resolution satellite data.





Entrenched Meander



The pieces of evidence for neotectonic activity viz. seismic activity, triangular faceted cliffs, asymmetrical and symmetrical terraces, entrenched river system, contrasting drainage morphometric styles in adjoining areas, support the view that there is a marked neotectonic control on the geomorphic evolution of the area.

This activity had continued till the later part of the Quaternary affecting and modifying the geomorphological features formed earlier and is still active even today.

(After **Agarwal and Bali**, 2009, Zeit. Geomorph)

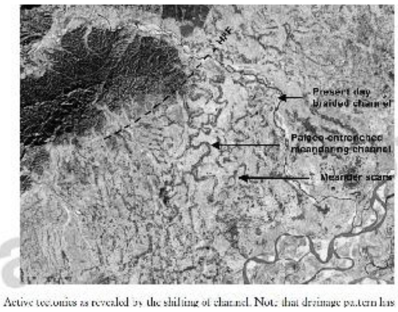


Fig 3. Active tectonics as revealed by the shifting of channel. Note that drainage pattern has

Normal fault

Strike-slip fault

Reverse fault

Fault Scarp

The bed of this major river has been disarticulated by the fault. The scarp hidden by the waterfall is about 7 meters high. The bridge failed where it crosses the fault to the right a few hundred meters, out of the frame of the photo.

Long term plate motion- 5 cm/yr

400 m in 10000 yrs

40 mm per year

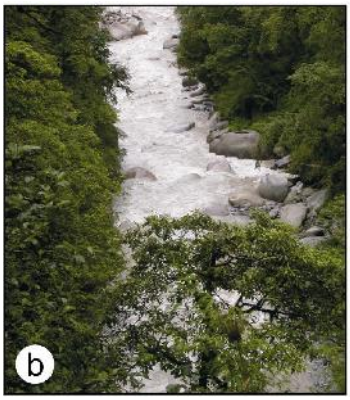
Izmit earthquake 1999

When uplift is too rapid to be accommodated by a river there will be disruption of the drainage pattern

Stream Offset

Skewed Fan

Entrenched Channel



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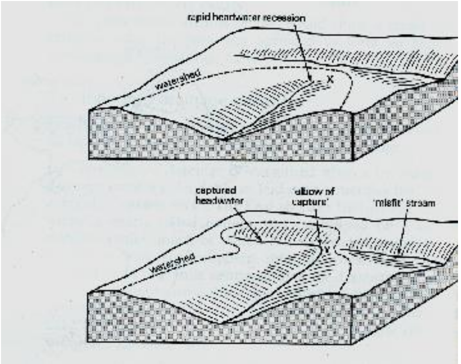

Pressure ridge
Faults like the San Andreas fault are rarely perfectly straight, but rather curve back and forth to some degree. When a bulge on one side of the fault is carried against a bulge on the other side, the excess

material is pushed upward

Sag Basin

Strike-slip faults like the San Andreas fault are rarely perfectly straight, but rather curve back and forth to some degree When a concavity on one side of the fault is carried against another on the other side, the ground between sags in a depression or basin. Sag basins can be quite large;

Shutter ridges occur where the fault carries high ground on one side past low ground on the other. The motion of the barrier is like the shutter of an old-fashioned box camera, hence the name

Rift Valley

- Where there has been uplift or subsidence, terraces are warped upward or downward, and the extent of the displacement can be determined by comparison with the longitudinal profile of the present river if, indeed, the river has adjusted to the past deformation

- When uplift is too rapid to be accommodated by a river there will be disruption of the drainage pattern