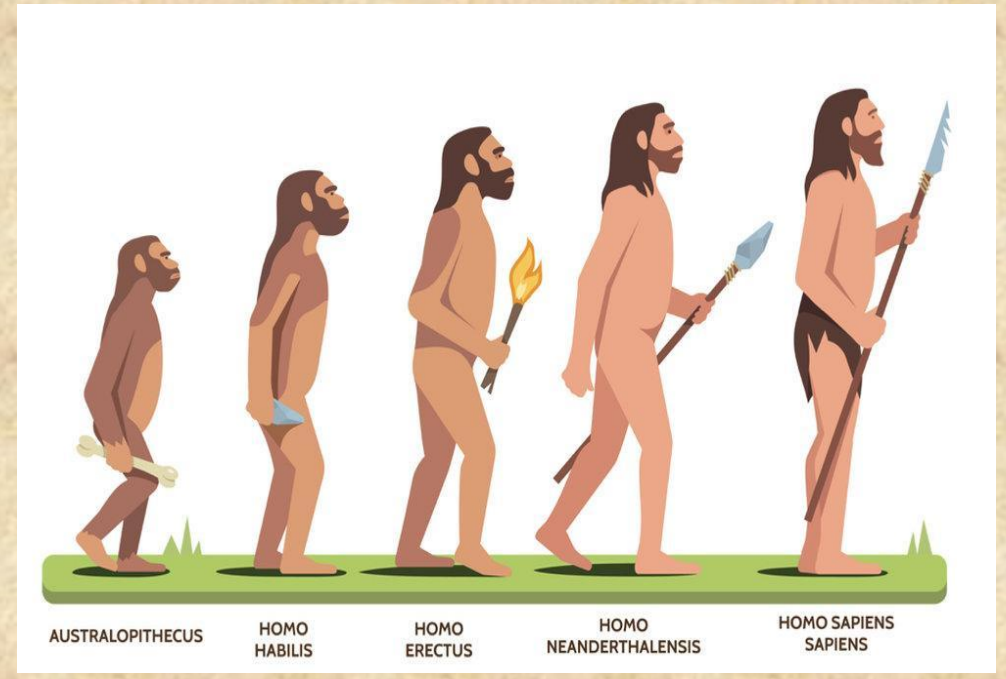
Quaternary Geology

Lecture 3

Dhiman Roy, PhD



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Course outline

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- Part-II
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Quaternary Stratigraphy

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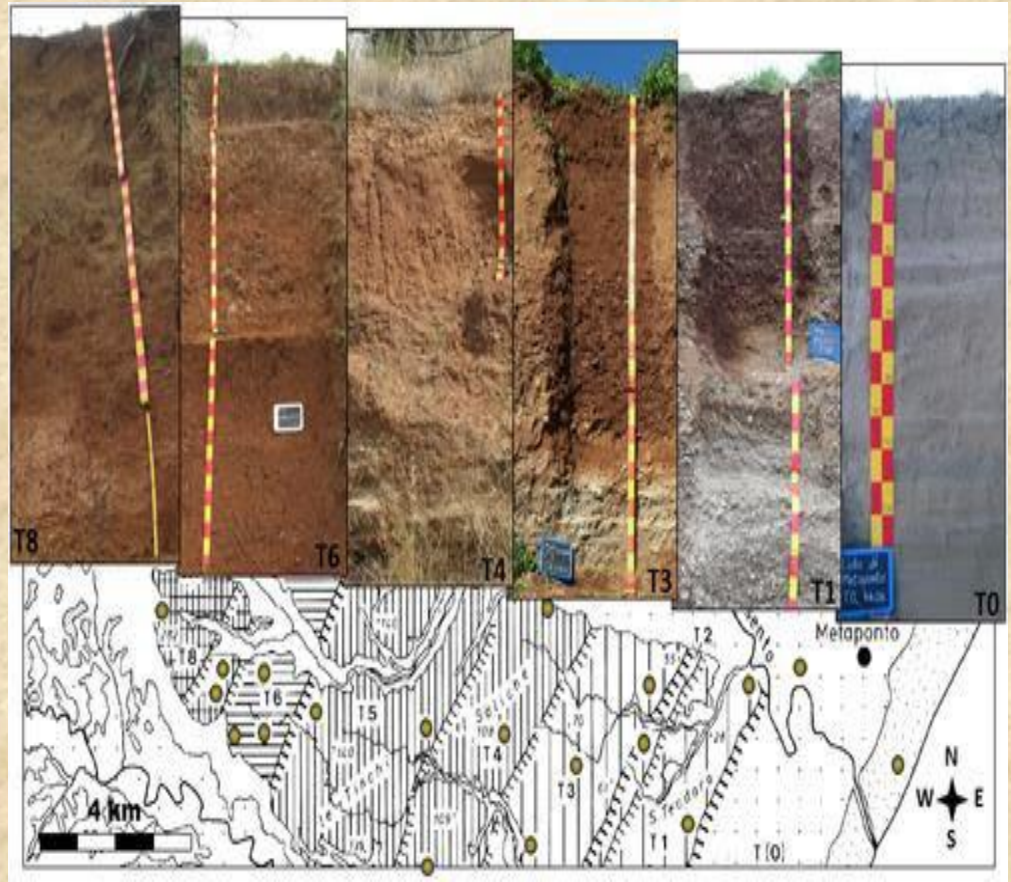
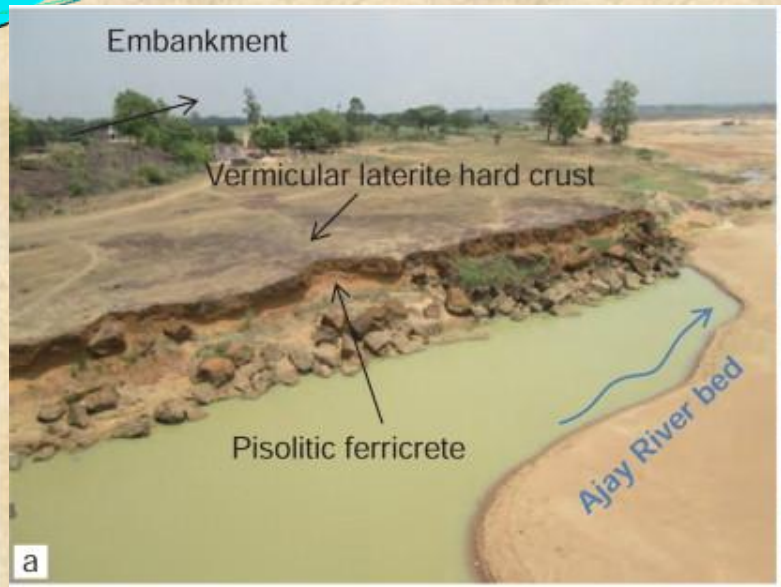


Talk outline



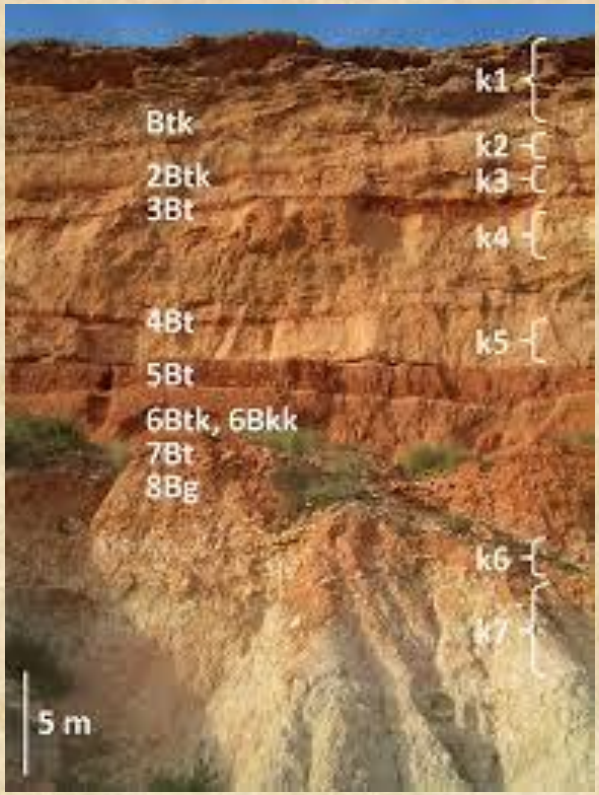
- Micromorphological Studies
- Reason of Reddish Brown color: Madhupur and Barind

Pedological Studies: Micromorphological studies

- Palaeosols or Geosols are becoming widely recognized in ancient siliciclastic alluvial and deltaic sequences.

- The average sedimentation rates in terrestrial setting are low. As a consequence, sediments will have a residence time of tens of years to thousands of years within the upper part of the weathering profile.

- Within this zone, effectively the zone of soil formation. These sediments can be radically modified by a variety of biological, chemical and physical processes associated with pedogensis (Allen and Wright, 1989).

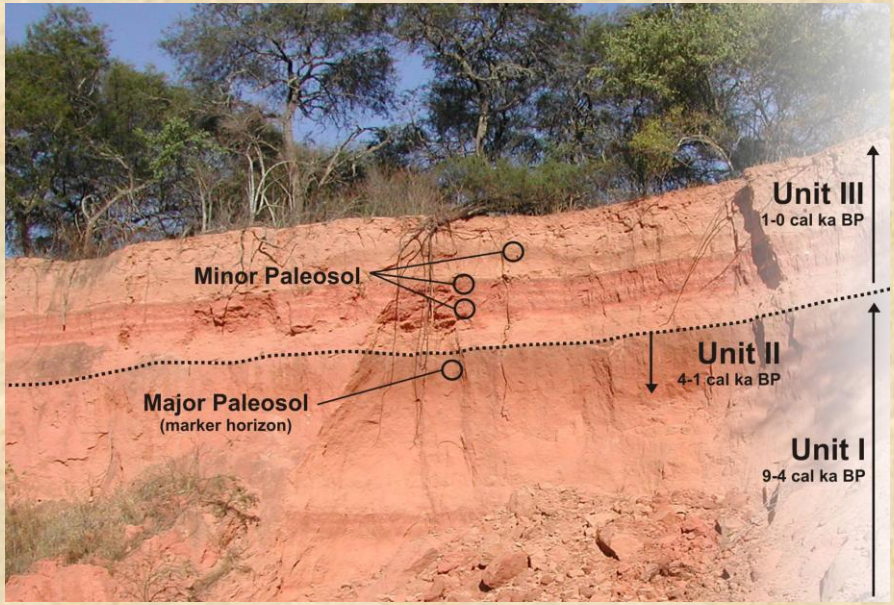


Pedological Studies: Micromorphological studies

- Soil is a natural body formed in the surface of the earth under the influence of climate, biota, topography and time.

- It will have vertically differentiated layers due to the relative intensities of biological, chemical and physical weathering and translocation of the products.

- A vertical section through these layers exhibits a soil profile (Valentine and Dalrymple, 1976).



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- Palaeosol are the soil horizons of the past.
- Palaeosol **represents** stable stratigraphic key horizons and may reflect environmental climatic condition of the past which no longer **exist today .**
- A palaeosol in stratigraphic horizon represents **a depositional** break (unconformity) in normal lithologic sequence.
- Soil is a climatic indicator and it develops in an area of wide **lateral** extension.
- Therefore, the presence of palaeosol in **stratigraphic** horizon represents in one hand, a marker horizon **which can be** used as a synchronous level and on the other hand, it **can be** used as a geochronological tool for stratigraphic correlation of lithosequences of hundreds or thousands of kilometers apart.
- Hence, the recognition of palaeosol horizons in stratigraphic section is quite important.

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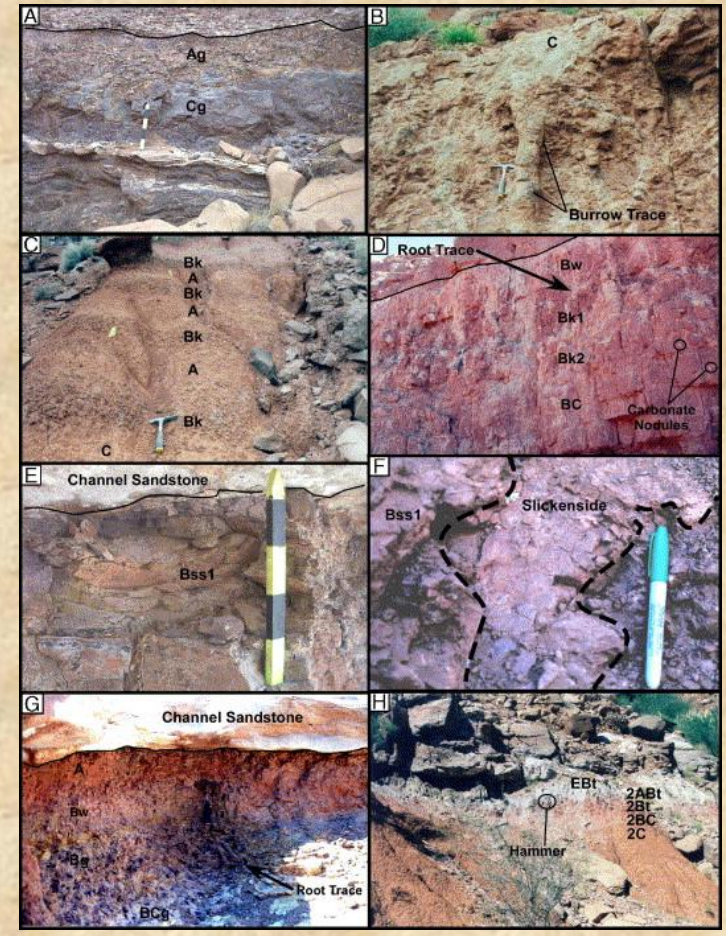
- In the Quaternary sequence of Bangladesh, palaeosol were used for the bases for stratigraphic subdivision.
- Recognition and identification of palaeosols in the Madhupur and Barind Formations in the Madhupur and Barind areas and also in the Lalmai hills areas, were carried out by micromorphological studies (Monsur, 1992).
- Micromorphological descriptions of undisturbed soil samples has been given in the literature, illustrates the pedofeatures and microstructures of thin section of strongly impregnated palaeosols of the Madhupur Formation
- One of the most distinctive aspects of some palaeosol is colour mottling reflecting localized changes in oxidation and reduction (Monsur, 1990).



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- There is a distinct Boundary between the iron-depleted reduction zone (white spaces) and iron-rich oxidation zone (blackspaces).
- This kind of colour mottling is a common feature of the Madhupur and Barind Formations.
- The mechanism of their formation can be explained in the following way: In sediments, where ground water table is close to the surface, the subsoil layers below the surface horizons are permanently saturated and topsoil can be periodically submerged, depending on the extent of the seasonal fluctuation.
- Soil that develop in this way is called Gley Soil (Allen and Wright, 1989). The lower Members of the Madhupur and Barind Formations, sometimes, have this characteristic.

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- However, the appearance of reddish brown colour, oxidation-reduction characteristics, types of colour mottling and the formation of Pseudogley indicate that the soil forming processes were quite active in the case of the Madhupur and Barind Formations of the basin.

- Micromorphological studies of the Madhupur and Barind Formations indicated that the upper part of the Formations represent a strongly impregnated soil with vughs, vesicles, chamber and channel microstructures having amorphous and cryptocrystalline pedofeature.

- On the other hand, the lower Members represent weakly impregnated soil with bridge grain microstructure.

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- It is quite clear that the deposits had undergone pedogenic processes. All the pedofeatures indicated that these are *in situ* developed soil and do not represent a transported or re-deposited soil materials.
- In the case of the Madhupur Formation, only two buried soil horizons were recognizable during the field observation.
- The samples below and above these soil horizons have exactly the similar pedofeatures.
- It means that the deposits include not only two soil layers, but several.

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- Buried soil can be differentiated and recognized easily by horizon after horizon.
- Buried palaeosol were developed by catastrophic floods. But there were also numerous minor floods in the flood plains which only a few centimeter of sediments might have deposited.
- Many ecosystems can cope with this degree of disturbance and continue to grow and incorporate this materials into the pre-existing soil, to form a cumulative one (Retallack, 1983).
- Hence, the Barind and Madhupur Formations represent such a cumulative palaeosols, formed progressively with the alternate increment of a few millimeters or centimeters of sediments by numerous minor floods in the depositional basin.

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- After the deposition of the lower part of these Formations cumulative palaeosols were formed.
- At the top of these Formations modern soil developed which is, in fact, a relict soil of the pre-existing palaeosol materials.
- The pedofeatures indicated a wet-humid palaeoclimate.
- Absence of large trees and the presence of grass type vegetation, and also the formation of these cumulative palaeosol indicates that the depositional basin was a flood plain

Reason of Reddish Brown: Madhupur and Barind

- The reddish brown colour of the Madhupur and Barind Formations is clearly related to the iron compounds.

- The present author has tried to explain how these iron compounds were formed which ultimately caused the deep reddish brown to light yellowish brown colour of these deposits.

- In this context, only the the petrographical observations with the aid of a polarizing microscope and the literature reviews are discussed (Monsur, 1992; Hassan, 1986). Iron in sediments can be divided into:

a) the iron present in primary minerals, the nature of which will depend on the type of parent materials undergoing weathering;

b) the iron present in secondary minerals and

c) free iron.

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- The primary iron-containing minerals are usually associated with igneous rocks, such as, ferromagnesian silicates (pyroxene, olivine and amphibole) biotite micas and the iron ores, comprising hematite, ilmenite and magnetite.

- The iron containing secondary minerals can not be defined as clearly owing to their heterogeneity (Oades, 1963).

- Biogenic products and chemical constituents, such as, calcite and dolomite, formed at the place of deposition usually contains less than 1% iron, except where the deposition has occurred in shallow seas, when oolite and perhaps iron minerals, as for example chamosite and/ or siderite may be found.

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- Iron present in many minerals occurring in the weathering sequence from the ferromagnesian silicates through the biotite micas and illite clay minerals to hematite and/or goethite and many other iron containing minerals.

- Clay minerals containing iron as an essential element are the "hydromicas", illites. chlorites, vermiculite, chamosite, glauconite, griffithite and granulite

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- A detailed study of clay minerals of the Madhupur Formation has been perfomed by Hassan (1986).
- He found the above mentioned iron rich clay minerals, such as, illite, chlorite and vermiculite.
- The sediments of the Madhupur and Barind Formations contain a lot of ferromagnesian minerals (quite fresh in the lower part of these Formations) derived from the Himalayan mountain ranges.
- These sediments undergone intensive weathering processes and released Fe ions in a free state.
- In the Madhupur and Barind areas these iron compounds are distributed throughout the sections in the form of nodules or in association with clays.

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- Pipestems are associated with roots channels.
- The plant roots are capable of oxidizing iron and it was observed that the rhizosphere system of hydrophyte plants tend to be more efficient in producing oxidative condition in the soil than mesophytic type.
- Pipestem are characteristic of poorly drained soils. The orange brown colour is, however, associated with dead roots, while roots are still living a pale blue or grey colour.
- The abundance of pipestems in the Madhupur and Barind tracts is in accordance with this statement.

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- A lot of papers explains the formation of iron compounds in red beds. Among the iron oxides the authigenic hematite (aFe203), goethite (aFeOOH), Lepidochrocite (gFeOOH) and hydrated-ferric-oxides gel (Fe(OH)3.H20) are important.
- The colours of the upper, middle and lower Members of the Madhupur Formation are, respectively, moderate reddish brown (10R 4/6), light brown (5YR 5/6) and pale yellowish brown (10YR 6/2).
- Similarly, the colours of the three Member of the Barind Froamtion from top to bottom are respectively, strong brown (7.5YR 4/6), brownish yellow (10YR 6/8) and yellowish brown (10YR 5/8).
- The colour of authigenic hematite and goethite are respectively 2.5 YR and/or redder, and 1OYR. The abundance of these two minerals is probably responsible for the colour variation of these Formations.

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- Well oxygenated upper Members of these Formations favoured the formation of hematite.
- Moreover, there is a possiblity of formation of hematite from the aging ferrihydrite.
- According to Oades 1963), hematite occurs in drier and more highly oxidized zones, usually nearer the surface, whereas goethite occurs more typically in wetter though well oxidized zones, often in subsurface horizons.
- The stratigraphic position of Madhupur Formation in the Lalmai hills is quite high in comparison to the Madhupur and Barind tracts.

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- The ground mass of thin sections of the soils from the Lalmai hills showed redder than any other sections (Monsur, 1992).

- This is because of higher concentration of hematite in Lalmai hills which is in accordance with the statement of Oades (1963).

- The higher concentration of goethite or limonite in the lower Members of both these Formations, probably, resulted in the yellowish brown or pale yellowish brown colour.