

# **ENVIRONMENTAL GEOSCIENCES**

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## **Lecture-41**

### **Various Stratigraphic Units of India: Pre-Cambrian Group, Paleozoic Group & Features**

Welcome to the SWAYAM NPTEL course on Environmental Geosciences. We are discussing the module eight. In the module eight, we have to discuss the various stratigraphic units of India, fossils, modes of preservation of fossils and its uses. We have discussed the lecture one. Now today we will discuss the lecture two, that is various stratigraphic units of India and within it we will discuss Precambrian group, Palaeozoic group and its features.

The salient topic of this lecture will be introduction to Precambrian group, Cuddapah system, Vindhyan system, introduction to Palaeozoic group, Palaeozoic of Spiti, Palaeozoic of Kashmir and Palaeozoic of Salt range. Here you can see the introduction to Precambrian group. Subsequent to their formation, the Archaean rocks which we have discussed in the lecture one, The Archaean rocks were subjected to diastrophism, erosion and denudation which led to ultimately the development of what is known as the Eparchaeon Unconformity. The Precambrian rocks lie above this Eparchaeon Unconformity and are well represented in different parts of the peninsula.

In India, the Precambrian rocks have given rise to two distinct formations and these formations are known as Cuddapah and the Vindhyan system, of which the Vindhyan is younger in age. Structurally, older Cuddapah system is more complicated than the younger Vindhyan system. Either of them, however, is practically devoid of fossils. You can see the Cuddapah system first because it is older one than the Vindhyan. The structure of Cuddapah system, it is a huge Cuddapah basin, is more or less crescentic in shape and with the concave side facing the east.

Enormous thickness of the Cuddapah sediments, that is six thousand meters, indicates that a slow and quiet submergence was in progress all through their deposition. The western side exhibits undisturbed sequence of rocks while the eastern side shows steep

folding. The name of the Cuddapah system has been derived from the Cuddapah basin of Andhra state where it is best developed. In the Cuddapah basin of Andhra state, the Cuddapah system lies unconformably above the schists and gneisses of Archaean Age and is overlain by Kurnool system of Vindhyan age. The huge Cuddapah basin is more or less crescentic in shape.

The western side of the basin exhibits an undisturbed sequence of Cuddapah rocks made up of quartzites and shales. In the eastern half of the basin, the same rocks have been folded and slightly metamorphosed. The effect of diastrophism is however most conspicuous along the concave eastern margin of the crescent, where the rock beds have been remarkably folded and even faulted. Now Lithology. The rocks of the system are devoid of fossils and include quartzites, indurated sandstones, slates, shales and limestones with some banded jaspers.

Contemporaneous volcanic activities prevailed on a large scale during the lower half of the system, the records of which are left in a series of bedded traps and tuff-beds. This is the stratigraphic succession of the Cuddapah basin given by W. King. You can see here schists and gneisses of archaean age is here, just unconformity is coming and then, is starting and then is starting the Gulcheru Quartzites and Vempalle Limestones and shales of Papaghni series. Again, Unconformity is here. Then, Nagari Pulivendla Quartzites and Pullampet Tadpatri shales of Cheyair series.

Then, again Unconformity is coming. Then, Bairenkonda Quartzites and Cumbum shales are coming of Nallamalai series. And after the Unconformity, Irlakonda Quartzites, Kolamnala Shales and Srissilam Quartzites of Kistna series remains. Above it remains the Kurnool system that is made up of sedimentary rocks of Vindhyan age and this is the stratigraphic succession of the Cuddapah basin. From the above succession, it is apparent that the Cuddapah system is made of alternating layers of quartzites and shales, and there exists an unconformity between any two successive series of the system.

In the field, each individual series has been found to overlap the older ones. Of the four series constituting the Cuddapah system, the oldest one is the Papaghni series, which is above four thousand five hundred feet thick and lies unconformably above the Archaean Rocks. The quartzite sandstones, grits and conglomerates of the Gulcheru stage form the basement and are overlain by greyish, micaceous limestones and shales of the Vempalle stage. The Vempalle limestones have been intruded by doleritic and basaltic sills which range in thickness between wide limits. These sills are said to have been formed during

the later part of the Cuddapah period and are held responsible for the development of deposits of barite asbestos with the Vempalle limestones.

The cheyair series is over ten thousand feet in thickness and its lower part that is Nagari or Pulivendla stage is made up of quartzites, sandstones and conglomerates which have been crushed along the eastern margin of the Cuddapah basin. The upper part of the series that is Pullampet or Tadpatri stage is composed of shale beds which have become slaty due to the metamorphism. There are some siliceous and calcareous bands and basic sills within the rocks of this stage. The Nallamalai series is over three thousand feet in thickness and forms the Nallamalai hills.

The Bairenkonda quartzites and Cumbum shales and slates have been folded conspicuously. The slates are at places phyllitic in nature. The youngest series named after the river Krishna overlaps all the older series and lies right over the Archaean rocks. It is made up of three distinct stages which together constitute total thickness of about two thousand feet. The Cuddapah system is made up of alternate layers of quartzites and shales and there exists an unconformity between any two successive series of the system.

The Vempalle limestones have been intruded by dolerite and basaltic sills which range in thickness between wide limits are possibly responsible for the development of deposits of varieties and asbestos. Limestone has been metamorphosed to marbles on account of its being impure has developed minerals such as serpentine and talc. This kind of marble is known as opicalcite. Now, other outcrops of Pre-Cambrian group in Peninsula and Extra-Peninsula, we can see here, the Kaladagi series, Cuddapah rocks occurring in South Maharashtra, in Bijapur district, then Chandrapur series, Raipur series, Bijawar and Gwalior series, are rocks of Cuddapah age occurring in respective locality of Madhya Pradesh. Kolhan series, Cuddapah rocks of Singhbhum, Delhi system, Cuddapah rocks of Rajasthan, and its stratigraphic succession is as follows, Delhi system,

The bottom most is the older bed that is Alwar series and the younger one is the Ajabgarh series. Next is the Pakhal series, Cuddapah rocks in Godavari valleys is known as Pakhal series. Then Pranhita valley to the west of Wardha coal field, Kuddaph rocks, Pengana beds. Erinpura granite and Malani igneous suite belong to the Cuddapah system. In the extra peninsula, the Simla, the Dogra, Hazara and Attock slates which occur towards the northwestern side of the Himalayan ranges and the lower part of the Haimanta system of Spiti may possibly be correlated with the Cuddapah system.

You can see here important economic mineral deposits of Cuddapah age. You can see here the rocks of Cuddapah age contain a number of important economic mineral deposits. In Andhra deposits of talc, asbestos occur at the contact of Vempalle limestone and the intrusive sills. Deposit of cobalt and copper ores are associated with the black slates of Delhi system in Rajasthan. Veins of barite occur in Vempalle limestones of Andhra and in the Alwar quartzites of Rajasthan.

In addition, the quartzites, slates and limestones of the Delhi and Cuddapah systems are utilised commonly as building and decorative stones. Now, we will discuss the Vindhyan system of the Pre-Cambrian rule. The Vindhyan system lies unconformably above the older formations and constitutes an unmetamorphosed column of calcareous, arenaceous and argillaceous sediments which exhibit a maximum thickness of about fourteen thousand feet. The system named after the Vindhyan range of mountains has been studied by a number of workers. The lower part of the system is made up of calcareous and argillaceous sediments which were deposited under a marine environment

The upper part on the other hand is made up of principally of arenaceous rocks of estuarine or fluvial origin. From the structural point of view, the Vindhyan rocks exhibit sign of remarkable diastrophism. The rocks of Vindhyan age are said to be devoid of fossils. Now, from the point of view of lithology and structure of constituent bed, the Vindhyan system has been divided into lower and upper subdivisions. The lower Vindhyan rocks are mainly calcareous and argillaceous in composition and have been subjected to folding.

The upper Vindhyan are, however, made of undisturbed and more or less horizontal layers of arenaceous sediments. The two subdivisions are separated from each other by a distinct unconformity. The Vindhyan rocks are developed characteristically in the Sone Valley and in certain parts of Rajasthan, Madhya Bharat and Andhra Pradesh. In most of the areas, only the upper part of the system is well developed. In the Sone Valley, on the other hand, the lower Vindhyan rocks occur and are overlain by the upper Vindhyan.

This region may therefore be taken as the type area for Vindhyan system. The lower Vindhyan rocks together form the Semri series, while the upper Vindhyan are subdivided into three series, that is Kaimur, Rewa and Bhandar series, which are separated from one another by two intervening horizons of diamond-wearing conglomerates. The geological succession of the beds in the Vindhyan system you can see here. The bottom most is the Semri series, then the Kaimur, then Rewa, and then

Bhander. And stage-wise also you can see the Basal stage, then the Porcellanite stage, Kheinjua stage, Rohtas stage of the Semri series, then Unconformity comes.

Again, the lower quartzites and shales. Then, Susnai breccia, upper sandstone quartzites, Bijaigarh shales, scrap sandstones, conglomerates, dhandraul quartzites of the Kaimur series. Then, diamondiferous conglomerate bed is coming here. Then, the Panna cells, lower Rewa sandstones, Jhiri shales, Siri shales, upper Rewa sandstones. of Rewa series. Again, diamondiferous conglomerate beds comes, and then the Ganurgarh shales, Bhander or Nagode limestones, lower Bhander sandstones, Sirbu shales, and upper Bhander sandstones remain of Bhander series.

So, this constitutes the, Semri series constitutes the lower Vindhyan, whereas Kaimur, Rewa, and these three constitute the upper Vindhyan system. The lower Vindhyan rocks constituting the Semri series are developed characteristically in the Sone Valley area. The series commences with a basal conglomerate bed which is overlain by Kajrahat limestone and these two horizons together form the basal stage. The overlying porcellanite stage is made up of silicified and porcellanite rocks. The shale and limestone and glauconite beds lying above the silicified and porcellanitic rocks together form the Kheinjua stage.

The Rohtas stage which forms the topmost horizon of the Semri series is made of alternate layers of shales and limestones. The Rohtas limestones are of good quality and are utilised along with the associated shale beds in the manufacture of lime and cement. In the Sone Valley, the Semri has been traversed by dykes of basic composition. In Rajasthan, the lower Vindhyan rocks are represented by Tirohan limestone. and Breccia, the Suket Shales, the Nimbahera Shales, and the limestones, and by a few beds of conglomerate grit, sandstone, and glauconite.

The Kaimur series in the Sone Valley lies unconformably above the lower Vindhyan rocks. The bottom-most beds are made up of quartzites, shales and some grits and conglomerates. The overlying Susnai Breccia is gritty in nature and is made up of fragments of porcellanite. The upper quartzites and sandstones lie above this Breccia and are overlain by the carbonaceous Bijaigarh Shales, which contain pyrites. These pyrites have sulphur content of about forty percent.

The main rock types are sandstones, conglomerates, siltstones, flagstones, etc., some of which exhibit distinct current bedding. The Rewa series lies above the Kaimurs and is separated from the latter by a diamond-bearing conglomerate bed. This series is best developed in the highlands of central India and is made up of coarse-grained sandstones,

sails, and flagstones, which appear to have been deposited under a stretch of shallow water. The Bhandar series rests upon the Rewa series with an intervening origin of diamondiferous conglomerate. This series is made up of shale, limestones and sandstone beds which together constitute the uppermost subdivision of the Vindhyan system.

The Bhandar series is well developed in Central India and is said to have been deposited under dry climatic conditions. In Andhra, sandstone, limestone, shales and quartzites and conglomerates of lower Vindhyan age lie unconfirmably upon the Cuddapah rocks and constitute the Kurnool system. The system has been divided into four series, of which the bottommost is known as the Banganapalli series and is made up of sandstones and diamond-bearing conglomerates. The overlying Jammalamadugu series is composed of limestones and shales. The Paniam series, made up of sandstones and quartzites, lies above the previous series and is overlain by the Kundair series, which is composed of limestones, and shales and forms the topmost horizon of the Kurnool system.

The limestones and shales, forming the Bhima series of Hyderabad and the conglomerates, sandstones, slates and quartzites of the Godavari valley, known as the Sullavai series, may be considered equivalent to the Vindhyan rocks. Now the important economic mineral deposits of Vindhyan age. The rocks of Vindhyan age are important from the economic point of view. They contain useful deposits of building and decorative stones, limestone, glass sand and diamond. The Vindhyan sand stones are used widely as building stones of good quality and have been utilized in the construction of palaces, forts and buildings at Delhi and in different parts of Rajasthan and Uttar Pradesh.

Some of the spherulitic limestones of Semri and Bhandar series are used as beautiful decorative stones. The Vindhyan limestones of Rewa, Sone Valley, Andhra and Hyderabad are used for lime burning and in the cement industry. In Uttar Pradesh, some of the Vindhyan sandstones have been produced due to the weathering and useful deposits of glass sand. The diamondiferous conglomerate horizons in the upper Vindhyan rocks of central India and in the Banganapalli Stage of the Kurnool system contained diamonds which appear to have been derived from some of the neighbouring volcanic necks. Now, we will learn the introduction to Palaeozoic Group.

The geological formations developed during the Palaeozoic era are generally found to contain fossils. These rocks differ radically from the unfossiliferous formation of Pre-Cambrian and Archaean ages. Palaeozoic rocks formed under marine environment and containing distinct remains of organisms are developed characteristically in the Extra-

Peninsula and have been studied in Spiti, Kashmir, Salt Range and adjacent areas and in certain parts of Burma. In the peninsula, on the other hand, the Palaeozoic group is represented by the Talchir and Damuda series of permacarboniferous age, the marine lower Permian rocks near Umaria in Madhya Bharat and a portion of the upper Vindhyan sequence which is possibly of Cambrian age. Now, the Palaeozoic of Spiti.

The Haimanta system of Spiti overlies the Vaikrita system of Pre-cambrian age. The lower Haimantas are greenish phyllites, shales and thick bedded quartzites. The Mid Haimantas are red and pink quartzites and shales. The upper Haimantas, also known as Parahio series, are mainly grey and green quartzites, slates, shales with thin beds of grey dolomites. In Kumaon the Haimantas are represented by Garbyang series consists of slaty to phyllitic, finegrained sandstone, calcareous sandstone and argillaceous dolomite.

The upper part of series, contains a stage known as Thabo stage which is overlain by another stage 'fenestella shales'. In the stratigraphic sequence also you can see the Haimanta system, then the Kanwar system, then the Kuling system. More important fossils remains in this system are Trilobites, Redlichia noetlingi Agnostus spitiensis, Microdiscus griesbachi, Olenus haimantensis and a few species of Ptychoparia. Brachiopods, then the Cephalopods, and then the Corals, these are the few important fossils remains here.

The Productus shales are overlain, in Spiti, by the Liang system Triassic age. Palaeozoic of Kashmir A complete succession of palaeozoic rocks exist in Kashmir and adjacent areas and appear to have been folded conspicuously in the form of synclines and anticlines. The Cambrian fauna of Kashmir differs from that of the Salt Range and Spiti areas. The geological succession of the palaeozoic rocks of Kashmir can be seen here.

From the Cambrian you can see. The clay limestone, clay slates, slates, quartzites etc remains. Then the Ordovician, we have the limestone slates, Silurian, Arenaceous slates, Upper Silurian, Devonian, Muth quartzites, then Carboniferous, we are having the Syringothyris limestones and the Fenestella slates, then Upper Carboniferous to Lower Permian, Agglomeratic slates, Panjal Traps and Gagamopteris slates, and Middle and Upper Permian, the Zewan beds. In Hazara area, unfossiliferous palaeozoic rocks made up of conglomerates, quartzites, phyllites etc. together form what is known as Tanwal series. It may range in age from Cambrian to Upper Carboniferous.

It is overlain by the glacial Tanakki conglomerates of Permo-carboniferous age. The more important fossils are trilobites and brachiopods. The Upper Silurian and Devonian

rocks in Kashmir are represented by unfossiliferous Muth quartzites. The upper part of the formation is made of calcareous states and quartzites known as fenestra states and which possibly range in age from middle to upper carboniferous and exhibit a number of important fossils like bryozoans, trilobites and brachiopods. The agglomeratic slates are generally devoid of fossils.

There are a few fossiliferous horizons which contain remains of brachiopods, bryozoans and pelecypods. In some parts of Kashmir, the Panjal traps are underlain by slaty rocks associated with pyroclastic materials. These rocks, known as the Gangamopteris beds, contain plant-fossils and vertebrates of Lower-Permian age. Unfossiliferous Palaeozoic rocks, made up of conglomerates, quartzites, phyllites and quartz-schists, have been studied in some parts of Kashmir and Hazara. These rocks together form a thick column and have been described as a Tanawal series.

It may range in age from Cambrian to upper Carboniferous and in the Hazara area is overlaid by glacial Tanakki conglomerates of Permo-Carboniferous age. Now, next is the Palaeozoic of Salt Range. Salt range, marine Palaeozoic rocks of Cambrian, upper carboniferous and Permian age occur in the salt range in Pakistan. In this area, the sequence commences with the Cambrian rocks and no distinct rock type of Pre-Cambrian age has so far been found to form the basement. The Cambrian formations are overlain directly by the glacial boulder beds of upper Carboniferous Age.

In the salt range, there exists a distinct gap of stratigraphical break in the succession, which is marked by the absence of rocks of Ordovician to lower Carboniferous Age. Important fauna of this range is the Trilobites, Brachiopods, Foraminifera, Sponges, Echinoderms, Gastropods and Pelecypods. The saline series is made up of salt marls. They are devoid bedding planes. The top part contains, gypsum dolomite and oil shale and also altered lava flows known as Khewra trap. Massive gypsum are called 'Kalabagh Diamonds'. The age of the saline series is still controversial. But the stratigraphic sequence you can see here, saline series is at bottom, then the unconformity is coming. Then of Cambrian age, we are having purple sandstones, neobolus beds, magnesian sandstones, salt pseudomorphshale, and then unconformity.

Then the glacier boulder bed, olive series, and productous limestone series of Permian age. The productus limestone series is subdivided into three parts. You can see here the lower, middle and upper. And the stages also is mentioned here. Amb, Katta, Virgal, Kalabagh, Kundghat, Jabbi and Chidru.

The important fossils are Brachiopods, then Pelecypods, Gastropods and Cephalopods. The Chidru stage, which constitutes the topmost horizon of the Productus limestone series, is overlain by the rocks of Triassic age. Now just summarizing the lecture, first of all we have discussed the introduction about the Pre-Cambrian group in which we have discussed that the Pre-Cambrian group consists of ancient rocks and are formed before the Cambrian period, primarily represented by the Cuddapah and Vindhyan system in India. These rocks are mostly devoid of fossils and have undergone significant diastrophism, erosion and metamorphism. Next, we have discussed the Cuddapah system.

The Cuddapah System, named after the Cuddapah Basin in Andhra Pradesh, comprises thick sedimentary sequences of quartzites, shales, and limestones. It exhibits complex structural deformations, especially along its eastern margin, and contains important economic mineral deposits like barite, asbestos, and cobalt. Then we have discussed about the Vindhyan system. The Vindhyan system extensively developed in Central India consists of unmetamorphosed calcareous, arenaceous and argillaceous sediments. It is divided into lower and upper Vindhyan with economic significance due to its limestones, sandstones and diamond-bearing conglomerates.

Next is the Introduction to palaeozoic group, the palaeozoic rocks in India contain well-preserved fossils, distinguishing them from the older pre-Cambrian formations. These rocks represent various marine and trans, terrestrial environments and provide key insight into early life and sedimentary processes. Palaeozoic of Spiti, the Spiti region in the Himalayas hosts a well-developed palaeozoic sequence, primarily composed of fossiliferous limestone, sands and sandstones. These rocks provide valuable insights into the marine environments of the early Paleozoic era.

Then the Paleozoic of Kashmir. The Kashmir region features a rich paleozoic stratigraphy including fossiliferous limestones and shales that indicate a long history of marine deposition. This sequence is crucial for understanding the geological evolution of the northwestern Himalayas. And lastly, we have discussed about the Palaeozoic of salt range. We have seen the salt range in Pakistan preserves a complete Palaeozoic sequence with well-preserved fossils, including trilobites and brachiopods.

It provides important evidence of ancient marine transgression and regressions in the Indian subcontinent. Thank you very much to all.