Introduction to Quaternary Geology of Rajasthan

Presentation by

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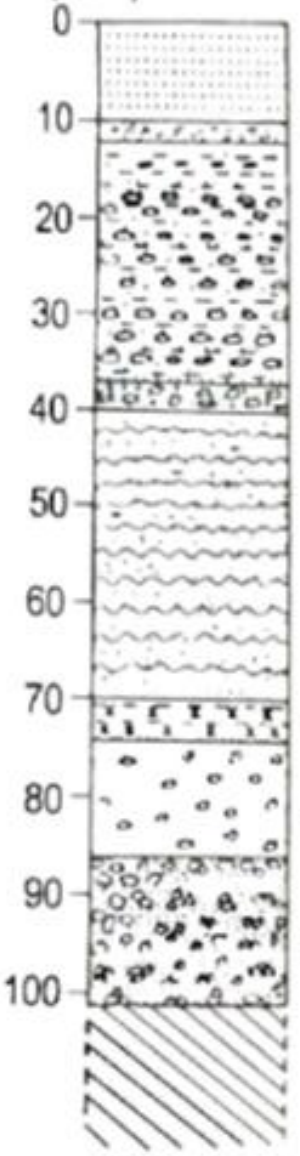
Introduction

- Quaternary formations are represented by fluvial, fluvio-lacustrine and aeolian deposits. Predominantly covers Thar desert of western Rajasthan. Thick sediments also occur in Eastern and SE Rajasthan.
- Cumulative thickness is estimated to be about 300m
- Depositional conditions are diverse because of incomplete succession distribution pattern.
- They are deposited in multiple stages in different sections.
- The oldest Quaternary lithounits is Kantili Basin which is of 1-8m thick in Bikaner basin.
- Laminated Gypsum beds of economic importance occurs in Jamsar area near Bikaner

Period	Climatic condition	Geological features
Late Holocene	Semi-arid phase (R)	Possible moderate to severe drought conditions. Slight variation in annual precipitation during the last 1000 years with change in atmosphere circulation pattern. Pattern of dune formation and mobilisation of sands remained unchanged.
Middle Holocene	Arid phase (H2)	Formation of new dunes on uplands through recycling of older aeolian and fluvial sands. Disappearance of Mesophytic species at Sambhar and decline of Indus valley civilisation in the northwestern regions.
Early Holocene	Humid phase (H1)	Significant increase in annual precipitation with increased monsoon activity. Flooding playa lakes. Stabilisation of Pleistocene dunes by growth of vegetation. Evidence of pre-Harappan culture (Mesolithic tools).
Upper Pleistocene (~ 40 Ka)	Arid phase (P4)	Major arid phase with large-scale dune build-up with recycled fluvial sands aided by strong southwesterly winds.
Middle-Upper Pleistocene	Humid phase (P3)	Climatic amelioration with increased precipitation, reactivation of moribund channels and flooding of playa lakes.
Middle Pleistocene	Arid phase (P2)	Decrease in precipitation and increasing evaporation, disorganisation of fluvial channels. Formation of calcrete in less arid and gypsum in more arid tracts. Formation of parabolic dunes in dried river beds.
Early Pleistocene	Humid phase (P1)	Thick deposits of continental sediments. Formation of saline lakes at fault controlled depressions.



LITHOSTRATIGRAPHY	MAJOR PROCESS	PROBABLE CLIMATE
Non-calcareous, loose fine sand admixed alluvium / colluvium	Aeolian/seasonal fluvial	ARID
Calcareous sand and silt, weakly developed Kankar pan	Fluvial	SEMI-ARID
Calcareous / non-calcareous fine sand with Kankar, Cross bedding and bioturbation structures	Aeolian	ARID
Coarse sand and other sheet flow and run off deposits, Kankar pans calcareous/ non-calcareous fine sand and silt, rolled Kankar clasts	Fluvial / Fluvio lacustrine	SEMI-ARID
Calcareous sand-well sorted, massive with lumpy indurated calcrete	Aeolian	ARID
Marly clays, calcareous sand and silt	Fluvial/ lacustrine	SEMI-ARID
Well sorted consolidated calc-cemented sands, impersistent calcareous concretions, coarse subangular fluvial sands	Aeolian - Fluvio-lacustrine	ARID
Calcretized gritty conglomerate, coarse sand with lateral and vertical variation to mottled finer sand and clays	Fluvial	SEMI-ARID
UNCONFORMITY		
Malani rhyolite and Jodhpur sandstone		

Ghaggar Basin & Jaisalmer area

- Following succession from Ghaggar Basin:
- 3. Youngest active dunes
- 2. Semi-stable pedogenised dunes
- 1. Consolidated aeolian deposits
- Jaisalmer area:
- 4. Blown sands and Sand sheets
- 3. Kankar, Gypsite and older fluvial deposits
- 2. Glacial pebble spread
- 1. Ironstone, Pseudo conglomerate and Silt stone (Shumar Formation)

Kuchaman Lake

- Following succession in Kuchaman Lake
- 5. Grit and Colluvium
- 4. Intercalated Silt sequence with grit
- 3. Hard lithified carbonate
- 2. Pebble and sand
- 1. Colluvium with calcareous cement

Didwana area of Nagaur district

- Oldest- Didwana Formation- Clay, Silt and Sand- fluvio-lacustrine and aeolian
- Middle- Amarpura Formation- Clay silt, fine sands and carbonates, fluvio-lacustrine
- Youngest- Jayal Formation- Boulders, Cobbles and pebbles (fluvial), locally ferricretised and calcretised
- A late Neogene age or early Quaternary age of Jayal Formation is assigned by Tiwari (1995).

Luni Basin

- Type III- Pebbly grit very coarse sands and well sorted medium fine sands showing evidence of human culture
- Type II- Cross-bedded, coarsely pebbly sandstone overlain by sand and calcrete gravel sheets
- Type I – Alternations of conglomerate, pebbly sandstone and sandstone interbedded with mudstones, slackwater deposits with incipient pedogenesis in weakly developed flood plains

Calcretes

- Common features of arid zones, extensive outcrops
- Near surface formations of Pliestocene aggraded alluvial and pediment plains
- Process of calcretisation is an integral part of aggradation of aeolian planes
- An arid to semi arid moisture regime
- Factor responsible for calcrete formation- 1. Large rabge in the degree of development and morphological appearance. 2 Antiquity of Landforms. 3Local physical setting of landforms

Types of Calcretes

- 1. Calcified Soils- Youngest form, deposited in shallow depressions, aeolian of fluvial, hard and dry, lime upto 10-35%
- 2. Soft nodule calcrete- Randomly distributed soft nodules with calcrete matrix, irregular shaped, 2-3cm in size, porous, recent accumulative inter-dunes, nodules comprise 25% of total material
- 3. Hard Nodule Calcrete- Most dominant type, randomly distributed in sandy matrix, 10-80% of total mass, 0.5cm to 2.5 cm size, Lime content is 70-85% and rest are detrital material
- 4. Honeycomb calcrete- Hard nodules, strongly cemented, isolated occurrences in Pokhran, Phalodi and Phalsund area
- 5. Hardpan and boulder calcrete- 30-70 cm thick crust, ultimate stage of calcrete formation, made up of honeycomb and nodular calcrete with fractured brecciated material, closely spaced gives boulder shape
- Age is Middle Palaeolithic to Acheulian

Soils

- Oldest soil types early-Quaternary in age.
- Geomorphologic parameters for soil formation include relief and topography, nature of slope and influence of drainage pattern. Other constraints are rainfall, nature of runoff and groundwater condition.
- Rajasthan is predominantly arid except eastern and southern parts so the aeolian soils are dominating formed by physical processes.
- Soil forming processes remain subdued in the AMB because of steep slopes whereas alluvial processes played role in Eastern Plains
- Plateau regions of southeast Rajasthan have good preservation of soils leading to development of red lateritic soils

Types of soils in Rajasthan

- 1 Sand dunes and associated soils: Western Rajasthan with varying height and nature of sand dunes. Matured sand with 75-85% fine sands, 10-18% medium sands and about 1-2.5% silt and 2-3% clay; low water retention capacity
- 2. Desert soils: In interdunal areas having rocky pavement covering large areas in Bagar, Jaisalmer, Sikar, Bikaner, Nagaur, Jhunjhunu, Churu; Pale brown to deep brown colour, single grained and well drained, sandy-loamy texture Along Rann it is salty e.g. Pachpadra
- 3. Mixed Soils: Covers a wide region of Pali, Nagaur, Ajmer, Jaipur and Dausa, fine blown sands of yellowish brown colour, sandy loamy to clay loamy, Also called Seirozems, Concretions also found in depth

Types of soils contd.

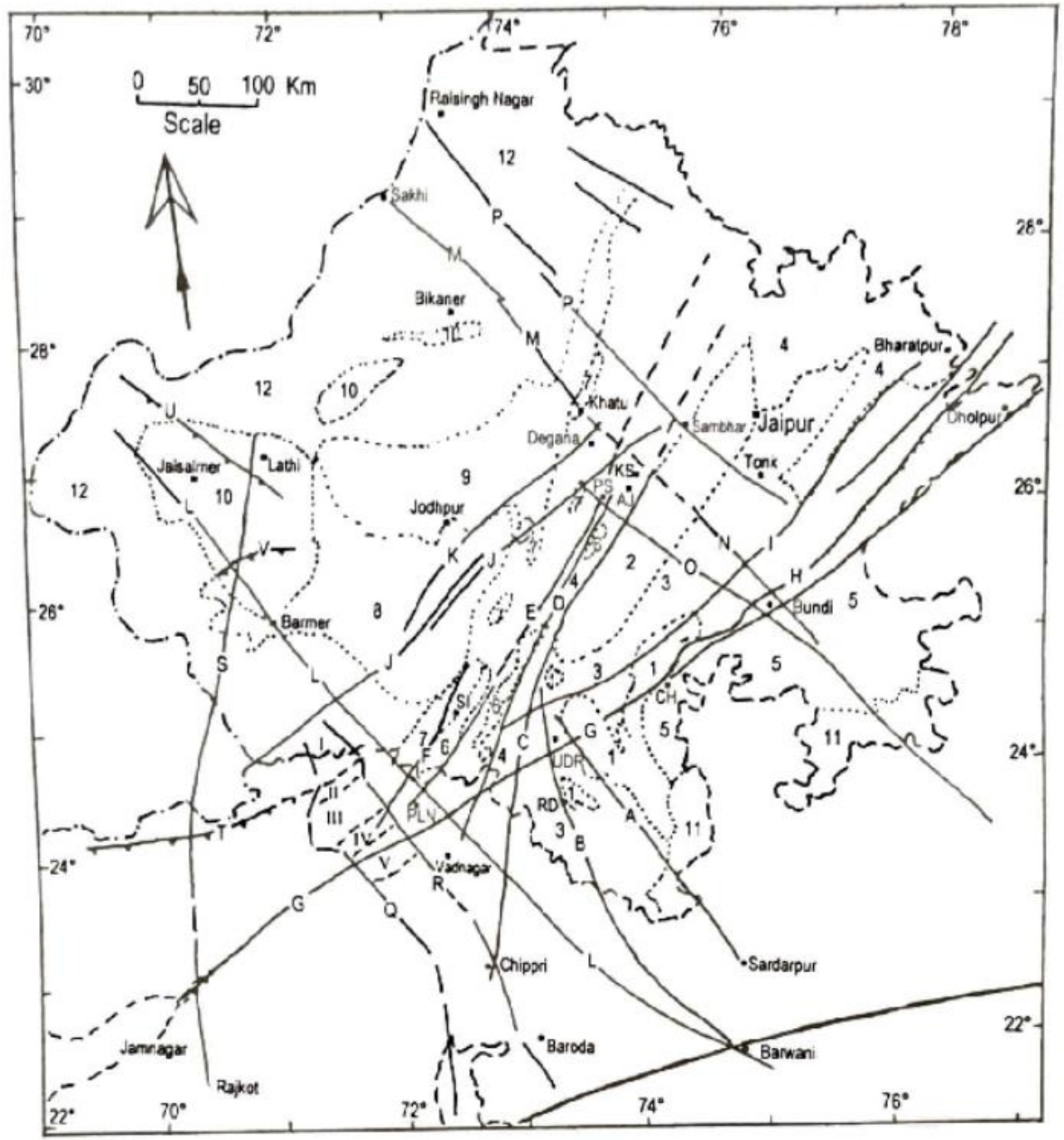
- 4. Hill Soils: Valley regions of AMB and on top of Hadauti Plateau, shows wide variation in composition and colour depending upon bed rock lithology. Eastern hill soils are loamy while western hill soils are sandy and silty. Soils get removed by erosion frequently
- 5. Alluvial Soils: Covers large parts of NW, E and SE plains of Rajasthan, transported by rivers. Confined to river basins like Chambal, Mahi, Ghaggar and Parvati. Black basaltic soils are common in eastern and SE Rajasthan. It is more clayey & high water retention
- 6. Red loams: South districts of Dungarpur and Banswara, residual lateritic soil in regions of high rainfall, red colour alkaline soils, high depth of soils, gravel-strewn or sandy in nature.

Quaternary Palaeoclimate

- Climatic conditions fluctuated several times during Quaternary in Rajasthan. Two major dry phases and four wet phases. Three minor wet phases are also recorded.
- Pre-Holocene aridity was severest during 3.8 and 3.5 Ka.
- Palaeoclimatic conditions have largely influenced the evolution of Quaternary landforms.
- Distinct climate phases have been recognized by various workers

Lineament pattern

- Most important tectonic elements to understand neotectonic movements in Rajasthan as they are the surface expressions of the reactivated faults formed at different times.
- Number of lineaments of several km lengths are found in Rajasthan which continue into neighbouring states also.
- Large scale lineaments are rectilinear with varying curvilinear features transecting rocks of diverse ages.
- Large scale lineaments show three broad azimuth distributions: ENE-WSW, NW-SE and N-S


70°
72°
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78°
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Scale
Raisingh Nagar
Sakhi
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Degana
Sambhar
Jaipur
Bharatpur
Dholpur
Tonk
Jaisalmer
Lathi
Jodhpur
Barmer
Bundi
Vadnagar
Chippri
Sardarpur
Jamnagar
Rajkot
Baroda
Barwani

Lineaments that follow the Precambrian structural Grains

- 1. Udaipur-Sardarpur Lineament: NW-SE trend from Udaipur to Saradarpur in M.P., evolved as basin margin fault and acted as channels for lava flows that floored the Palaeoproterozoic Aravalli Rift basin.
- 2. Rishabdev-Barwani Lineament: Broad curvilinear pattern, extends for 350km from south of Udaipur to Barwani in M.P. Separates shallow water facies and deep water facies of the Palaeoproterozoic Aravalli Supergroup. It has occurrences of serpentinite along way.
- 3. Kishangarh-Chipri Lineament: NNE-SSW trending lineament is a major tectonic boundary between the Delhi Supergroup rocks and the pre-Delhi rocks in east. Chipri is close to Ahemdabad and Kishangarh is north of Ajmer with the outcrops of nepheline syenite

- 4. Palanpur-Ranakpur-Phulad-Pisanganj Lineament: It is almost a geomorphotectonic line constraining the western limit of the Delhi fold belt. It is rift shoulder of Main Delhi Basin, south of Ajmer. In south it coincides with Kui-Chitraseni Fault represented by diapiric bodies of gabbro and norite. Traceable in broken lines up to Jhunjhun
- 5. Pisanganj-Vadanagar Lineament and Sadri-Palanpur Lineament- Sub-parallel lineaments constraining the Mount Ab-Plateau bounding the Delhi Fold Belt
- 6. Sirohi Lineament- West of Mount-Abu, marking the western boundary of Aravalli Mountain Belt. Also marks the undeformed platformal sequence called the Marwar Supergroup.

Lineaments that Cross-cut the Precambrian Grains

- Azimuth orientation have two distinct pairs having trends $N35^0W$-$S35^0E$ and $N65^0E$-$S65^0E$ and the other pair is N-S and E-W.
- Rajkot-Lathi Lineament is the only N-S trending lineament passing through Rajasthan.
- NE-SW trending important lineaments are- 1. Chambal-Jamnagar Lineament, 2. Chittaurgarh-Machlipur Lineament, 3. Mount-Abu-Bharatpur Lineament, 4. Luni-Sukri Lineament, 5. Mokalsar-Degana Lineament.
- NW-SE trending important Lineaments are- 1. West Margin Cambay basin Fault, 2. East margin Cambay Basin Fault, 3. Jaisalmer-Barwani Lineament, 4. Bundi-Khatu-Sakhi Lineament, 5. Ajmer Sadia Lineament