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III B.Sc., GEOLOGY-General Stratigraphy

ARCHAEAN SUCESSION OF INDIA [TYPE AREA KARNATAKA]

Introduction:

The term Archaean was introduced by J.D Dana (1872) for the ancient rock succession of Canadian Shield. Later this succession was divided into two units. The lower and the older unit made up of highly deformed and metamorphosed rocks referred to as Archaean group. The upper unit consisting of less deformed and less metamorphosed rock succession was named as the "Proterozoic Group".

Archaean are the oldest known rocks on the earth's surface dating back to about 3600 my before present. These rocks are totally "azoic", meaning unfossiliferous. They are highly folded and faulted due to multiple episodes of structural events. They are also intruded by numerous plutonic igneous bodies. All these above cited events have rendered these rocks extremely complex. For this reason the Archaean are called "Basement Complexes or Fundamental Complexes".

Distribution of Archaean in India:

The various units of Archaean rocks form an enormous extent of the surface of India. They cover nearly two thirds of the peninsular India. They are very well developed in south India, Aravalli hill ranges of Rajasthan, Bundelkhand region of Madhya Pradesh, Singhbhum area of Bihar and Orissa and also along the Eastern Ghats. In the extra-Peninsular India, the Archaean rocks occur along the whole length of the Himalayan Mountain forming the bulk of the high ranges. This portion of the Himalayas is known as "Central Himalayan axis" and runs as a broad central zone from Kashmir to Assam.

Petrololgy of archeans

In the all the localities of occurrence of Archean rocks of India, the most common rock is gneiss. This characteristically shows constant banded and foliated structure that is gniessosity. The mineral composition varies from granitic to gabbroic. The next abundant rock in archean is schistose. Mica schists are most common and other varieties hornblende, talc, chlorite, epidote, silliminite and graphite. In addition to these most common rocks, the archeans also contain bands layers and lenses of slates, phyllites, granulites, marbles, dolomites, and banded ferruginous quartzites etc. The archean rock generally show all variations from low grade regional metamorphism to high grade plutonic metamorphism.

Classification

Number of workers have studied these Archaean rocks of Karnataka and have suggested different schemes of classification and succession. Views drastically differ regarding their origin and hence order of superposition of these rocks. Earlier workers regarded the entire succession as of igneous origin. Later these views were modified in the course of time and at least some members of this succession were assigned a sedimentary origin. Following are the few attempts of classification of Archaean of Karnataka.

Schmith classification:

In his opinion the schists and gniesess have been produced due to the metamorphism of preexisting igneous country rocks. Schimith classified the dharwar system on the basis of degree of metamorphism. He has divided the dharwar system into lower hornblendic division and the upper chloritic division.

B. Rama Rao classification:

After a careful and detailed field work B Rama Rao concluded that the dharwarian schists were originally sedimentary rocks. His field observations included remnants of current beddin, ripple marks, graded bedding and similar sedimentary structures partially obliterated by the process of metamorphism and diastrophism. The interbedded lava flows suggest the volcanic eruption in submarine conditions. On the basis of conglomerate horizons he devided the dharwarian succession into three divisions.

Succession of Archaean by B. Rama Rao is as follows:

----------Eparchaean Interval----------

Felsite porphyry dykes

	Closepet Granite
	Charnokite
Archean	Peninsular Gniesses
	Champion Gniesses
	Upper Dharwars
Dharwarsystem	Middile Dharwars
	Lower dharwars

----------Basement not known----------

Classification by Radhakrishnan and Vasudev:

This is more recent and accepted classification because it is based on radio metric age data of various units and also on degree of metamorphism. In this classification distinction is made

Radiometric age	Stratigraphic Units		General Characters
2100M.Y.	Felsite and porphyry dykes		
2380M.Y.	Closepet Granite		
	Dharwar Super Group (Younger Greenstones belt) Sedimentary – Volcanic succession	Rannibennur Group **?**	Least metamorphosed and gentle deformation
		Chitadurga Group	Greenschist facies of metamorphism and gentle to strong deformation
		Bababudan Group	Greenschist to lower amphibolites facies of metamorphism
---------- Unconformity ----------			
More than 2600 M.Y.	Peninsular Gneissic Complex (fundamental gneiss)		Migmatitic and amphibolites facies of metamorphism
More than 3200 M.Y.	Sargur Schist Belt (Older Greenstone belt)	Higher degree of metamorphism than Darwars	Upper amphibolite to granulite facies of metamorphism
More than 3500 M.Y.	Gorur Gneiss	?	
---------- Basement not known ----------			

between older schistose rocks and younger schistose rocks. Dharwar Supergroup is considered as metamorphosed sediments that were deposited in basins formed over the basement of peninsular gneiss and also of older schistose rocks. Both older and younger schistose rocks are renamed as Greenstones.

Succession of Archaean according to Radhakrishnan and Vasudev is as follows:

Lithology:

Lithology of various units of Archaean of Karnataka is as follows

Sargur schist Belt or Lower Greenstones:

The oldest rocks dated so far in Karnataka area are **grey gneisses and included schists.** "Sargur Schist Belts". These are regarded as metamorphosed remnants of granulitic rocks with Kyanite, Sillimanite, Graphite and other minerals suggestive of intense thermal metamorphism. These together are forming the basement for a well developed group of schistose rocks of younger age i.e. 'Dharwar Schist Belt".

Older Gneissic Complex:

Large part of Karnataka and the Indian peninsula in general are covered by **granites and gneisses of differing ages.** A variety of age determination values **ranging from 3400 to 2000my have been obtained for these rocks of gneissic complex.** These gneisses have been described in earlier literature as ***"Peninsular Gneisses.***

Dharwars or Younger Schist Belt:

In recent literature these formations are described as "Younger Greenstones". These are prominent schistose rocks of Karnataka and have been given a Super group status.

Two main divisions are recognized in this Super group. The older of the two is mainly igneous in character and is named as "Bababudan Group" and hosts the main Iron Ore Formation. These rocks are comparatively more metamorphosed than the upper formations. The group above the Bababudan Group is called the "Chitradurga Group". This is the more extensive group of schistose rocks largely sedimentary in character composed of conglomerates, quartzites, limestones, greywackes and associated magniferous and ferruginous cherts. This formation is given the name "Chitradurga Group" , after the township of Chitradurga in Karnataka.

Younger [Closepet] Granites:

A striking feature in the geological map of Karnataka is the occurrence of a long linear belt of a granitic body extending in NS direction for nearly 500 km keeping an average width of 20 kms. The most characteristic rock type is coarse-grained porphyritic granite. These have been named after the town of Closepet [Present day Ramnagaram]. These are radiometrically dated as 2528 +/_ 5my. These are the **youngest unit of the Archaean complex** of Karnataka, hence known as younger granites.

The great era of Archaean came to an end with a large-scale orogenic activity. As a result, Dharwarians were isoclinally folded and converted into one of the largest mountain chains. These ranges were subjected to prolonged erosion and have been peneplained before the sedimentary basin came into existence during the Proterozoic era. This time period of erosion and non-deposition is known as "Eparchaean Unconformity" in the Indian stratigraphy.

Economic importance of Archeans:

The Dharwar schists and some of the igneous intrusives associated with them constitute the most important metalliferous and non-metallic mineral bearing formations of India.

Chromite: Chromite deposits occur in association with some type of ultrabasic rocks, mainly in the root zone of ancient mountains. The chief deposits are those of Keonjhar, Cuttuck, and dhenakal in odissa.

Copper: Singhbhum and Manbhum of Jarkhand Guntur and Nellore of A.P. Jabalpur of M.P., Chitaldrug Karmatak

Gold: Quartz veins containing Gold occur in many parts of the peninsula. Generally as veins intrusive into the Dharwar schists. The most notable of these are the deposits of Kolar Gold Field. The other are Wainad of Nilgiris: Hutti Gold Fields of Raichur, Ramagiri Ananthapur Dt. of A.P.

Iron ore: The ore bodies are associated with and derived from banded hematite- quartzites. The largest concentration of deposites is in southern singhbhum, Other deposits occur in bastar, chanda and durg of M.P/Chattishgarh, Ratnagiri of Maharastra.

Manganese ore: Gondites, Kodurites and Lateritic concentrations derived from Dharwar Schists and phyllites.

Lead-Zinc ores: Jaipur and Mewar districts of Rajasthan, Zawar near Udaipur large size-Aravali age.

Manganese ore: gondites, kodurites and lateritic concentrations derived from dharwarian schists and phyllites.

Apatite: singhbhum and mayurbhanj: kodurites of eastern ghats.

Asbestos: Hassan and Banlore of Karnataka. Salem of Tamilnadu. Rajasthan A.P archean rocks.

Beryl: Mewar Jodpur and Ajmer in Rajasthan. Bihar and Andhra Pradesh Pegmatites.

Building and Ornamental stones.

Clays, Corundum, Feldspar, Gemstones

	Kristna Group (300 m)	Srisailam Fm (300 m)	Quartzites and Shales

Graphite – khondalites: kyanites and sillimanite: magnesite.
Mica- Bihar, Rajasthan and A.P. Archeans Gniesses Steatite etc.

The Cuddapah System

The proterozioc rocks were deposited in the Cuddapah depression, Godavari graben, and Narmada-Son- Damodar graben. Both these grabens appear to have originated during the Cuddapah times. The Cuddapah rocks include shale, slate, quartzite and limestone. These rocks have been greatly metamorphosed and lack in fossils.

The spectacular, crescent (semi-circular) shaped Cuddapah basin, situated in the parts of the Andhra Pradesh and Telangana states, covers an area of 42,500 sq. km, in parts of Chittoor, Ananthapur, Kadapa, Kurnool, Mahabubnagar, Nalgonda, Guntur and Krishna districts. The region, about 300 km along its length and 140 km across. The shape of the basin is westerly convex, and concave towards the eastern side. It is marked by a profound non-conformity called as the Eparchean un-conformity. The basin is surrounded by Archean gneisses with enclosed greenstone belts. The lower and older Cuddapah Supergroup occupying the much of the basin.

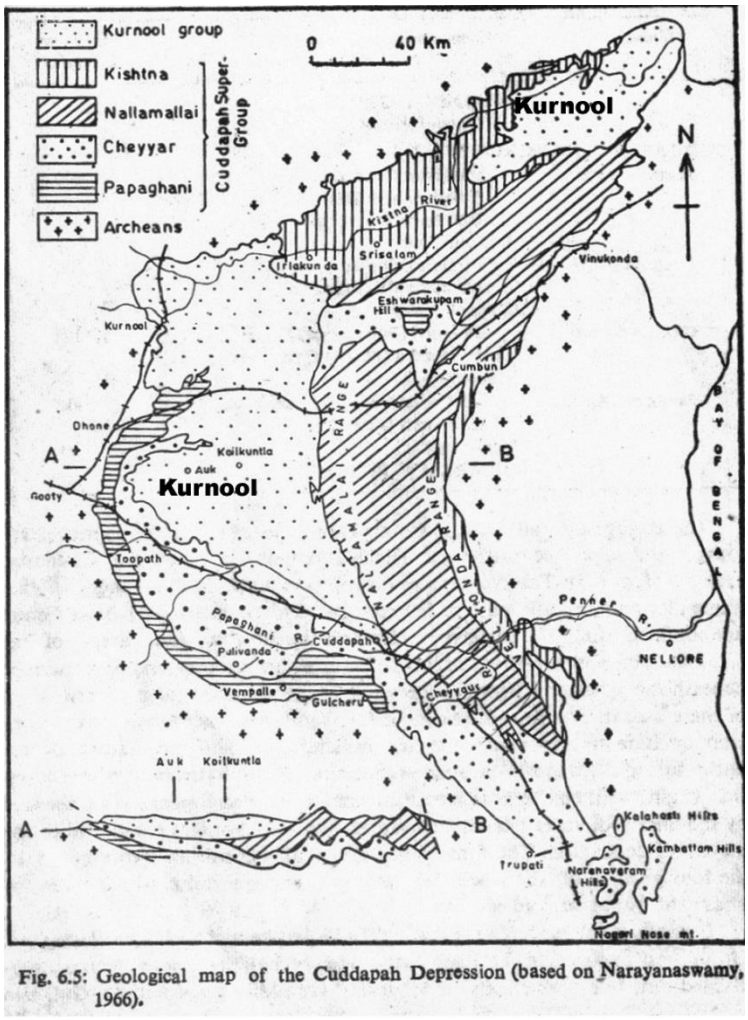

Fig. 6.5: Geological map of the Cuddapah Depression (based on Narayanaswamy, 1966).

The Cuddapah Supergroup comprises over 6 km thick succession. The rocks show, in general, a higher degree of metamorphism and deformation along the eastern flank of the crescent as compared to the rocks of the western flank. The succession has been divided into groups. Each group is separated from one another by marked unconformities.

The main part of the Papaghani and Chitravati (Cheyair) groups are exposed along the southwestern margin of the Cuddapah crescent. The Nallamalai Group is exposed in the range of that name along the middle part of the crescent. The rocks of the Kristna Group are confined along the eastern margin and the north areas of the crescent basin. The rocks of the Cuddapah Supergroup are presumably concealed beneath the younger Kurnool Succession in the western and northern parts of the crescent. The four divisions of the Cuddapah succession have overlapping characters over one another indicating a shifting nature of the basin during the deposition of the succession. Each division of the succession begins with coarse sediments succeeded by the finer sediments and carbonate rocks indicating a cycle of deposition. The Cuddapah Supergroup is composeddominantly of argillaceous and arenaceous sequences with sub ordinate calcareous sediments.

----------unconformity----------		
Nallamalai Group (3500 m – 6000 m)	Cumbum Fm (2000 m)	Phyllites, Slates, Quartzites, Shales, Dolomites
	Bairenkonda (Nagari) Fm (4000 m)	Quartzites, Shales, Conglomerates
----------Angular unconformity----------		
Chitravati Group (5000 m)	Gandikota Fm (300 m)	Quartzites and Shales
	Tadpatri (Pullampet) Fm (4600 m)	Shales, tuffs, Quartzites, Dolomites
	Pulivendla (Nagri) Fm (100 m)	Conglomerates and Quartzites
----------Disconformity----------		
Papaghni Group (2000 m)	Vempalle Fm (1900 m)	Stromatolitic dolomites, Chert-breccia, quartzites with basic flows and intrusives
	Gulcheru Fm (200 m)	Conglomerates, arkose, quartzites and shales
----------Nonconformity----------		
Dharwar gneisses and granites (Archeans)		

Each group starts with quartzites and with the shale unit representing cyclic repetition of quartzite-shale sequence reflecting successive transgression and regressions in the basin. Igneous activity contemporaneous with sedimentation is manifested as sills, flows and other intrusive.

Distribution:

There are four main areas of occurrence of the Cuddapah rocks: (i) Cuddapah and Kurnool districts of Andhra Pradesh, (ii) the Chhattisgarh region of Chhattisgarh, (iii) Rajasthan-Delhi region, and (iv) the Lesser Himalayas in the extra Peninsula.

Stratigraphic Succesion of Cuddapah Super Group

Unconformity: Eparchean Unconformity separates Cuddapahs from Archean basement.

Papaghani Group: The series is named after the Papaghani River in whose valley its rocks have been exposed. It consists of quartzites (Gulcheru quartzite), sandstones (in the lower part), shales, slates (Vempalli slates), limestones and marbles (in the upper part). The series is intruded by magma in the form of dykes and sills which has metamorphosed limestone into marble, serpentine and talc. Slates, limestones and basalts are important because of the occurrence of deposits of barytes and asbestos.

Chitravathi Group: It lies in the valley of the Cheyair river and consists of two stages, the lower called the Pulivendhula (Nagari) composed of quartzites and the upper Tadipatri (Pullempet) made of slates.

Nallamalai Group: The series derives its name from the Nallamalai hills where it is exposed. Its component rocks are quartzites in the lower part called as Bairenkonda quartzite, and indurated shales and slates () in the upper part called as Cumbum shales. The limestones interstratified with the shales contain deposits of lead and galena.

Krishna Group: This is the youngest and the upper most series of the Cuddapah system which occupies the part of the Krishna valley. It consists of quartzites in the lower part, shales in the middle part and quartzites (Srisaillum quartzites) in the upper part. A zone of unconformity separates this series from the overlying lower Vindhyan rocks.

The cuddapah supergroup is composed dominantly of argillaceous and arenaceous sequences with subordinate calcareous sediments. Each of the three groups starts with quartzite and with a shale unit representing cyclic repetition of quartzite-shale sequence reflecting successive transgressions and regressions in the basin. Igneous activity contemporaneous with sedimentation is manifested as sills, flows and other intrusive.

The most significant and economically important volcanic episode in the basin is represented by the volcanogenic bedded barites deposit associated with barium-rich acid volcanic in the Pullampet formation (Mangampet region).

(ii) Madhya Pradesh, Orissa and Maharashtra

The Cuddapah system of rocks in Madhya Pradesh, Orissa and Maharashtra has many outcrops which consist of following main series.

Bijawar Series: it occupies parts of Chhatarpur and Panna districts of Madhya Pradesh. It is composed of sandstones and quartzites at the base overlain by limestones and ferruginous sandstones. It has basaltic intrusions whose dykes are rich in diamonds.

Gwalior Series: The Cuddapah system of rocks found in the vicinity of Gwalior is called Gwalior series which largely consists of sandstones, shales and quartzites overlain by shales, limestones, hornstones, jaspers and basaltic lavas of the Bijapur type. The lower part of this series is called Par and the upper as the Morar series. Dr. Heron considers the Gwalior series as an isolated outcrop of un-metamorphosed Aravalli series (Wadia, 1975, p. 118).

Rajpur Series:this series belongs to the Upper Cuddapah and occupies a large area in the upper Mahanadi valley in Durg, Rajpur, Bilaspur (Chhattisgarh) and Sambalpur (Orissa) districts. It consits of shales and limestones.

Kaldgi Series: It lies in Bijapur district of Maharashtra between the towns of Belgaum and Kaladgi. Its upper parts are highly ferruginous and yields iron ore.

Pakhal Series-It occurs in the Godavari valley and consists of rocks like quartzites, shales and flinty limestone. Similar rocks in the valley of the Pranhita are called the Penganga beds.

(iii) Rajasthan and Delhi Region

The Cuddapah rocks in Rajasthan and Delhi are designated as the Delhi system which covers a large area from Idar to Delhi. "Alwar Group" the oldest of the Delhis. It largely consists of quartzites, slates, grits (Gritstone or grit is a hard, coarse-grained, siliceous sandstone) and flagstones (Flagstone is usually a form of a sandstone composed of feldspar and quartz and isarenaceous in grain size). "Ajabgarh Group" the youngest and consists mainly of phyllites and slates. Dr. A.M. Heron has classified the Delhi system as follows:

(iv) Extra - Peninsular Region

Outcrops of the Cuddapah system are also noticed in Kashmir, Shimla and the Nepal Himalayas in which slates and quartzites are the main rocks.

The deposits of slates, with flaggy quartzites, in southern part of Pirpanjal, Ramban and Kishtwar areas are called the Dogra slates (after Dogra Rajputs inhabiting the region) which are used as building material for roofing and flooring. Similarly in the Shimla Himalayas the slates are designated as the Shimla system.

Life: The Cuddapah rocks are azoic or unfossiliferous although limestones and shales are well suited for the preservation of organic remains. Either life did not exist during the Cuddapah times or early organisms did not have hard parts in their body to preserve as fossils.

Economic importance:

Asbestos: The traps sills travesrsing the dolomitic limestone of Vempalle formations.

Deccan Traps

Towards the end of the Mesozoie (close of cretaceous) period, after the formation of the Bagh and lameta beds, the Indian peninsula was affected by intensive volcanic activity, due to which stupendous masses of lava and pyroclastic materials were ejected out, which covered a larger part of the peninsula in its southern, western and central parts and is of maximum extension next to the Archaeans.

Deccan volcanism Structure and Lithology:

The lava flows occur in general in the form of beds, obliterating the previous topography and converting the countries into plateaus. Because of their tendency to form flat-topped plateau-like features and their basaltic composition, they are termed as plateau basalts. Their step-like or terraced appearance is suggestive of the name Deccan Traps to these volcanic formations. (The word trap in Swedish language means step like or terrace). The step-like appearances of the out-crops are because of differential composition and weathering.

The eruption was of the Hawaiian or the fissure type without any violence, as no fragmentary material is available. The lava had high basicity leading to rapid crystallisation and of basalt-glass or tachylite. The most common rock of the Deccan Trap is augite basalt.

The decomposition of the basalt has given rise to a dark deep-brown or reddish soil called the regur from the local word 'regadda' (black cotton soil). At places it has also been altered into laterite rich in iron and alumina.

Distribution:

The Trap now covers about 5 lakh square km. of area in Gujarat (Kachchh, Saurashtra), Maharashtra, Madhya Pradesh (Malwa Plateau) and northern Karnataka. Isolated outliers of lava are found as far off as Rajahmundry (Andhra Pradesh), southern Bihar and Sindh (Pakistan). The Deccan Trap has the maximum thickness of about 3,000 m along the coast of Mumbai from where it decreases towards the east.

These flows have been divided into the following three divisions.

Division	Distribution	Rocks
Upper Traps (450m)	Maharashtra, Gujarat	Traps with inter trappeans and volcanic ash beds
Middle Traps (1200m)	Central India, Malva Area	Traps without inter trappeans and volcanic ash beds at top
Lower Traps(150m)	Central province, Eastern Area	Traps with inter trappeans and volcanic ash beds
Lameta beds-Infra trappeans		

(i) The Lower Traps (150m)-this is separated from the Lameta and Bagh Beds through slight unconformity. It occupies parts of Madhya Pradesh, Narmada, and Berar (Maharashtra state) etc. The lavas have few ash beds and show numerous fossiliferous inter-trappean beds.

(ii) Middle Traps (1200 m)-this is found in Malwa (Malwa region includes districts of western Madhya Pradesh and parts of south-eastern Rajasthan.) and Central India. Here lava and ash-beds form thickest part of the series. **It has no inter- Trappean fossiliferous beds.**

(Hi) Upper Traps (450 m)-this spreads over Maharashtra and Saurashtra. Here lava flows have numerous ash beds and are interbedded with inters- Trappean "sedimentary beds containing fossil vertebrata and molluscan shells.

Age of the Deccan Traps:

The enormous areal extent and thickness of Deccan traps and the presence of inter-trappean beds in between the consecutive lava flows are sufficient to indicate that the formation as a whole has a considerable range in the geological time-scale.

The age of the Deccan Trap is fixed by

(i) The presence of fossils chiefly plants found in the inter- traps,

(ii) The age of the underlying beds (called the infra traps),

(iii) The age of the overlying beds.

1. In the Narmada valley the traps are underlain by the Bagh beds of upper cretaceous age, possibly in part equivalent to the lametas.
2. Recent work on the intertrappean fossils especially by B. Sahui and his collaborators, lands supports a lower eocene age for the beds from which the fossils were obtained.
3. Smith Woodwords work on the fish remains from the lametas has shown that perhaps they are more allied 10 eocene than to cretaceous formations.

Hence, the age of the trap lies between upper Cretaceous and the lower Eocene periods.

Inter Trappeans:

These volcanic eruptions were not continuous but occurred at intervals separated by long or short periods of quiescence (period of inactivity). These periods of diminished or no activity were marked by deposition of layers of volcanic ash or tuffaceous material or lacustrine or fluviatile sedimentary beds called **Inter-trappeans,** which in turn, were covered by subsequent outpourings of lava flows. These are made of dark coloured, cherty or siliceous rocks metamorphosed by the overlying lava-flows. Some of the beds consist of impure calcareous matter. These beds contain fossils of land plants and animals especially physaprincipii, unionatica and paladin etc.

Divisions	Stage	Series	Age
Upper Gondwana (Characteristic fossil: Ptylophyllum flora)	Jabalpur	Umia	L. Cretaceous
		Jabalpur	U. Jurassic
	Rajmahal	Kota	M. Jurassic
		Rajmahal	L. Jurassic
	Mahadeva	Maleri	U. Triassic
		Pachamari	U. Triassic
Lower Gondwana (Characteristic fossil: Glossopteris flora)	----------Unconformity----------		
	Pachat	Panchet	L. Triassic
	Damuda	Raniganj	U. Permian
		Barren measures	M. Permian
		Barakar	L. Permian
		Karaharbari	L. Permian
	Talchir	Rikba plant beds	U. Carboniferous
		Talchir boulder beds	U. Carboniferous
----------Unconformity---------- Precambrian Basement			

Infra Trappeans:

The formations which occurred below the deccan traps are Infra Trappeans. Lameta beds occurred bellow the deccan traps and above the Archeans and upper Gondwanas. The name implies from the lameta hills of Jabalpur, Madhya Pradesh. These are fluvial and lacustrine deposits. Limestones, sandstones and mudstones are present in lameta beds, among these limestones are important rock formations. The fossils of Physa and Carbicula of mollusca, Lepidosteus and Pycnodus of Fishes, and Lametasaurus Indicus of Dinosaurs are found in Lameta beds.

Rajahmundry sandstones are occurred bellow the deccan traps in Godavari valley region but above the Gondwana formations. These are equivalents of Lameta beds. Theser are yellow, white and green coloured sandstones having the fossil assemblages of Cepalopods, Lamelibranches, Gasteropods.these are overlain by

Economic Importance:

Economics-Basalts of the Deccan Trap are used for the construction of roads and buildings. Quartz, agate, carnelians and amethyst etc. found in the almond-shaped cavities of the Trap are used as semi-precious stones. Magnetite found in the beds of the rivers of this region supplies iron-ore. The bauxite deposits are used in petrol refining. The decomposition of basalt yields argillaceous dark loamy regard soil which is rich in calcium, magnesium, carbonates, potash and phosphates and is utilized for the cultivation of cotton.

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Gondwana Sequence of India

Gondwana group / system introduced by H.B. Medlicot in 1872, named after the Gond Kingdom of M.P

Age: Upper Carboniferous to Lower Cretaceous

Type rocks: Sedimentary rocks, such as Glacial, Fluvial and Lacustrine deposits.

Classification: Three fold classification by Vredenberg and Fiestmantel in 1910 based on Plant fossils. And Robinson in 1967 based on the Floral differences of Permian and Triassic age.

Recent classification: Two fold classification by two Indian scientists M.S. Krishnan and Radhakrishnan, based on characteristic fossils Glossopteris flora and Ptylophyllum flora.

Mesozoic formations of India

Triassic of Spiti

Triassic means three fold classification introduced by Von Alberti. Also called as Lilang system/ group. These are mainly marine sedimentary formations. Main rock formations are limestones and shales. main fossils are Lamellibranches, ammonoids, brachiopods, etc.

Period/ System	Epochs/ Series	Age/ Stage
Triassic	Upper Triassic (Keuper)	Quartzite formations
		Monotis shale
		Coral limestone
		Juvavite beds
		Tropites beds
		Grey beds
		Halobia beds
	Middle Triassic (Muschelkalk)	Daonella Limestones
		Daonella Shales
		U. Muschelkalk
		L. Muschelkalk
		Nodular Limestone
	Lower Triassic (Buntter)	Basal Muschelkalk
		Hedenstroemia beds
		Meekoceras bed
		Opiceras bed
		Otoceras bed

Jurassic of Kutch

Based on Jura mountains in West Europe the name given by Brogniart in 1829. These formations marked by extensive marine transgression and humid tropical climatic conditions. The rock formations are limestone, shales and sandstones.

System/ Period	Series/ Formations	Stages
Jurassic	Umia	Marine sandstones
		Bhuj beds
		Umia plant beds
		Ukra beds
		Barren sandstones and shales
		Trigonia beds Ammonite beds
		Zamia beds
	Katrol	Ganjasar beds
		Upper Katrol
		Middle Katrol
		Lower Katrol
		Kantkote sandstone
	Chari	Dhosa oolite or Mebha oolite
		Antheleta beds
		Anceps beds
		Rehmani beds
		Macrocephalus beds
	Patcham	Cora beds
		shelly limestone
		Kuar Bet beds
----------Unconformity---------- Precambrian Basement		

Cretaceous of Trichi (Trichinopally)

Creta means Chalk. Based on this textural character the name given by Halloy. It is indicate the Cenomanian Transgrassion, means Universal Marine transgression which occurred in M. Cretaceous. Rock types are limestones, chalk deposits, clays, etc. The main fossil contains are Dinosaurs, marine fossils.

System/ Period	Series/ Formations	Rocks/ Beds
Cretaceous	Niniyur formations	Okars, lime sands, shales
	----------Unconformity--------- Ariyalur formations	Sandstones Marley clays Limestones, shales
	----------Unconformity--------- Trichinopally formations	Sandstones, Clays, Limestones

	----------Unconformity--------- Uttatur formations	Coral limestone, Calcareous shales and clays
	----------Unconformity--------- Dalmiapuram formations	Pyritiferous grey shales, Limestones

Proterozoic Formations

Beginning of the Proterozoic Era is placed at about 2500 m.y. ago and the Era came to end at about 570 m.y. ago. Proterozoic Succession divided into Three units (Lower, Middle and Upper). Upper Proterozoic further subdivided into Riphean and Vendian units on the basis of small form of Stromatolites. Vendian also known as Eocambrian (early or lower cambrian). It is a Transitional Phase from Pre Cambrian to Phanerozoic Eons.

Sarkar has identified three subdivisions in the Proterozoic formations of India. Their ages are 2500 to 1600 m.y., 1600 to 900 m.y., and 900 to 570 m.y..

The Precambrian basement rocks (strongly deformed) are separated from the Proterozoic formations (less deformed) by Main (Eparchaean) Unconformity, that represents a major tectonic Cycle.

Main divisions	Southern peninsula	Northern peninsula
Upper purana (570-900 m.y)	Kurnool group Bhima group (Karnataka) Sullavai group (Godavari vally) Indravathi group (Odisa) Chattisgarh group (Chattisgarh)	Upper vindyan group Malani volcanic (Rajasthan)
Unconformity		
Lower purana (900-2500 m.y)	Cuddapah supergroup (A.P) (900-1600m.y) Kaladgi group (Karnataka) Pakhal group (Godavari vally)	Lower vindyan group (900-1600m.y.) Gwalior group (900-1600m.y.) Delhi super group (1600-2000 m.y.) Bijawar group } Kolhan group } (2000-2500 m.y.)

The Aravalli Range literally meaning 'line of peaks', is a range of mountains in western India running approximately 800 km in a northeastern direction across Indian states of Gujarat, Rajasthan, Haryana and Delhi.

They form the Aravalli mountain system, which runs across the state from the north of Delhi in the north-east to the Gulf of Cambay in the south-west. The central part of the Aravalli ranges is occupied by a great synlinorium composed of Aravalli and Delhi rocks. .

The oldest formations are known as **Banded Gneissic Complex** exposed in central and southern Rajasthan.

The Delhi Super group overlies the Aravallies. Delhi super group is divided into lower Raialo group, middle Alwar group and upper Ajabgarh group. (**Some of the Geologists believed the Raialo group considered as a transitional stratigraphic unit).** Raialo group is rich in crystalline limestones, grits, schistose rocks and quartzites. The famous marble of **Makrana** (Nagaur district) belongs to this group. Alwar group and Ajabgarh group consist mostly of calc-silicates, quartzites, grits and schistose rocks.

The other important lithological formations consist of a thick series of sedimentary rocks comprising sandstone, limestone and shales. These have been classified as upper and lower

Vindhyans (after Delhi Super group) in the east and Marwar in the west. The deposition of these rocks in western Rajasthan was preceded by igneous activity, which included a thick pile of lava, mostly of an acidic nature. The plutonic equivalent of these lava are seen in the form of granite bosses and sills in Jalor, Siwana, Mokalsar and Jodhpur areas. Rocks of the above mentioned igneous activity have been designated as Erinpura granite and Malani igneous suit.

At Alwar area the Alwar and Ajabgarh Group rock formations are separated by a impure limestone and metamorphosed which is called as **"Kushalgarh Limestone"**. This limestone contains a few horizons of brecciated rocks known as **"Hornstone Breccia".**

Granitic intrusions in the succession of the Delhi Supergroup (Ajabgarh group) observed at many places along the Aravalli range. They are together known as **"Erinpura Granite".**

Precambrian formations of Rajasthan				
PROTEROZOIC	Vindhyan System			Sandstone, limestone & boulders
		Malani Rhyolites		Rhyolite, tuffs
	Delhi System	Ajabgarh Series		**Erinpura granite** Upper phyllite Limestone Biotitic limestone and calc-schist Phyllites, biotite schist and composite gneiss
				Kushalgarh Limestone
		Alwar Series		Quartzites Arkose, grit and conglomerates
	???	Raialo Series		Garnetiferous biotite schist Limestone (marble) Local basal grit
ARCHEAN	Aravali System			Impure limestone, quartzites, phyllites, biotite-schist, composite gneiss Quartzites, grits and local soda-syenites, conglomerate Local amygdaloids and tuffs
		BhilwaraSupergroup (Bundelkhand Gneiss and the Banded Gneissic complex))		Schists, gneisses and composite gneiss Quartzites