ROLE OF GEOLOGY IN FORESTRY

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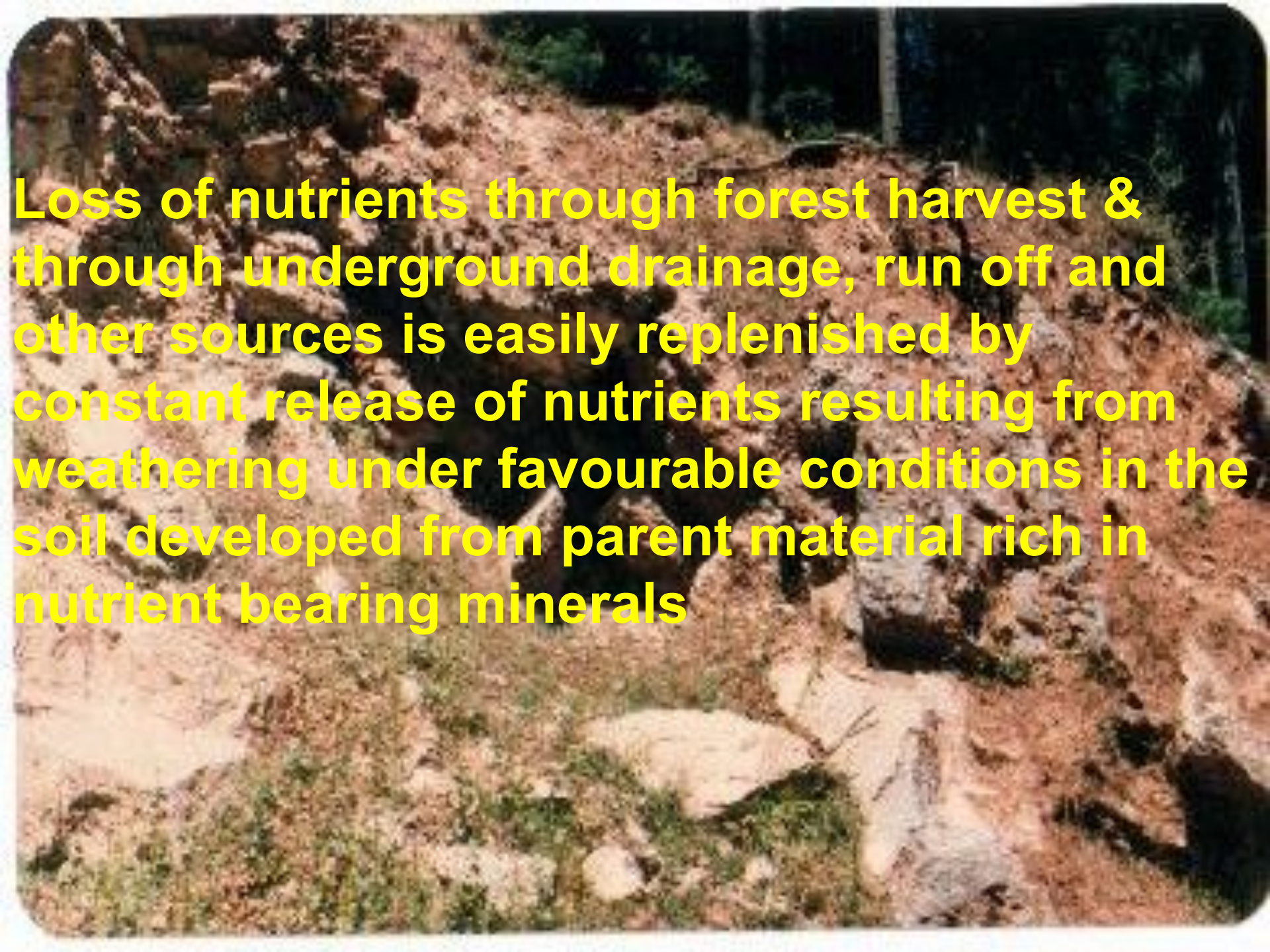
Geology

Mineralogical studies has special importance in forestry where trees have much longer period of growth as compared to agricultural crops and depends to a large extent on the minerals as a source of nutrients in the soil.


Loss of nutrients through forest harvest & through underground drainage, run off and other sources is easily replenished by constant release of nutrients resulting from weathering under favourable conditions in the soil developed from parent material rich in nutrient bearing minerals


A thorough knowledge about the content and nature of minerals present in the soil is, therefore, of fundamental importance in diagnosing the fertility potential & various other aspects of soil - plant- parent material relationship in forestry

The nature and amount of minerals are largely responsible for influencing several properties of soil

Mineralogical composition helps in tracing the parent material of soil

Geology plays important role in knowing about the nature and amount of minerals

Paramount importance of geological studies in forestry is thus quite obvious and merits greater attention in the soil investigation

Mineralogical studies helps in evaluating

Petrographic origin of soils
The stage of weathering
The nutrient reserve
Physical and Chemical properties

Determination of mineralogical make up on regional basis of soil research

- Soil classification
- soil mapping
- Soil fertility

Primary Minerals : Quartz, feldspar, micas etc.

Secondary Minerals : Calcite, hematite, limonite, hornblende, clays eg. kaolinite, montimorilonite, hydrous mica

Light Minerals : sp Gravity less than 2.85
Quartz, feldspar, biotite etc.

Heavy Minerals : sp Gravity more than 2.85
Hornblende, tourmaline, chlorite etc

Mineralogical composition as an index of weathering

As the minerals vary considerably in their susceptibility to weathering, the more easily weatherable minerals disappear in early stages of soil formation, whereas the more resistant minerals continue to remain in the soil mass for a long time and provides information about degree of weathering

Pettijohn gave series of minerals in order of resistance to weathering

Zircon, tourmaline, monazite, quartz, garnet, biotite, apatite, microcline, ilmenite, magnetite, staurolite, kyanite, epidote, hornblende, topaz, zoicite & olivine

Minerals in order of resistance to weathering are:

Nephaline-Leucite are most decomposed minerals followed by olivine and other similar minerals
Next group of minerals in order of resistance are Pyroxenes and Amphiboles followed by Biotite-Muscovite group
Less decomposable group of minerals are Feldspars
Least decomposable silicate minerals are garnet, staurolite, kyanite, zircon etc.
Quartz is most resistant to weathering

Mineralogical composition in relation to soil fertility

Plant nutrients - Weathering of minerals, the reserve and availability of nutrients depends largely on mineralogical composition of soils and parent material

Important nutrient elements derived from following minerals:

K - Orthoclase, muscovite, biotite etc.

P - Apatite

Ca - Plagioclase, hornblende, calcite, augite etc.

Mg - Biotite, chlorite, olivine, dolomite etc.

Fe - ilmenite, hematite, magnetite etc.

S - Gypsum

Feldspar & Basalt - Used in the powdered form as slow acting fertilizer

Gypsum & Dolomite - Amendment for soil reclamation

Clay Minerals

Among many minerals present in the soil, none are as important as the clay minerals since most of their physical & chemical properties of the soil mass are largely influenced by these minerals. By virtue of their colloidal nature, clay minerals perform a series of functions which determine

The retention and availability of moisture

Adsorption of nutrients

Cation exchange capacity

Swelling

Contraction

Plasticity

greatly responsible for overall fertility status of the soil for plant growth

In the areas where either the parent material and the soil are inherently poor in the nutrient bearing minerals or the rate of weathering due to adverse climatic conditions is very slow, the loss of nutrients from the site is not replenished quickly with the result that soils are unable to satisfy the nutrient requirement

These areas are being provided application of fertilizers and manure's or by adoption of other suitable silviculture and management practices

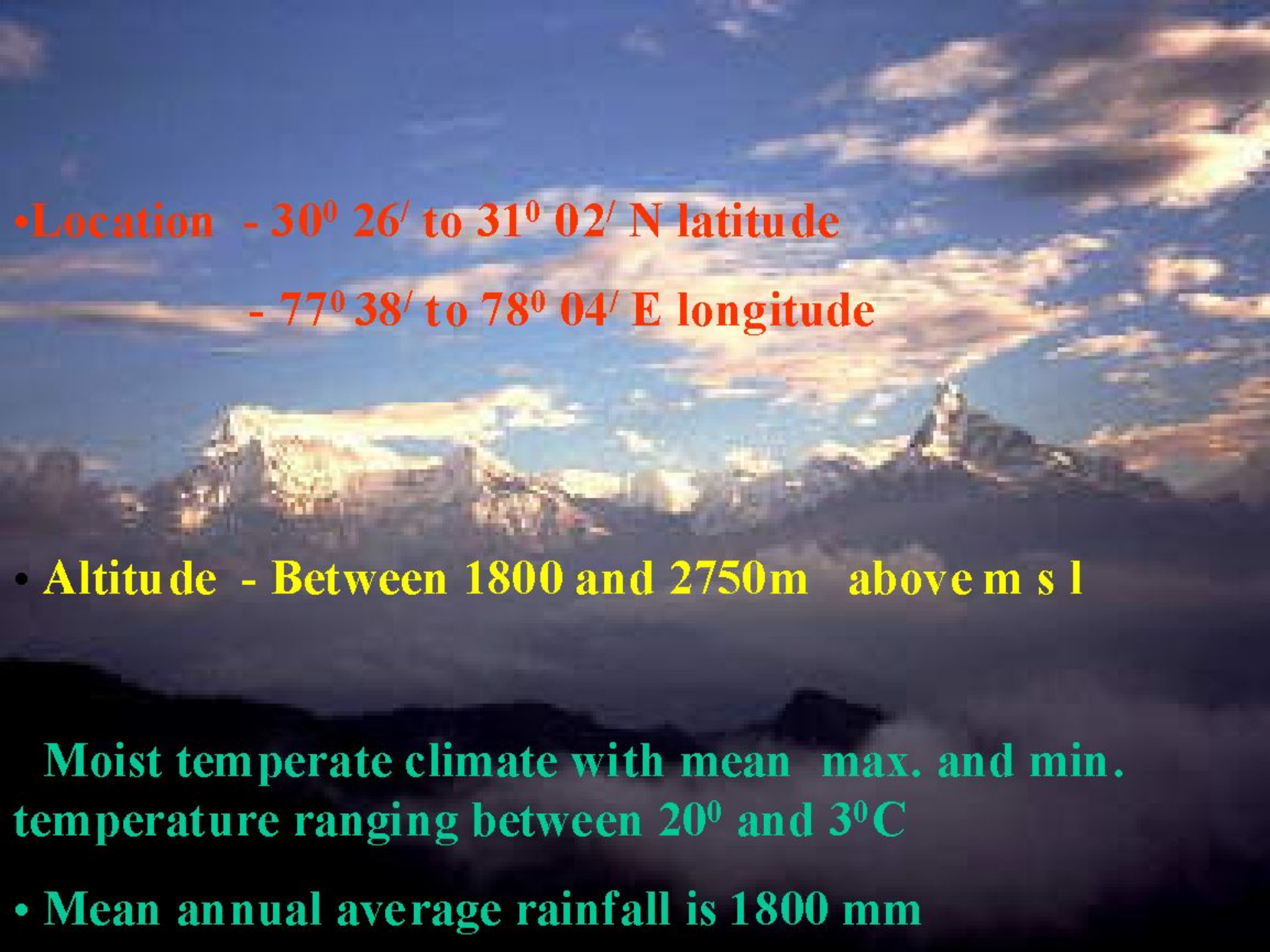
The quality of forest growth deteriorates or may even meet with failure

A thorough knowledge about the content and nature of minerals present in the soil is, therefore, of fundamental importance in diagnosing the fertility potential and various other aspects of soil -

Micromorphology

- Accepted as indispensable tool for investigating minute details of soil
- Detection and presence of salts, colloids, micro-organisms etc. in soil mass in undisturbed condition for understanding dynamics of soil


Kanasar Range of Chakrata Forest Division



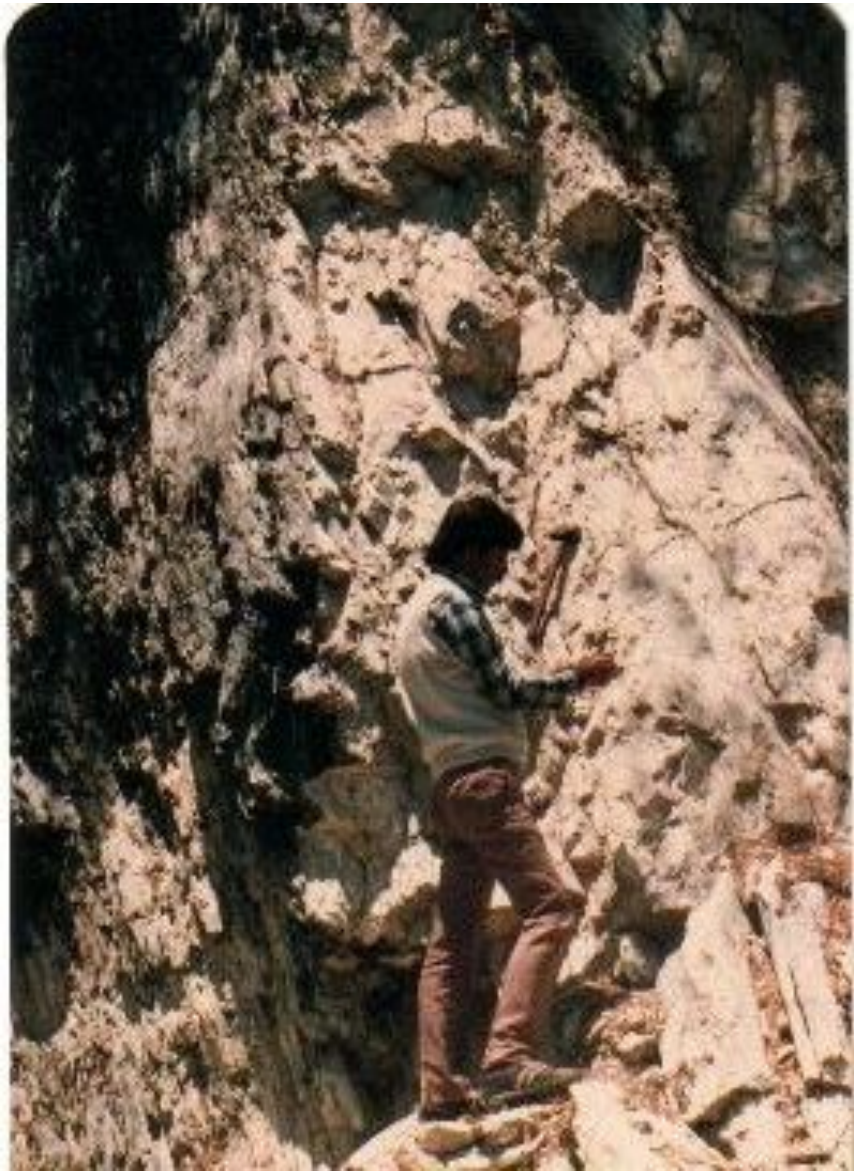
- Location - 30^0 26/ to 31^0 02/ N latitude
  - 77^0 38/ to 78^0 04/ E longitude
- Altitude - Between 1800 and 2750m above m s l

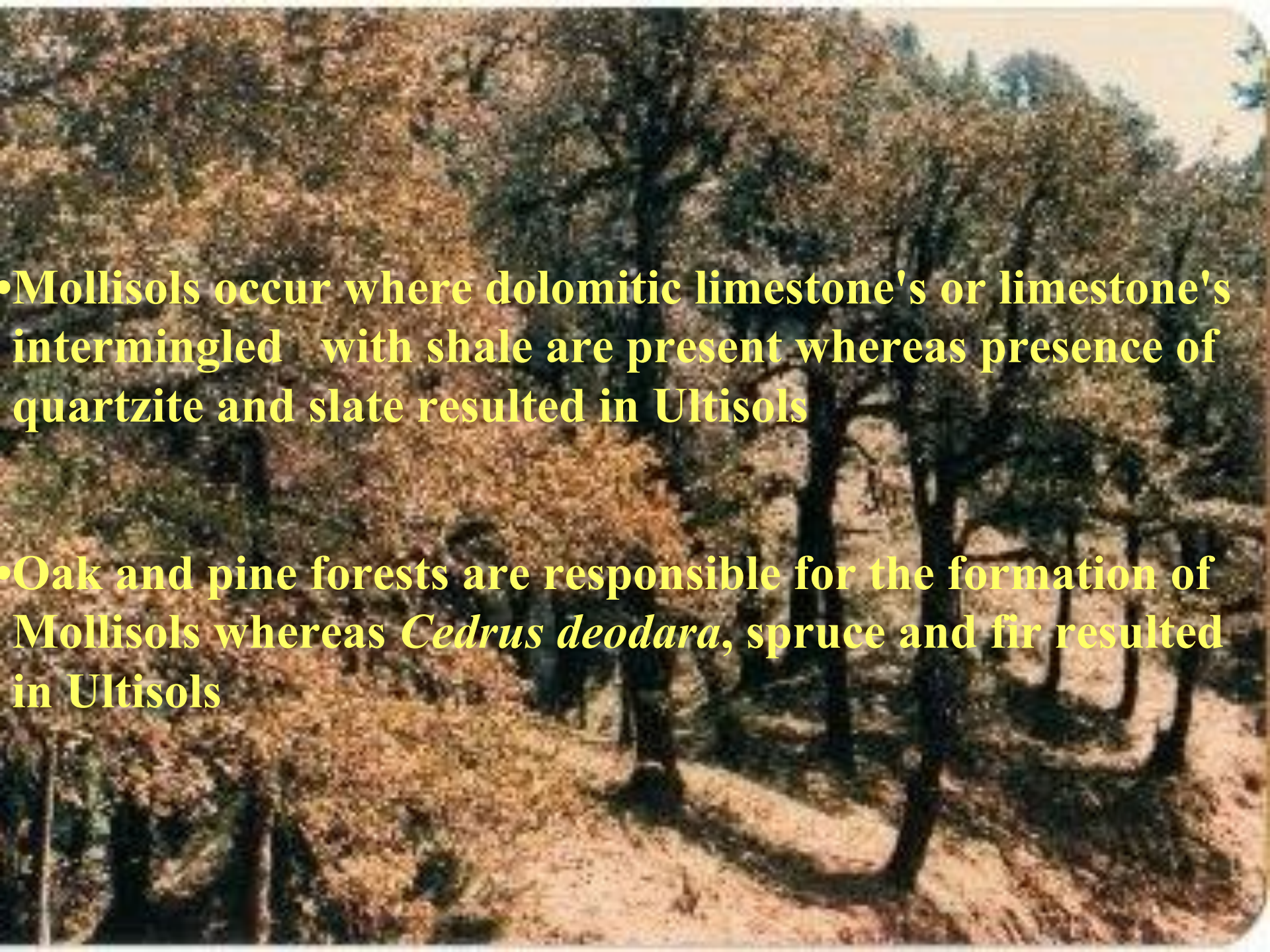
Moist temperate climate with mean max. and min. temperature ranging between 20^0 and 3^0C

- Mean annual average rainfall is 1800 mm

Findings

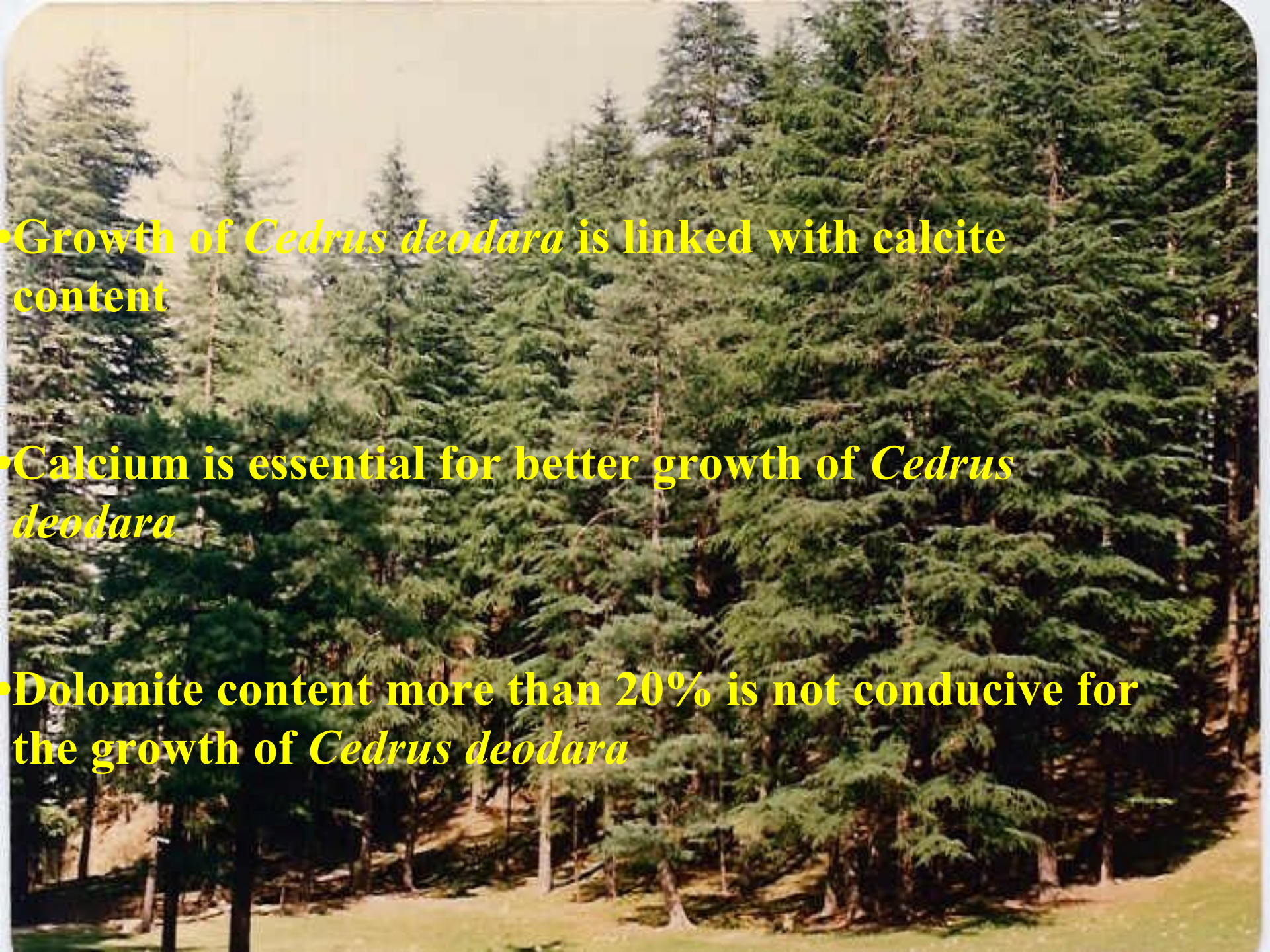
- Geologically rocks belong to Pre-Cambrian to Early Paleozoic in age with recent deposits
- Limestone's, dolomites, dolomitic limestone, quartzite's, slates, shale's etc.
- Soils belonged to Mollisols and Ultisols
- Vegetation is climatic climax and falls under 12/C- Himalayan Moist Temperate Fores



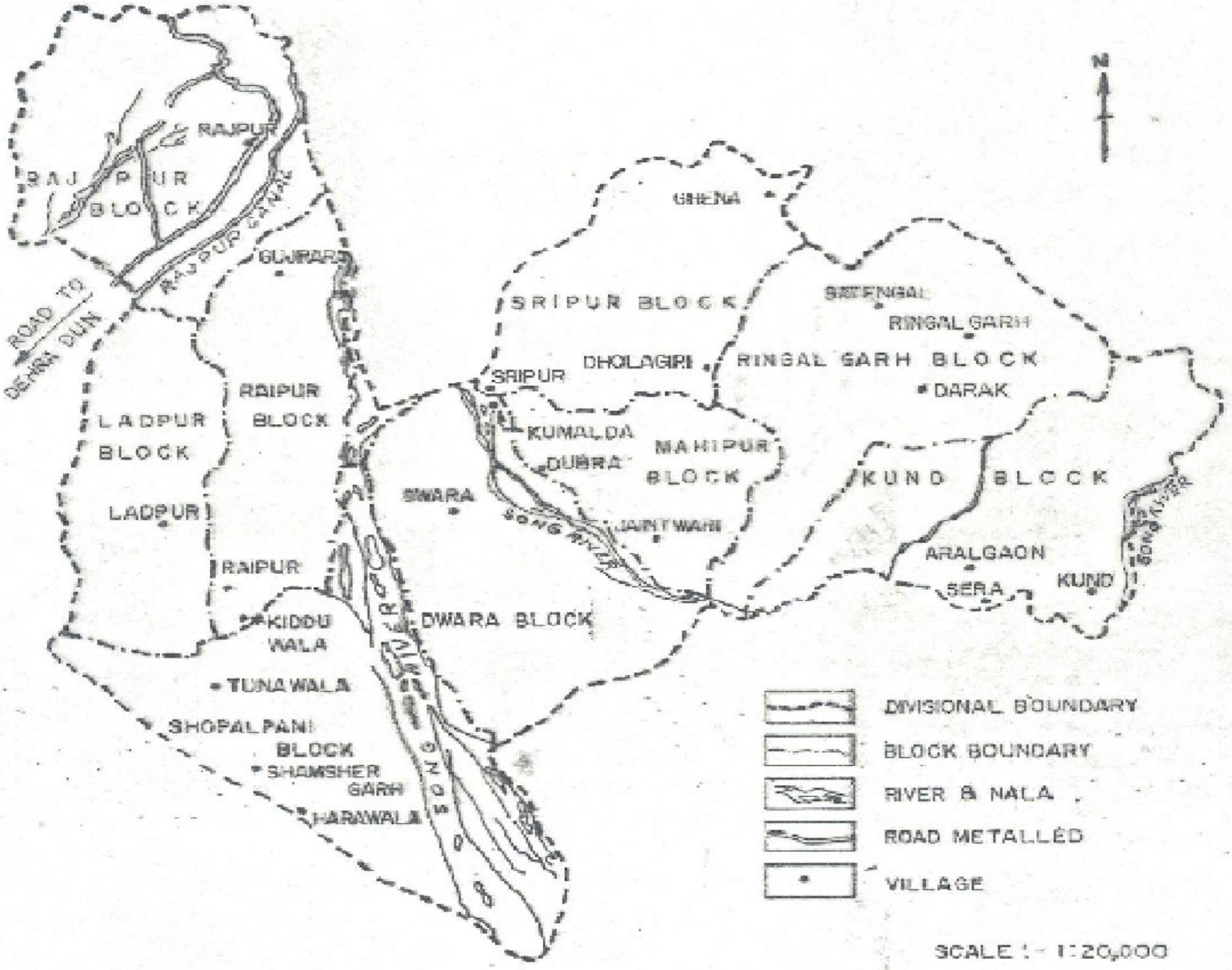


- **Mollisols occur where dolomitic limestone's or limestone's intermingled with shale are present whereas presence of quartzite and slate resulted in Ultisols**

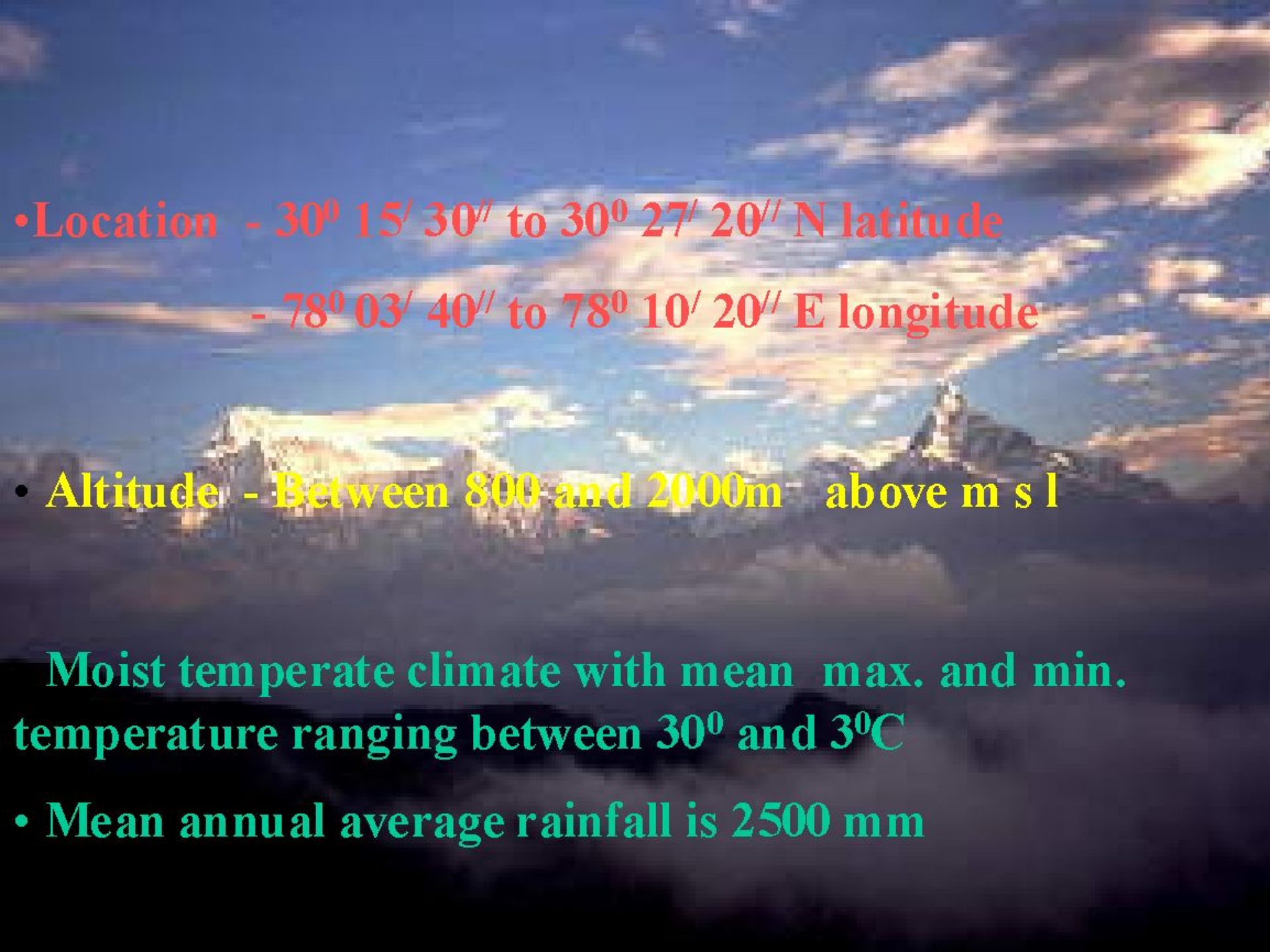
- **Oak and pine forests are responsible for the formation of Mollisols whereas *Cedrus deodara*, spruce and fir resulted in Ultisols**



- Growth of *Cedrus deodara* is linked with calcite content
- Calcium is essential for better growth of *Cedrus deodara*
- Dolomite content more than 20% is not conducive for the growth of *Cedrus deodara*


N
RAJPUR
RAJPUR BLOCK
RAJPUR CANAL
GUJRARI
ROAD TO DEHRA DUN
GHENA
SRIPUR BLOCK
SEEPNGAL
RINGALGARH
DHOLAGIRI
RINGAL GARH BLOCK
SRIPUR
DARAK
RAIPUR BLOCK
LADPUR BLOCK
KUMALDA
DUBRA
MAHIPUR BLOCK
KUND BLOCK
SIMARA
SONG RIVER
JAINTWARI
LADPUR
ARALGAON
SERA
KUND
RAIPUR
KIDDU WALA
DWARA BLOCK
TUNAWALA
SHOPALPANI BLOCK
SHAMSHER GARH
HARAWALA
DIVISIONAL BOUNDARY
BLOCK BOUNDARY
RIVER & NALA
ROAD METALLED
VILLAGE
SCALE :- 1:20,000

Raipur Range of Mussoorie Forest Division



- Location - 30^0 15/ 30// to 30^0 27/ 20// N latitude
  - 78^0 03/ 40// to 78^0 10/ 20// E longitude
- Altitude - Between 800 and 2000m above m s l

Moist temperate climate with mean max. and min. temperature ranging between 30^0 and 3^0C

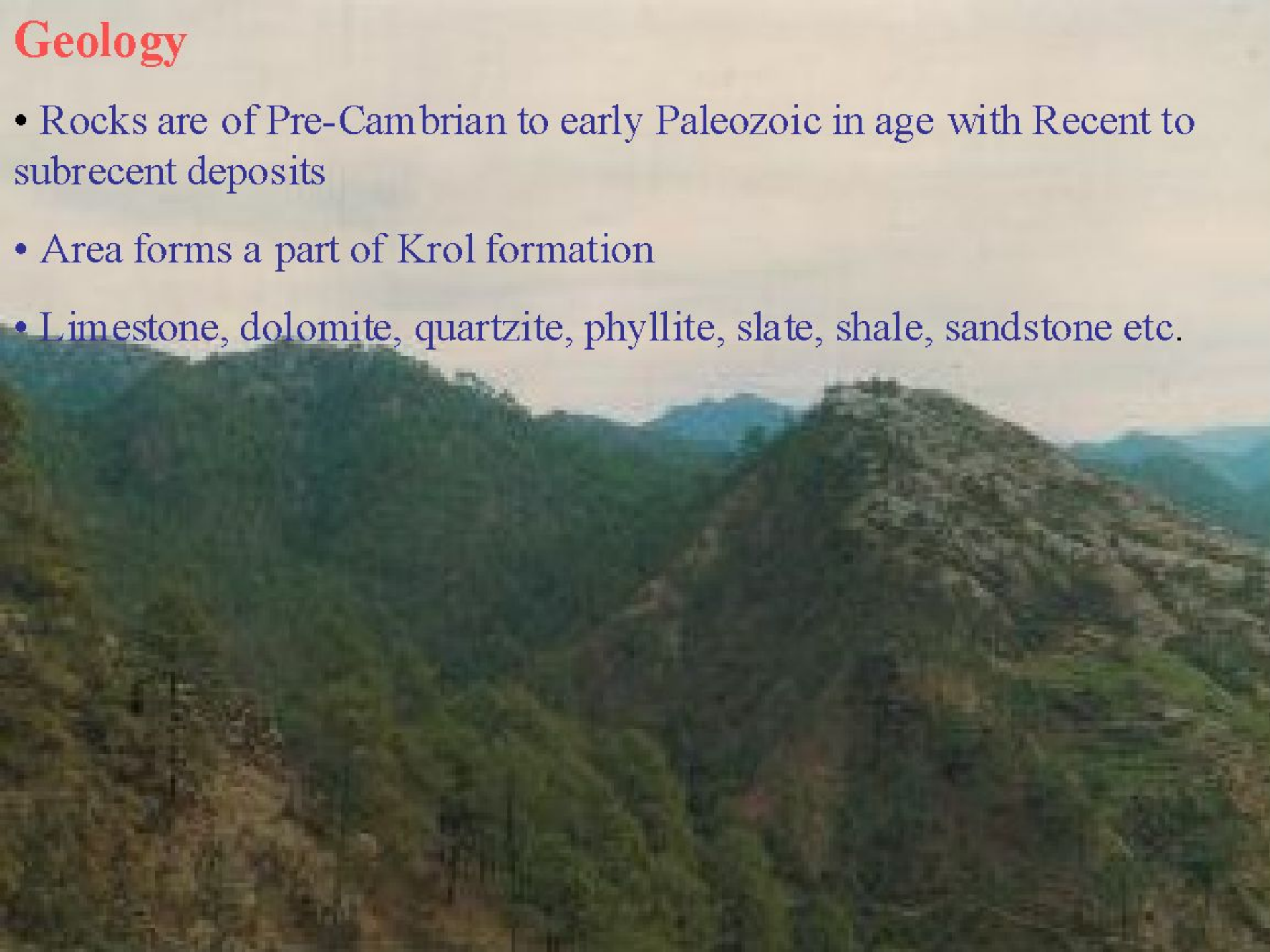
- Mean annual average rainfall is 2500 mm

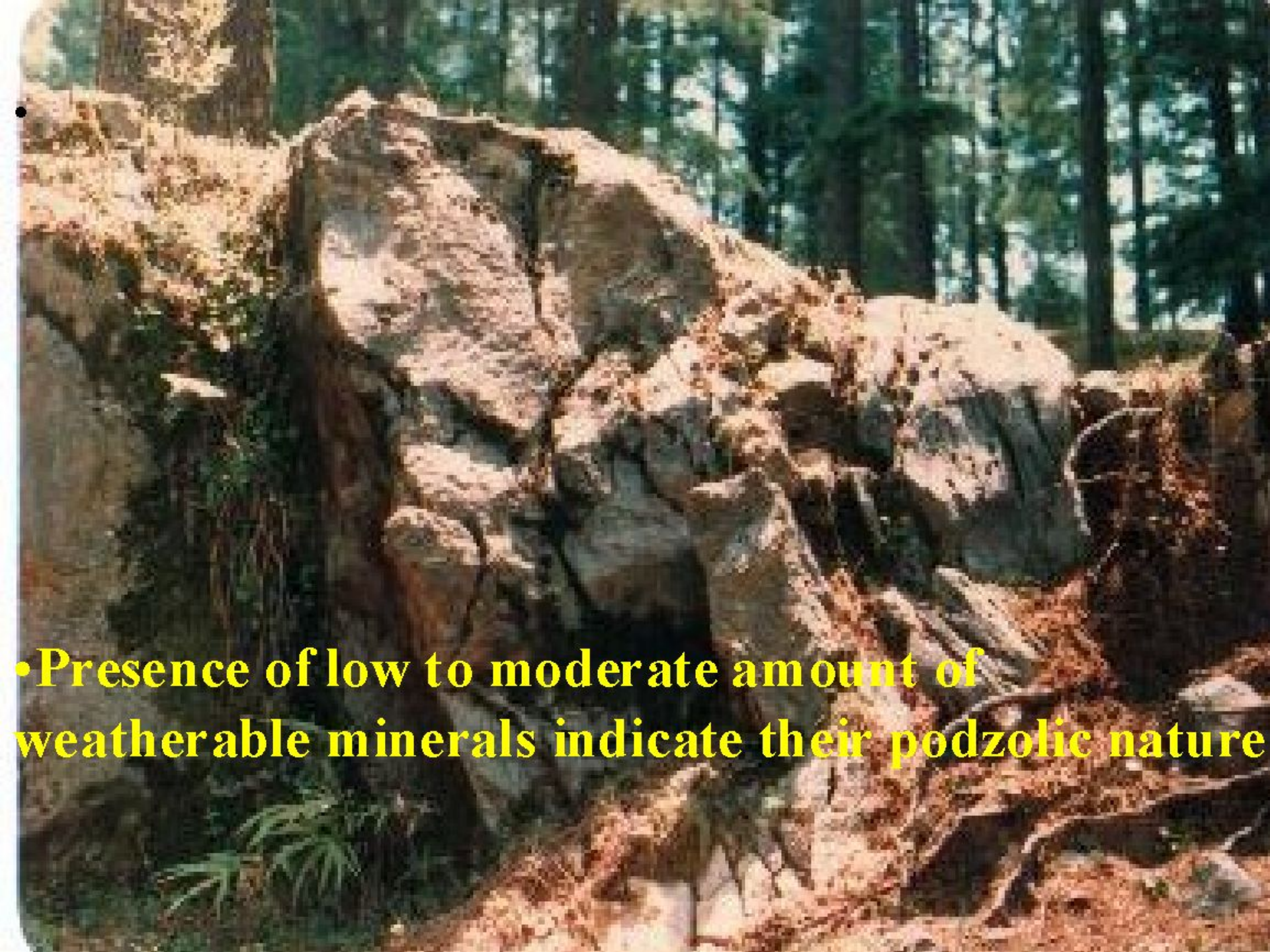
General information about the sites

Profile No.	Location	Altitude	Vegetation	Parent Material
1	Ladpur block	800 m	*Dalbergia sissoo*	Boulders Limestone Quartzite
2	Dwara block	900 m	*Scrub*	Limestone Shales
3	Raipur block	1000 m	*Shorea robusta*	Limestone Boulders
4	Rajpur block	1100 m	*Shorea robusta*	Limestone Boulders
5	Mahipur block	1200 m	*Shorea robusta*	Slate Shales
6	Sripur block	1500 m	*Quercus leucotrichophora*	Phyllite Limestone Quartzite
7	Ringalgarh block	2000 m	*Pinus*	Limestone

Geology

- Rocks are of Pre-Cambrian to early Paleozoic in age with Recent to subrecent deposits
- Area forms a part of Krol formation
- Limestone, dolomite, quartzite, phyllite, slate, shale, sandstone etc.




•Presence of low to moderate amount of
weatherable minerals indicate their podzolic nature


•Mollisols - Dolomitic limestone, limestone, boulders & slate are responsible for *Shorea robusta, Dalbergia sissoo*, scrub
• Inceptisols - Quartzite, phyllite, , shale & limestone are responsible for oak and pine forests

- **Soil organic matter was generally higher under different forest vegetation at higher altitudes than at lower ones**

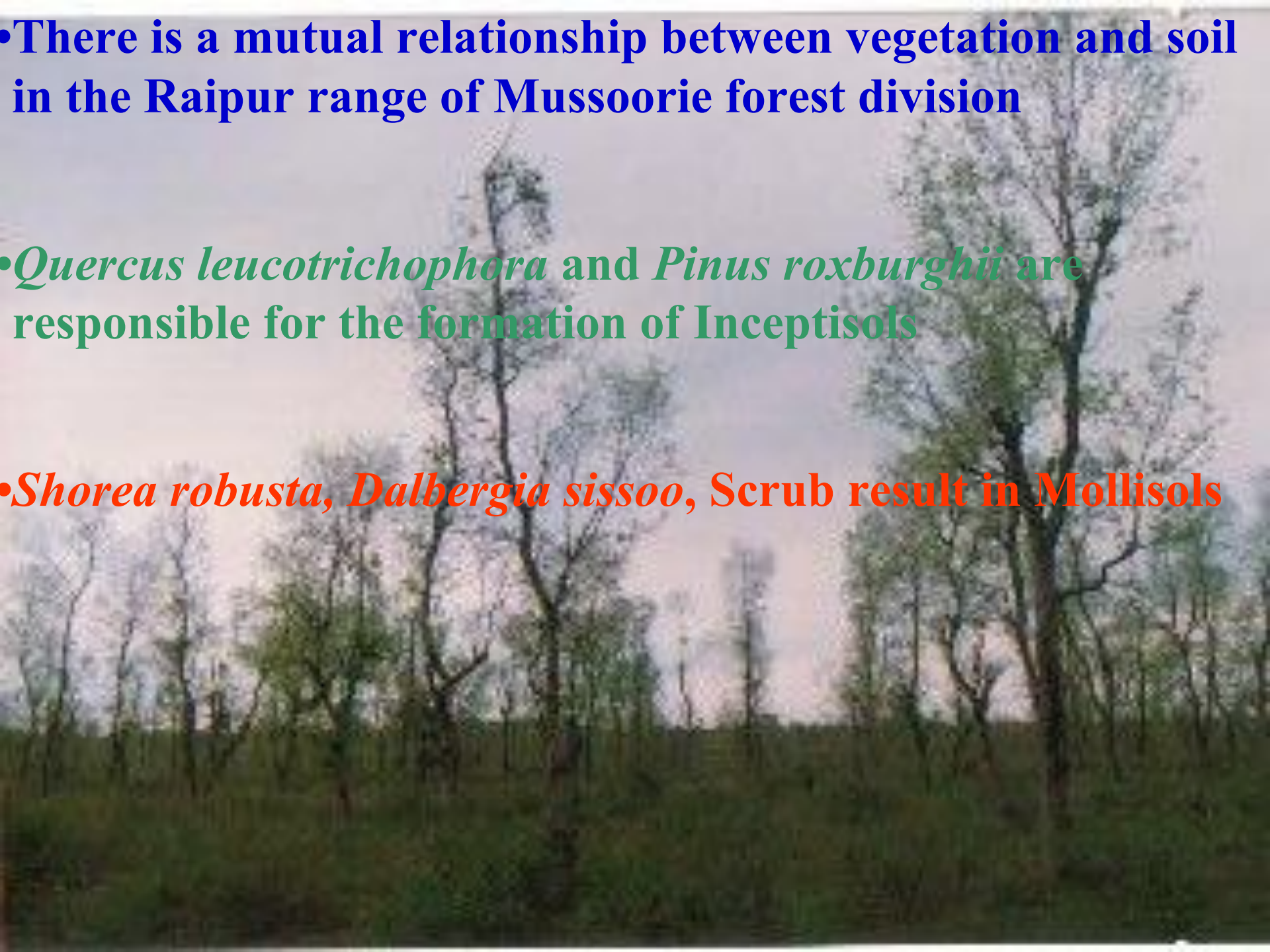
- **Clay illuviation has advanced pedogenesis in Ringalgarh, Sripur and Dwara blocks (Higher altitudes) compared to Ladpur, Raipur, Rajpur and Mahipur Blocks (Lower altitude)**

- **Soils of study area show some relationship with the parent material.**
- **Mollisols occur where dolomitic limestone (at Dwara) or limestone , boulders and slate (at Ladpur, Raipur, and part of Ringalgarh) are present**
- **presence of quartzite (at Mahipur and part of Sripur) and phyllite, shale and limestone (at Satengal, Ringalgarh and Kund) resulted in Inceptisols**

- **High Ca:Mg ratio in upper horizons as compared to lower ones indicate role of vegetation on pedogenesis**

- **Organic matter and base saturation indicate high fertility status**

- **Light minerals - 80% & Heavy minerals - 20% and were resistant to weathering due to high grade of metamorphic origin**

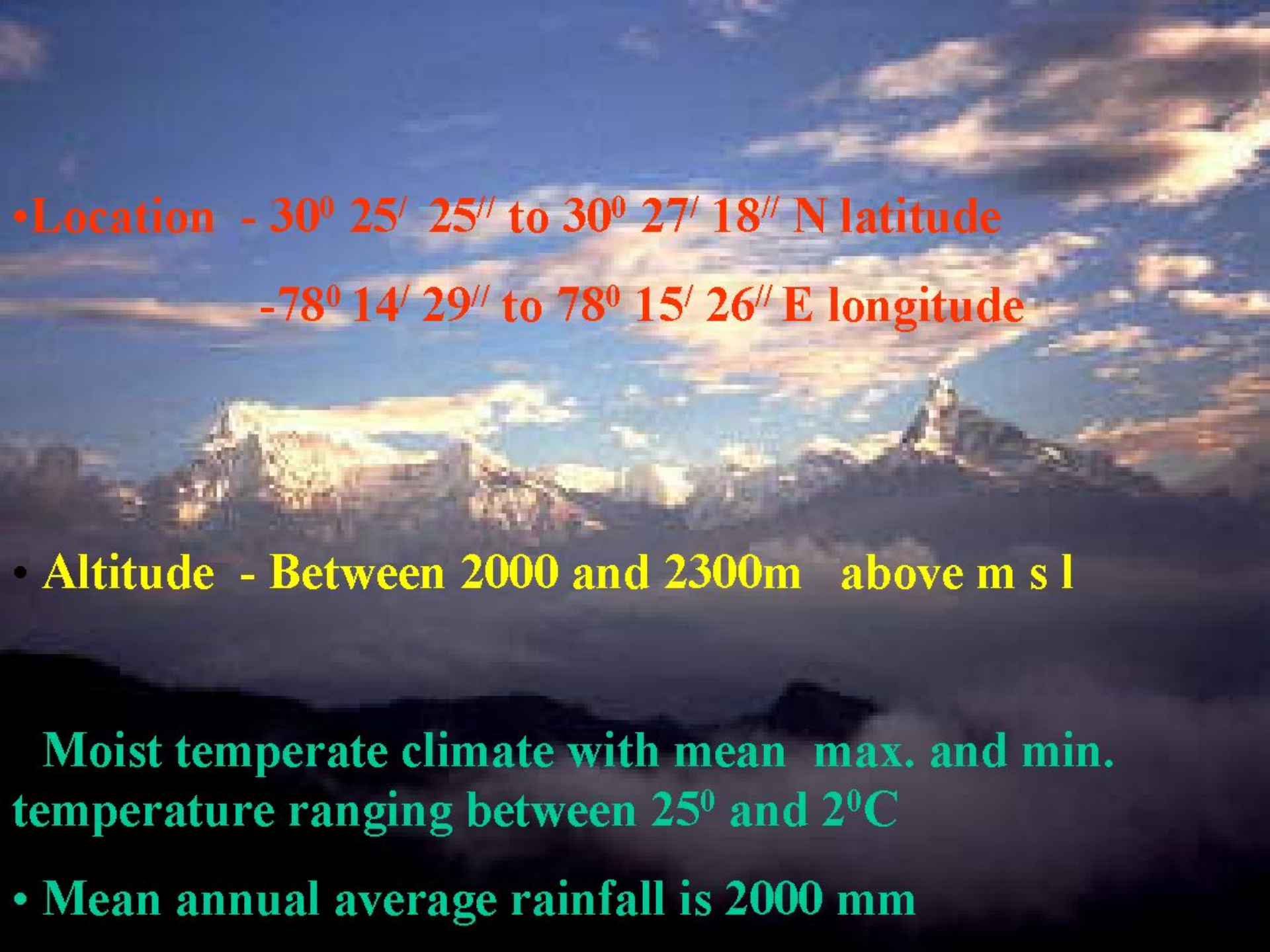


- **There is a mutual relationship between vegetation and soil in the Raipur range of Mussoorie forest division**

- ***Quercus leucotrichophora* and *Pinus roxburghii* are responsible for the formation of Inceptisols**

- ***Shorea robusta, Dalbergia sissoo*, Scrub result in Mollisols**


Jaunpur Range of Mussoorie Forest Division



- Location - 30^0 $25'$ $25''$ to 30^0 $27'$ $18''$ N latitude

  -78^0 $14'$ $29''$ to 78^0 $15'$ $26''$ E longitude

- Altitude - Between 2000 and 2300m above m s l

Moist temperate climate with mean max. and min. temperature ranging between 25^0 and 2^0C

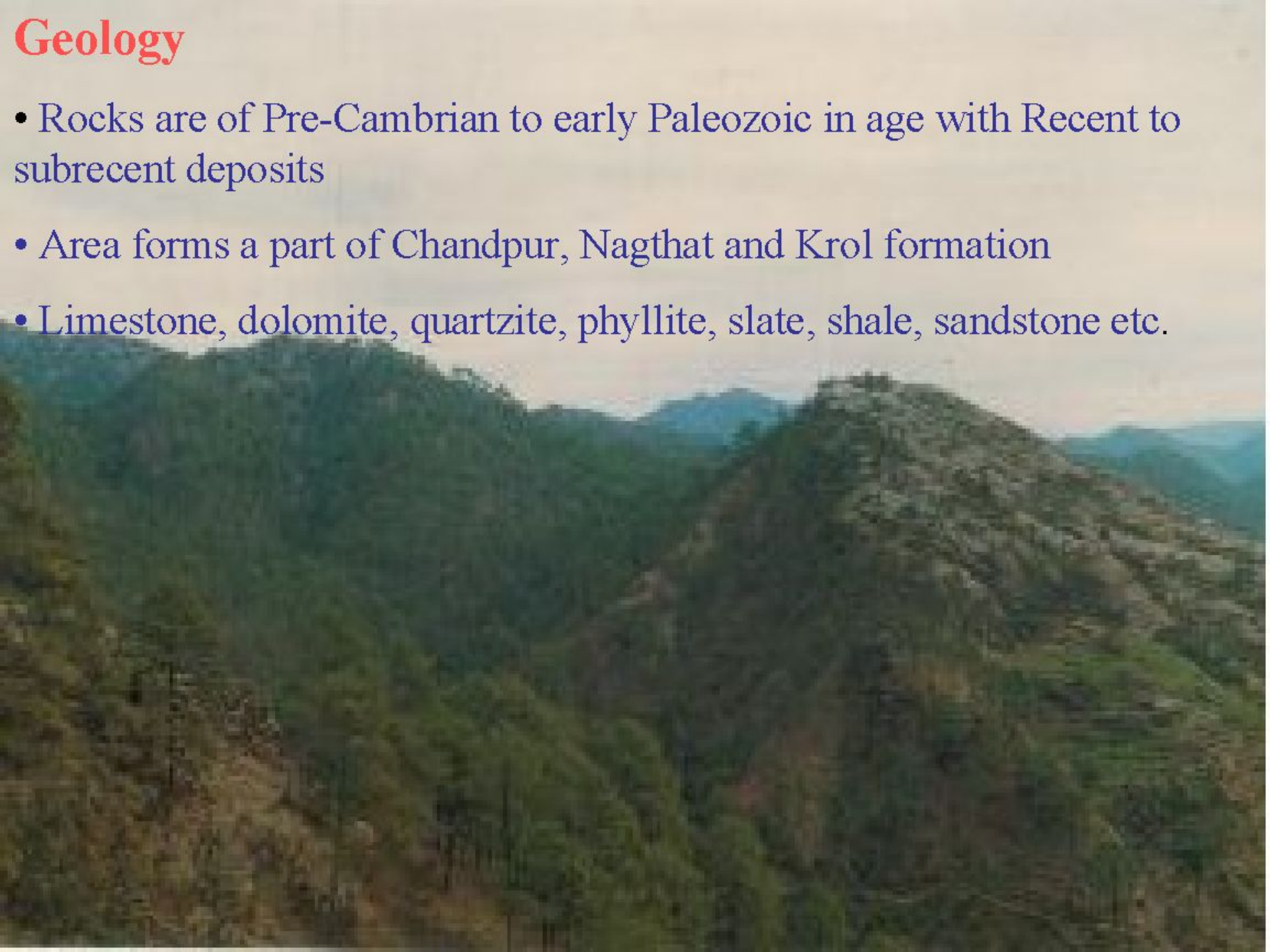
- Mean annual average rainfall is 2000 mm

General information about the sites

Profile No.	Location	Altitude	Vegetation	Parent Material
1	Dhanaulti block	2290 m	*Cedrus deodara*	Limestone Dolomite Quartzite
2	Kund block	2260 m	*Pinus roxburghii*	Limestone Shales Slate Quartzite
3	Than block	2100 m	*Quercus leucotrichophora*	Limestone Quartzite Phyllite Sandstone

Geology

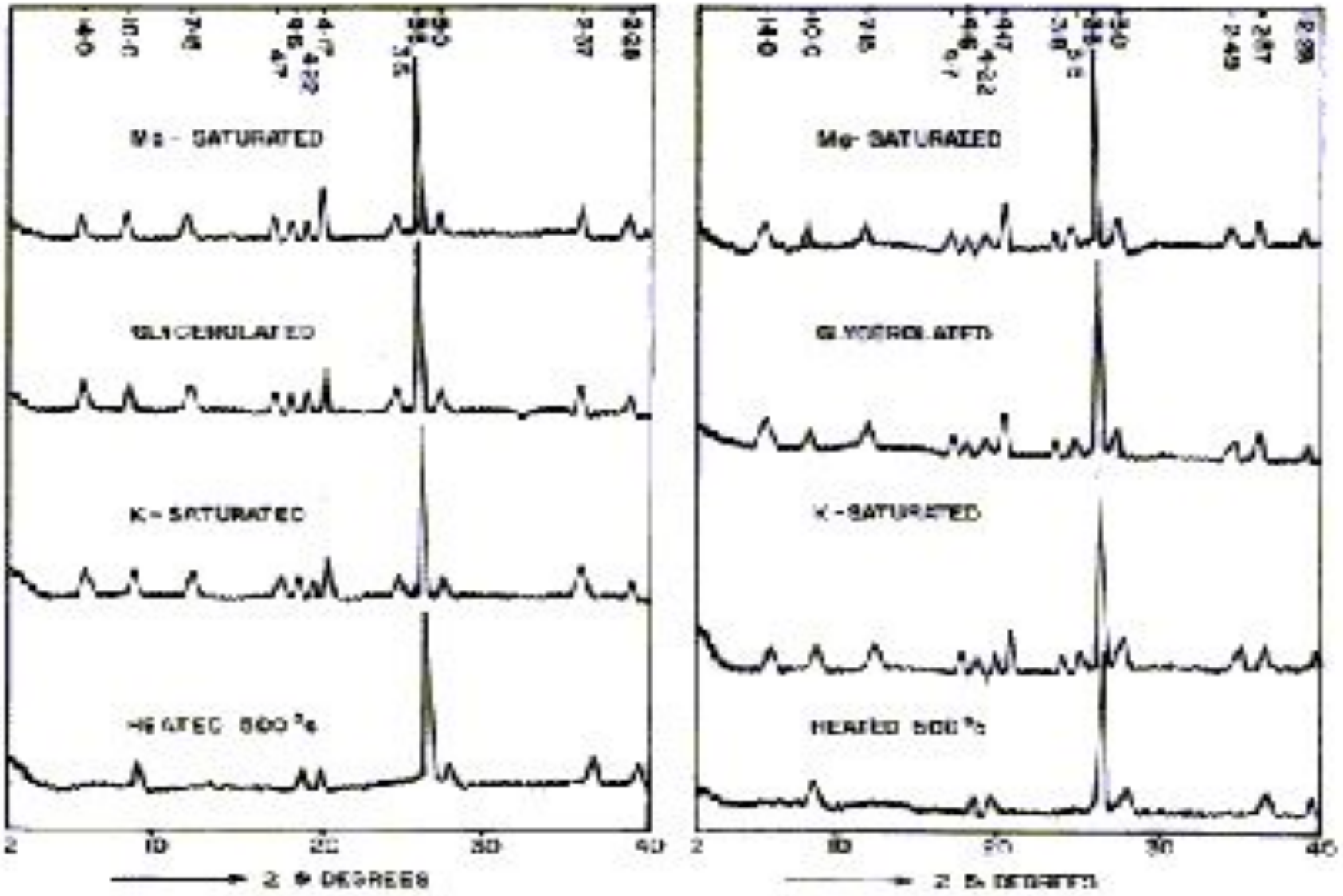
- Rocks are of Pre-Cambrian to early Paleozoic in age with Recent to subrecent deposits
- Area forms a part of Chandpur, Nagthat and Krol formation
- Limestone, dolomite, quartzite, phyllite, slate, shale, sandstone etc.



X - Ray studies

- Illite
- Kaolinite
- Montimorillonite
- Calcite
- Muscovite
- Chlorite

3 X-RAY DIFFRACTION PATTERN OF CLAY FROM DHANAULTI



Sand Mineralogy

Light Minerals

- Quartz dominating minerals contributing 65 to 80%
- Feldspar accounting for 10 - 25 %
- Mica present in variable proportion 8 - 15 %
- Higher proportion of feldspar and mica at bottom and lower proportion at top indicate intense weathering activities
- Relative distribution of feldspar were mostly influenced due to variation in parent material and weathering activity

Heavy Minerals

- Biotite constitutes 10 - 21 %
- Calcite constitutes 14 - 25 % and its contents increased along with the depth
- Opaque minerals (Magnetite, Hematite and Ilemenite) constituted 17 - 27 % and showed increasing trend along with depth, which may be due to pedogenic processes of decomposition, leaching at the surface and enrichment at the bottom horizon

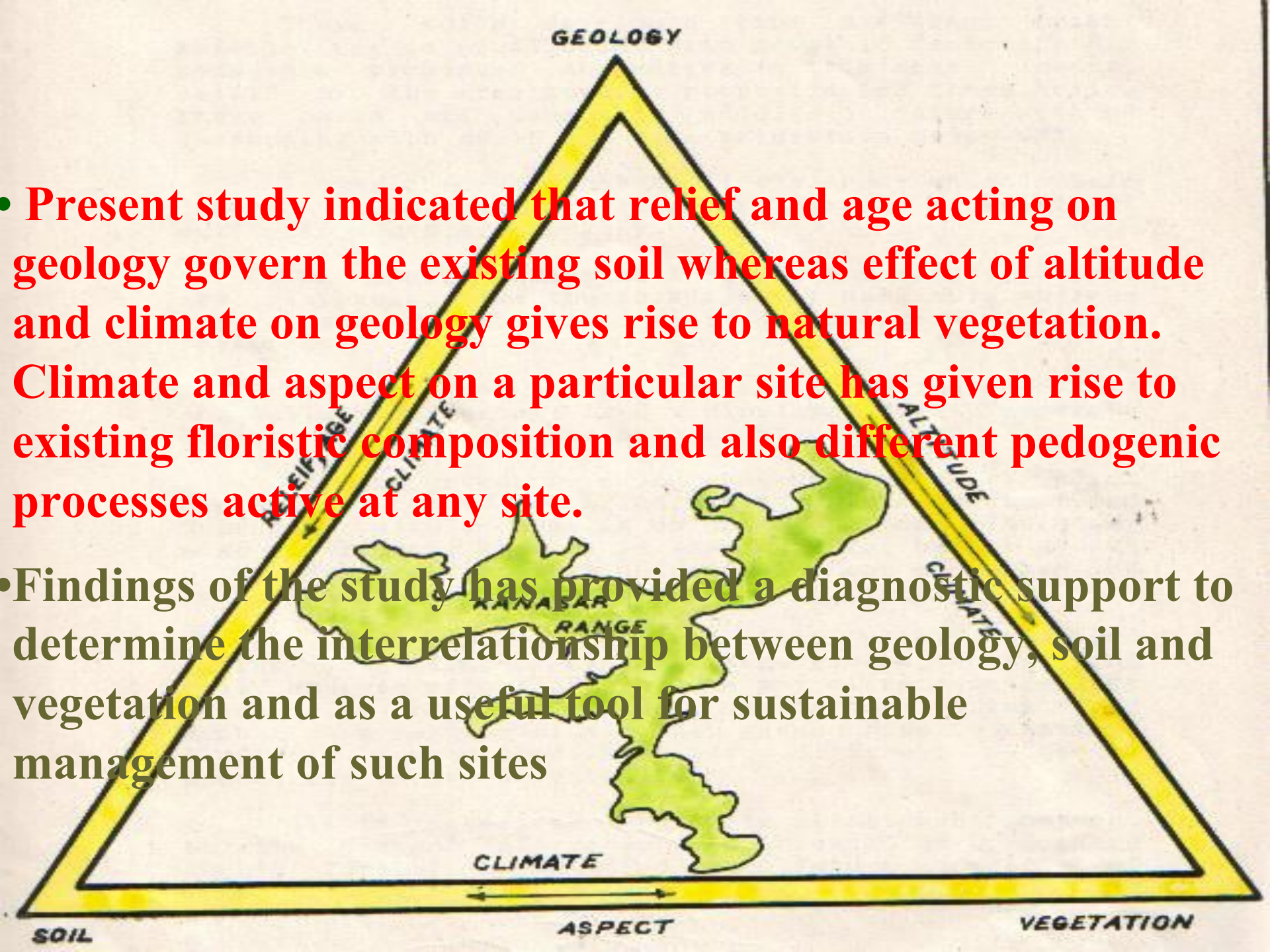
- **Soils of Jaunpur Range of Mussoorie forest division belong to Typic Hapludoll (Dhanaulti block), Typic Argiudoll (Than block), Ruptic-Alfic Eutrochrept (Khatta and Maind block)and Typic Dystrochrept(Kund block). All these polypedons are members of fine loamy, mixed, messic family.These soils developed from different parent materials are in equilibrium with geogenic factors.The soils are generally acidic in nature with pH increasing with depth.**

Soils of study area show some relationship with the parent material. It has been observed that *Cedrus deodara* forests occur in the soils of Mollisols order developed on limestone , dolomite, quartzite and shale (Dhanaulti and Than blocks) whereas presence of phyllite (Kund, Khatta and Maind blocks), slate, sandstone, slates, shale etc. resulted in Inceptisols order.

- **There is a mutual relationship between vegetation and soil in the Jaunpur range of Mussoorie forest division**

- ***Quercus leucotrichophora* and *Pinus roxburghii* are responsible for the formation of Inceptisols**

- ***Cedrus deodara* result in Mollisols**



- **Present study indicated that relief and age acting on geology govern the existing soil whereas effect of altitude and climate on geology gives rise to natural vegetation. Climate and aspect on a particular site has given rise to existing floristic composition and also different pedogenic processes active at any site.**

- **Findings of the study has provided a diagnostic support to determine the interrelationship between geology, soil and vegetation and as a useful tool for sustainable management of such sites**

Flow sheet for the preparation of thin sections.

Prepare profile face

↓

Collect and dry the Sample

↓

Cut block with diamond saw

↓

Clean block

↓

Stick block to glass slide with Canada Balsam

↓

Label

↓

Cut off excess specimen

↓

Grind and polish the specimenth

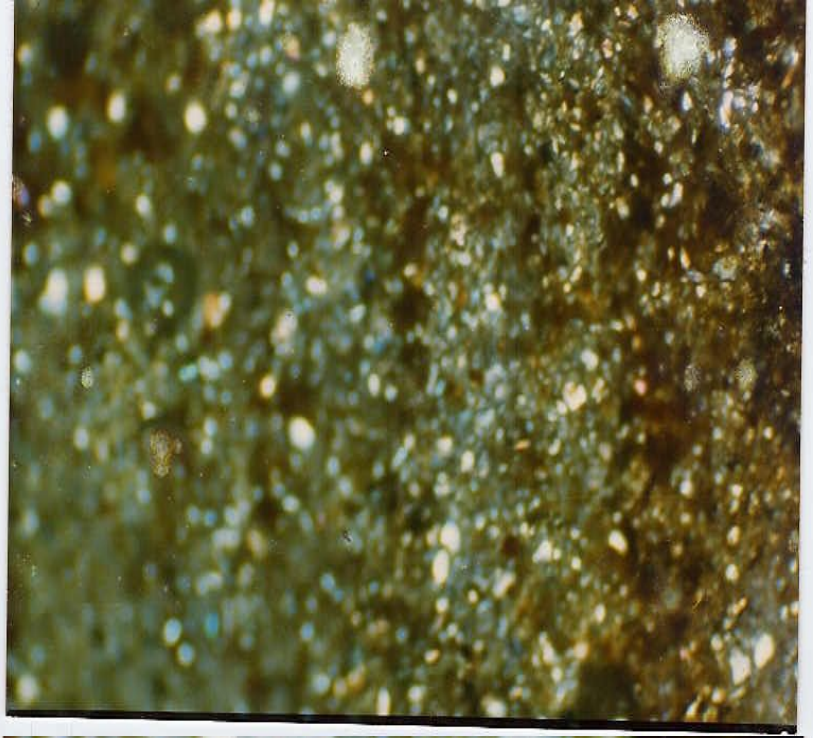
↓

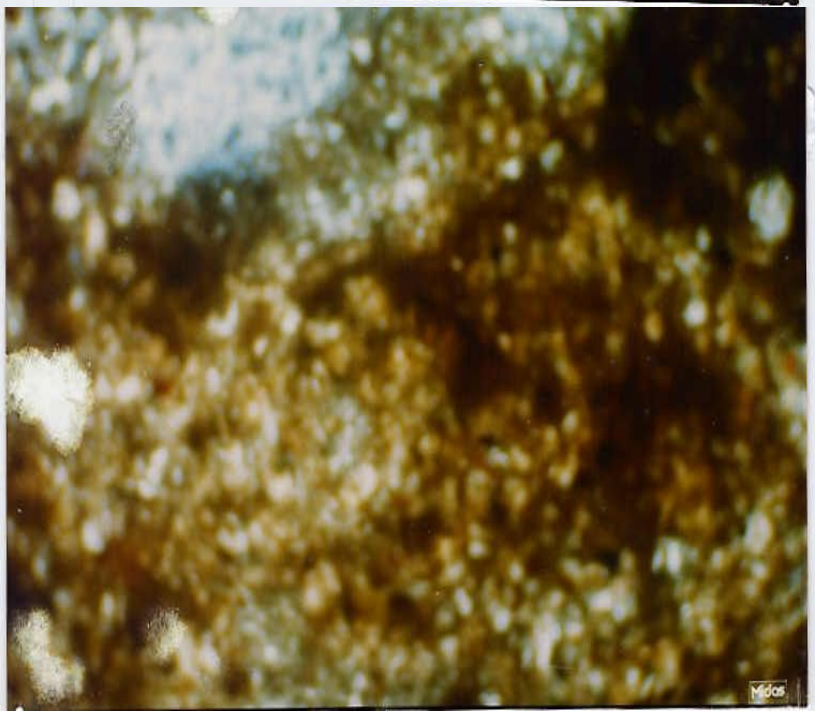
Clean specimen and attach cover glass

↓

Label and catalogue


a
b
d
e
f





- From field, micromorphological and mineralogical observations conducted in sodic soils of Sultanpur(Uttar Pradesh), it has been concluded that sedimentation and pedogenesis have been closely interrelated in the area.

- The dominant process of soil formation in sodic soils are eluviation and illuviation, decomposition, synthesis, weathering, porosity and structure

Clay Mineralogy

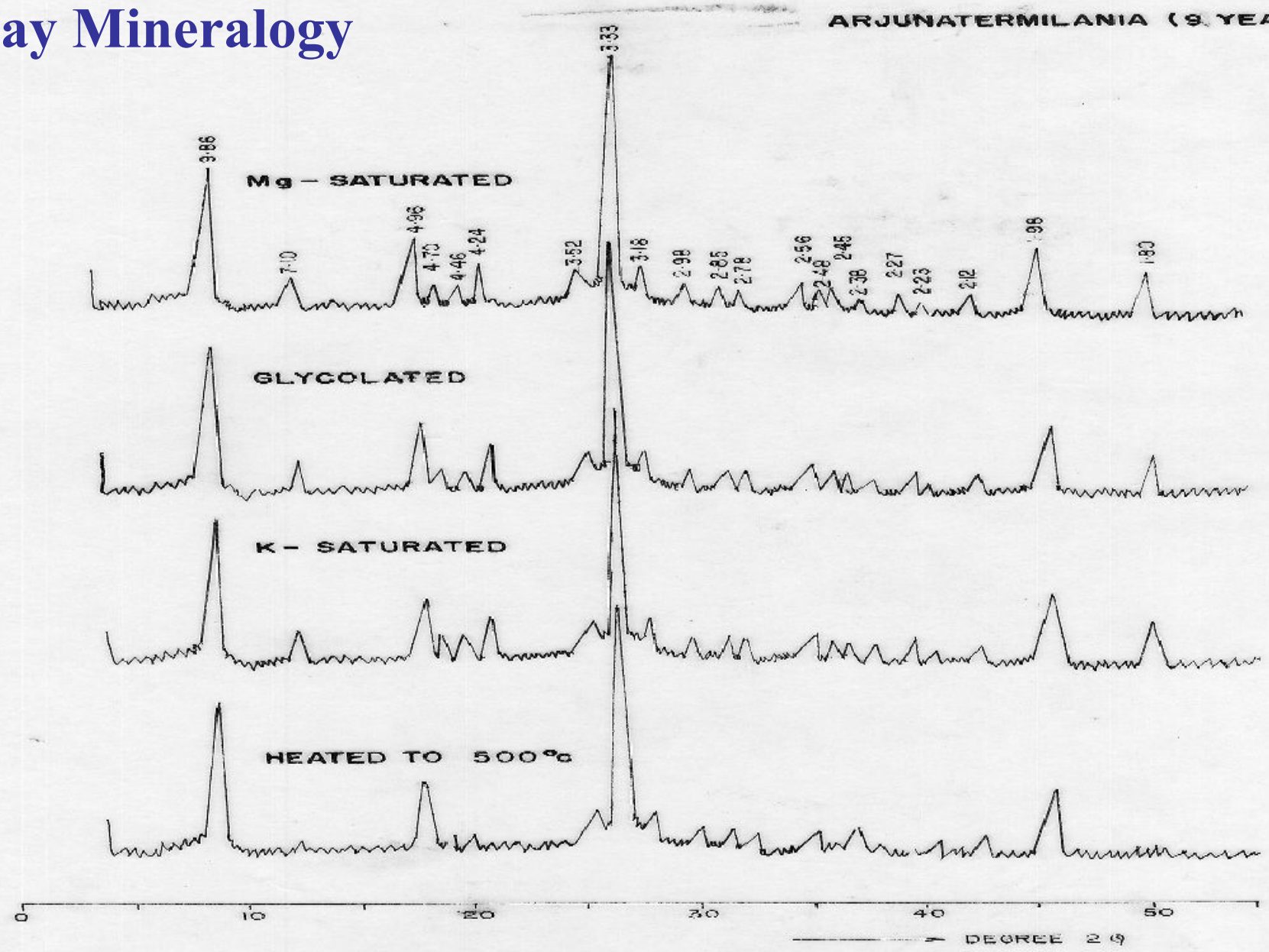
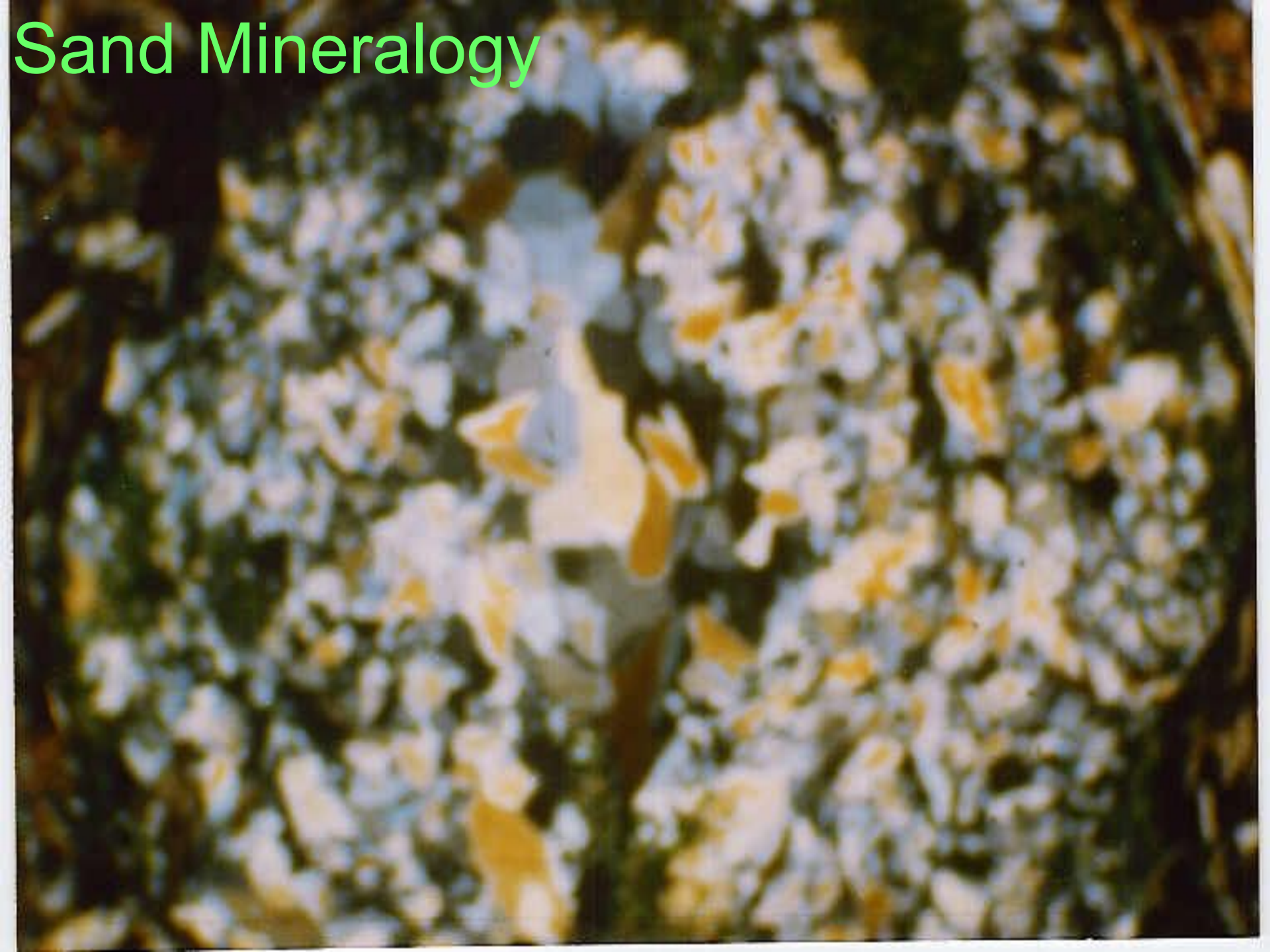
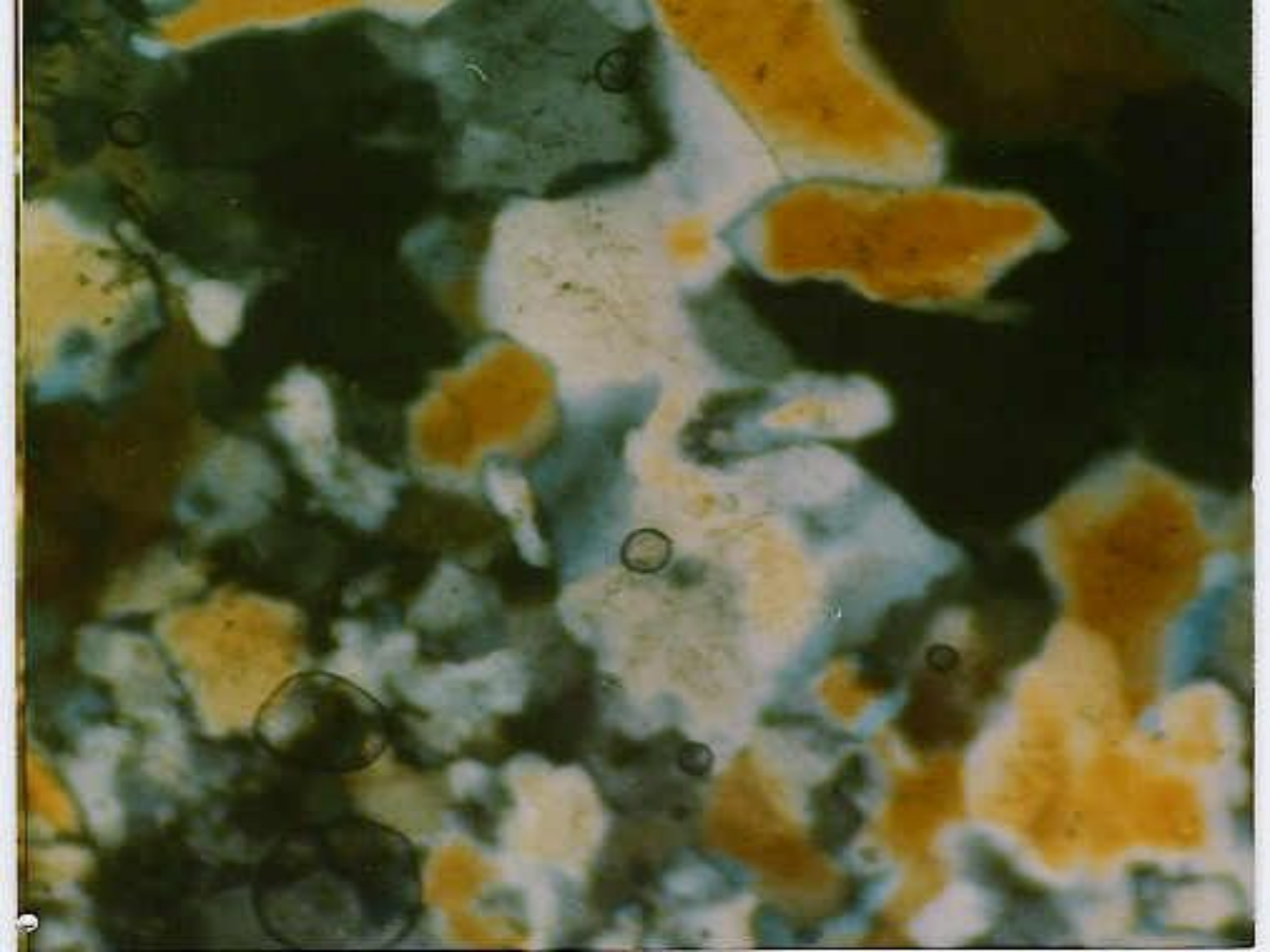


Fig. – 9 X-RAY DIFFRACTROGRAM OF CLAY FRACTIONS OF SODIC SOILS FROM RAMSHAHPUR

Sand Mineralogy





- The arrangement, size, shape and frequency of particles and examination of thin sections of soils revealed mosepic plasmic fabric for these soils

- Due to plantations, the root faunal activity has started the soil porous and channels has also

- Due to ameliorative role of these activities, the calcic pan has started dissolving into soft lime.

Applicability

- The fertility potential depends largely on the mineralogical composition of soils
- Helpful in understanding the ecological status of forest growth and in investigating the various problems like deterioration in growth, quality, loss of vigor, mortality etc. in forest crops often caused by nutrient deficiency and soil factors which are related to mineralogical composition
- Soil is being enriched through nutrient contribution from minerals

- Can assist the managers and landusers in developing a thorough knowledge about the content and nature of minerals present in the soil in diagnosing the fertility status and other soil-plant-parent material related aspects of forestry
- Useful to determine proper nutrient requirement for a particular species for a sustained growth on such sites
- Can assist in determining the site matched species as per mineralogical approach for plantation
- Mineralogical studies should be carried out occurring under different conditions of soil, climate, geology etc. to bring out suitable remedial measures

Suitable Strategies

- Detailed geological, soil and vegetation survey
- Different types of maps should be consulted
- Site matched species as per mineralogical studies should be identified and planted
- Comprehensive study of different geological parameters of the sites should be conducted

- **Group discussions with Researchers, SFDs, and stakeholders should be encouraged**

- **Strong liaison between scientists and SFD's to mitigate the problem should be developed**

- **A visual record of soil mineralogical changes may be maintained in the laboratory for perfecting future management strategies**

- **Mineralogical investigations should be carried out under different conditions of soil, climate, geology etc.**

THANKS