ENVIRONMENTAL GEOSCIENCES

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Lecture-42

Various Stratigraphic Units of India: Mesozoic Group & its Features

Welcome to the SWAYAM NPTEL course on Environmental Geosciences. We are discussing the module eight. Module eight is covering the various stratigraphic units of India, fossils, modes of preservation of fossils and its features. We have already discussed two lectures, lecture one and two. Today we will discuss the lecture three, that is various stratigraphic units of India and in this lecture we will cover the Mesozoic group and its features.

The important coverage of this lecture will be the introduction to Mesozoic group, Mesozoic of Kashmir Triassic System, Mesozoic of Salt Range Triassic System, Mesozoic of Kutch Jurassic System, Jurassic of Spiti, Jurassic of Kashmir, Jurassic of Salt Range, Mesozoic Cretaceous System, Deccan Traps Cretaceous Systems and the Gondwana group, the Cretaceous System. Now let us start from the introduction to Mesozoic group. The Mesozoic rocks are separated from the underlying Paleozoic group by a distinct unconfirmity. In India, on the other hand, the Mesozoic group of rocks generally lies confirmably or with a slight break in the sequence above the rocks of the Palaeozoic age. Mesozoic rocks occur in India especially in the extra peninsula as well as in some parts of the peninsula and the group has been divided into three systems that is the Triassic systems, the Jurassic systems and the Cretaceous systems.

In the Triassic systems, you see the Triassic rocks are well developed in Kumaon, Spiti, Kashmir and the Salt Range. The Jurassic system, the rocks of Jurassic age are developed characteristically inCutch, Rajasthan, Kumaon, Spiti, Baluchistan, Kashmir, Hazara and the Salt Range. Whereas the Cretaceous system is the characteristic rocks of Cretaceous age occur along the eastern coast of South India in the Narmada Valley, in the Salt Range as well as in Spiti, Kumaon, Tibet, Sind and Baluchistan. The upper part of the Gondwana system of the peninsula is also of Mesozoic age. Now, first we will discuss the mesozoic of Spiti, which is in the Triassic system.

In Spiti, a complete succession of mesozoic rocks occurs conformably above the Productus shales of Permian age. The most perfect development of Triassic rocks has been observed in Spiti and its adjoining areas, say Kumaon and Garhwal. The best available exposure has been studied at Lilang and hence sometimes the triassic of Spiti is also referred as Lilang system. It is also referred as Lilang system which constitutes a typical and perfect sequence formed under marine environment. Lithology wise see the triassic rocks of Spiti consists simply of limestones, shales, quartzites of variable character and fossil wealth.

Classification, Triassic of Spiti has divided into three main groups, the Lower, the Middle and the Upper Triassic. The Mesozoic succession in Spiti shown as the Lower Triassic rocks have been again divided into Hedenstroemia beds, Meekoceras bed,Ophiceras bed and the Otoceras bed Whereas the Middle Triassic rocks include Dauhnella limestone, Dauhnella shales, Daonella limestones, Daonella shales, Upper Muschelkalk, Lower-Muschelkalk, Nodular limestones and Basal-Muschelkalk The Upper Triassic Keuper formation consists of Quartzite series, Monotis shales, Coral limestones, JuvaVites beds, Tropites beds, Grey beds, and Halobia beds. The lower Jurassic and upper Triassic rocks are represented by Kioto, megalodon limestones, which is further characterized into tagling stage and the para stage.

The upper jurassic formation comprises the Sulcatus beds and is separated by an unconformity from the overlying Upper-Jurassic Spiti shales, which include Lochambal beds, Chidamu beds and Belemnites gerardi beds. Another unconfirmity separates these from the cretaceous formation, which consists of chikkim series and giumal series. Now let us discuss the life in the triassic system. Triassic system has yielded a rich collection of fossils, chief among which are those belonging to a group of ammonites. The numerous species of lamellibranchs and a few members of brachiopods have also been found from these rocks.

The Productus shales of Permian age are overlain conformably, in Spiti, by the Lower-Triassic rocks. The period of transition from Triassic to Jurassic in Spiti area appears to have witnessed no break in the sequence of sedimentation. Now Mesozoic of Kashmir, which lies in the Triassic system. Triassic rocks are very extensively developed in Kashmir. They can be traced very easily along the flanks of Pir Panjal, in Lidar Valley, Wardhwan Valley and Gurais Valley and also along north of Jhelum.

Now classification you see, the system has been divided into three parts that is the lower, middle and upper Triassic divisions. Each of these divisions is further distinguished into different zones on the basis of fossils, chiefly Ammonites, Brachipods and Lamellibranchia. These zones are listed, as you see here, in the lower Triassic, mainly the Otoceras zone, Ophiceras zone, Meekoceras zone, and Hungarites beds. In the middle Triassic, the nodular limestone, Gymnite zone, Rhynconella zone, Ceratites zone, and Ptychites zone. In the upper Triassic, mainly the Lamellibrancha zone, Spiriferina zone, and Massive limestone.

Now lithology, you see the system is chiefly composed of homogeneous, compact, light, blue-coloured limestones with some beds of shales in the lower triassic and intercalated shales and sandstones in the middle triassic. The upper triassic is mostly composed of massive limestones. Fossil-wise, like triassic of Spiti, Kashmir triassic rocks have also yielded rich assemblage of ammonite fauna with subordinate number of lamellibranchs and brachiopod fossils. Important ammonite genera have been mentioned in the above table of zonal classification. Now mesozoic of salt range which lies also in the Triassic system.

The Mesozoic rocks, particularly those of Triassic and Jurassic age, appear to have been well developed in the salt range. The Triassic rocks, made up mainly of limestones, mars, sandstones, and dolomites, these are overlain towards the western side of the salt range by limestones, sandstone, and shales of Jurassic age. The belemnite beds of Cretaceous age lie in this area above the Jurassic rocks. the mesozoic succession in the short range you can see here from the bottom lower triassic, we are, the ceratite beds in which the clay and sand stage lower ceratite, ceratite mass, ceratite sandstones, upper ceratite limestone. Middle triassic you see middle triassic the arenaceous limestone upper triassic the crinoidal dolomite lower jurassic crinoidal limestone. Lower and middle Jurassic variegated series, upper Jurassic limestone and shales, lower Cretaceous-Belemnite beds.

In the salt range, the productless limestone series of Permian Age is overlaid with a slight but distinct uncompromisingity by unfossiliferous sands and clays and lower ceratite limestones of lower Triassic Age. The Ceratites sandstones as a whole appear to be the same as the lower part of the Hedenstroemia bed in Spiti. The hard limestones and grey marls lying above the Ceratite sandstones are together known as Upper Ceratite limestones. This horizon is presumably equivalent in age to the Muschelkalk and Ladinic formations of the Spiti. The rocks comprising the system are usual, limestones of flaggy

character which have yielded number of fossils of Cephalopods, Lamellibranchs, and Brachiopods.

The upper Jurassic rocks are represented in the salt range by limestone beds with intermediate layers of shales. Amongst the important fossils of the Berymnite beds, you can see the Hibolites, Olcostephanus; Blanfordiceras, Neocomites belonging to ammonites, Exogyra, Pleurotomaria, Astarte, etc. Now Mesozoic of Kutch which belongs to the Jurassic system. Jurassic system is next to the Triassic system in the standard stratigraphic scale and is well represented in Indian stratigraphy both in extra-peninsula and peninsular India. In extra-Peninsula, the Jurassic rocks conformably overlie the Triassic rocks at many places, example in Spiti, in Salt Range, and in Kashmir.

In peninsula, development of Jurassic rocks has been studied in Rajputana, Cutch, and east coast of the peninsula. Mesozoic rocks ranging in age from Middle Jurassic to Lower Cretaceous are particularly well developed in Kutch, where they exhibit a complete succession. Jurassic rocks are regarded as the oldest and the most important stratigraphic formation in Kutch where they occupy a large area extending in the form of broad band running east-west along the whole length of the Kutch. These sedimentary rocks represent a phase of marine transgression along the western coast of India during the Jurassic period. The individual rock beds appear to have been deposited under a relatively shallow stretch of marine water and exhibit a gentle slope towards the sea.

The enormous thickness of the sedimentary column is probably due to gradual sinking of the basin along with the deposition of more of the sediments. In Kutch, the Jurassic beds constitute the oldest formation and in some places it is underlain by a few patches of rocks of Pre-Cambrian age. The Jurassic succession outcrops along three more or less parallel anticlinal ridges running approximately east to west. The Jurassic and Lower Cretaceous succession has been subdivided in Kutch into four series known as Pacham, Chari, Katrol and Umia and in these in their turn are made up of number of stages. The sequence of the beds of the Kutch region you can see from bottom we are having the Patcham

In the Patcham, the stages are Patcham Basal Limestone, Patcham Shell Limestones, Patcham Coral Beds, then second is the Chari. In it, the stages are Macrocephalus Beds, Rehmani Beds, Anseps Beds, Athleta Beds, Dhosa Beds. Then, we are getting the upper Katrol. Katrol you can see the stages Kantkote sandstones then Katrol then Gajansar beds.

In Umia the stages are Zamia cells, Ammonite beds, Trigonia beds, Ukra beds, Umia plant beds and Marine sandstones.

Lithology wise The Jurassic rocks are chiefly yellow coloured sandstones and limestones in the Patchm Series; shales and limestones in the Chari Series, and sandstone and shales in Katrol series. The Umia formations are composed of two phases, i.e., the marine sandstones with sea fossils and sails and sandstones with land-front fossils like conifers, ferns, cycades resembling the Gunvana phases. Now life, you see, Jurassic formation have yielded quite a good assemblage of fossils. The most dominant group are those of lamellibranchs, cephalopods and ammonites.

Now Jurassic of Spiti. Rocks of Jurassic age succeeded the upper Triassic formations in Spiti. These rocks have been distinguished into a lower group of a great thickness of massive limestones known as Kioto limestones and an upper group chiefly composed of shales and known as Spiti shales. So these two are the important formations, Spiti shales and Kioto limestones and Spiti shales. Kioto limestone is un-fossiliferous for most of its thickness.

It is only a thin basal part. distinguished as 'Megalodon Stage' which has yielded fossils of Lamellibranchs like Megalodon, Lima, and some Ammonites, from which the group has been assigned a Lower Jurassic age. The Spiti shales are black and micaceous in character and palaeontologically the most important Jurassic formations in the world stratigraphy. Now Jurassic of Kashmir. Jurassic rocks have been traced in Ladakh and Banihal in Kashmir state.

At Ladakh, Jurassic formations comprising chiefly of limestones and sands directly overlie the Triassic limestones in a conformal manner whereas in Banihal. They occur on the north side of the Banihal pass within a sink line of Triassic rocks. Jurassic of Ladakh have yielded fossils similar to those of the Spiti formations. Now, Jurassic of Salt Range. Ceratite beds of Triassic Age are overlain by Jurassic rocks, which are actually of middle to upper Jurassic Age in Salt Range.

Lithologically, they comprise sandstones, shales and limestones, the latter being oolitic and the shales being rich in gypsum and pyrite bands. Fossils found from upper Jurassic include Pecten, Lima, Ammonites and some Belemnites whereas from Middle Jurassic, genera like Pleuratomaria, Natica, Pecten, Cerithium etc. have been found. Middle Jurassic is traversed by coal seams at few places. From a comparative study of the Jurassic rocks of Spiti, Cutch and the Salt Range, it has been found that those occuring in

the Salt Range and in Cutch are similar in many respects. The Jurassic succession in the Himalayan region, for example in Spiti, is on the other hand somewhat different in its characteristics.

The workers in the field of Indian stratigraphy are of the opinion that the Jurassic rocks of Cutch and the Salt Range were deposited during a period of marine transgression over a vast area. The geosynclinal basin in the Himalayan region appears to have witnessed a recession of sea during the same period. Now, we will discuss the Cretaceous system. It has been stated earlier that the peninsula as a whole continued to exist as a landmass after the Vindhyan period and only a few patches of sedimentary rocks of post-Vindhyan age were deposited along the coastal tracts during a few subsequent periods of marine transgression. In South India, therefore, there occurs no complete succession of Mesozoic rocks and along the eastern coast there exist only three patches of rocks of Cretaceous age.

These patches rest upon a basement of Archaean gneisses and Charnockites and are sometimes fringed, along their western margins, by thin strips of rocks of Upper-Gondwana age. Of these three patches, the largest patch, about two hundred fifty square miles in area, occurs in the Trichinopoly district, while the smallest one is located near Pondicherry. This system includes rock formations under entirely different conditions during the same, during the same general time, that is the Cretaceous period. The Cretaceous systems are grouped as the marine rocks of North Himalayan, the marine rocks of northern Himalayas and Coromandel coast, the fluviatile rocks of Madhya Pradesh and Deccan, and the part of igneous rocks, that is volcanic and plutonic, of peninsula, that is the Deccan Traps. Now, Coromandel coast.

The Coromandel coast Now the Coromandel Coast. The Coromandel Cretaceous rocks, which are actually of upper Cretaceous age, are regarded as the most intensely studied formations of southern India because of their geological and paleontological importance. Lithologically, these rocks consist of limestones, sandstones, grits and gravel beds. They have been divided into three stages mainly on the basis of their order of superposition and fossil contents.

These stages are remaining in the ascending order and the stages are the Uttatur stage, the Trichinopaly and the Ariyalur stage.. In Narbada Valley, you see, in Narbada Valley, the bagh beds of Narmada Valley provide a second example of the development of marine cretaceous rocks in peninsular India. These consist of isolated outcrops running along the

Narbada Valley and in an east-west direction from Bagh in Gwaliar to Baroda in Wardhwan. Composite rocks of this series are much heterogeneous in composition and consist of sandstone, shales, cherts and limestones, which are generally impure and shelly in character. For most of their thickness, the bagh beds are unfossiliferous.

Most of the fossils obtained from these rocks being confined to a part of the sequence, twenty to thirty meters in thickness. Sandstones underlying the bagh beds are known as Nimar sandstones and are of excellent quality, building and millstones. Marine Cretaceous of Extra-Peninsula In extra-peninsula, marine Cretaceous rocks are developed in at Spiti, northern Hazara, Sindh and Baluchistan. In Spiti, the Cretaceous rocks have been divided into a lower grumal series composed chiefly of sandstone and quartzites that overlie the spiti shales of Jurassic age and an upper chikkim series composed mainly of limestones and shales.

The last mentioned series is overlain at some places by a newer formation, that is the flysch consisting of unfossiliferous sandstones. Both the Gibbon series and the Chikkim series have yielded a good number of typically cretaceous fossils. Of these, the important ones are Hoplites, Acanthodiscus, and Perisphinctes of Ammonites. Pecten, Gryphea, Ostrea of lamellibranchs are common in Guimal series whereas Belemnites, Hippurites and some foramanifera like Texularia, Nodoseria are common in the Chikkim Series. Now next is the Fluviatile lameta series.

The Fluviatile and Estuarine facies of the Cretaceous system is well represented by the lameta series that is in the intra-trappean beds which comprises a number of isolated outcrops developed in Madhya Pradesh and Deccan. At the latter place, they directly underlie the Deccan trap and hence are known as infra-trappean beds. Lametta series is composed of sandstone, grits, clays and siliceous limestones which seldom acquire any great thickness but are comparatively of wider lateral extent. The series rests unconformably over the older rocks. You see here the fossils of land water animals and land animals like Reptiles, chiefly Dinosaurian, have been formed from these rocks.

This series has provided with a large number of fossils of Dinosaurian Reptiles which show close resemblance to the Madagascar Dinosauria of Cretaceous age. Chief fossils are Titanosaurus, Lametasaurus, Laplatasaurus, Stegosauria, belonging to Dinosaurian Reptiles and Paludina and Bulinus etc. belonging to Freshwater Seas and Eosseranus, Lepidosteus and Pycnodus of Fishes. On the Evidence of Fossils, the series have been assigned an age between Danian and Eocene. Now, the Deccan Traps of the Cretaceous

System. The distribution you can see here, the Deccan Trap has been defined as the greatest volcanic formations in Indian geology that consist of lava flows which started towards the end of the Cretaceous period, that is subsequent to the Bagh Beds and Lemita Beds, covering all types of pre-existing topographic features under them.

These volcanic rocks occupy greater parts of Kutch, Kathiawar, Gujarat, Hyderabad, Deccan and Madhya Pradesh. They are remarkably horizontal in attitude throughout their development with some exception where dip is again very gentle. Petrology The most important rock of Deccan Traps is a basalt of which augite basalt type with a greyish green color. It often shows vesicular and amygdaloidal textures. Acidic volcanic rocks like Rhyolites, Granophyres and more basic rocks like Gabbro and Limburgite have also been found to occur at some places in Kutch, Gujarat and Bombay.

Microscopic analyses of Trap basalts show them as fine-grained basalts, remarkably free from olivine; augite and felspar are the chief minerals, with secondary minerals like calcite, quartz, glauconite, etc., which generally fill the cavities in the original rock. The Deccan Traps have been divided into three groups that is the lower traps, the middle traps and the upper traps. Of these the middle traps are the thickest about fifteen hundred meter and include traps of Marwar and Madhya Pradesh which are completely barren of inter-trappean beds and hence are unfossiliferous. The lower traps are represented at Narbada, Berar, besides Madhya Pradesh and are frequently traversed by fossiliferous intertrappean beds. The upper traps include basaltic flows of Bombay and Kathiawar along with a number of intertrappean beds which are highly fossiliferous.

The life, you can see here, the many animals and plant fossils have been found from the intertrapian beds, that is, sedimentary beds having been enclosed within the traps. These intertrappean beds are composed chiefly of volcanic detritus, clay, impure limestones, and contain embedded in them plant remains like those of palm and dicotyledon trees and freshwater animal fossils. Of the latter group, the molluscan shells are common. Physa princepii is the most common gastropod of these beds. Now, next is the Gondwana group belonging to the Cretaceous system.

The Gondwana system is one of the most important stratigraphically, geologically and economically systems of India. This system is in fact a composite group of rocks formed under different period of geologic time ranging in age from upper Carboniferous to upper Jurassic but all of them exhibiting a remarkable uniformity and regularity throughout their development. It has been named after the ancient Gond kingdom of the South

Narbada. Its development is mostly confined to peninsular India, though isolated tracts of Gondwana rocks are also found in such detached parts of extra-peninsula as Kashmir and Assam. In peninsula, the Gondwana rocks can be traced easily along three large tracts, that is in Bengal along the valley of the Damodar river, in Madhya Pradesh parallel to Mahanadi valley, in Maharashtra which are where these rocks follow the Godavari river.

Isolated outcrops of Gondwana rocks are also observed in other parts of Peninsula like Kathiawar, Cutch and Rajputana. Now classification of Gondwana system. Two classifications have been suggested for this system. One divides this into two major groups, the lower and upper Gondwana, whereas other classification shows the threefold division, that is the lower Gondwana, middle Gondwana and upper Gondwana. The two fold subdivisions of the Gondwana group together with the established geological succession are shown just below you can see here the lower Gondwana comprises of Talchir series, Damuda series and Panchet series whereas upper Gondwana comprises of Mahadeva Rajmahal and Jabalpur series. In the lower Gondwana for talchir series the stages are boulder bed, talchir and rikba.

For Damuda, the stages are Karharbari, Barakar, Barren Measures, Raniganj. For Panchet, it is Panchet stage. For Mahadeva, the two stages that is Pachmari and Maleri. For Rajmahal, the two stages that is Rajmahal and Kota. For Jabalpur, the three stages that is Chaugan, Jabalpur and Umia.

So, this is the two-fold classification. But, the following, this table, but here you can see the three-fold classification given as lower Gondwana, middle Gondwana and upper Gondwana in which the series are talchir series, damuda series in the lower Gondwana and this talchir and damuda is comprised of barakar stage, barren measures and raniganj stage. Middle Gondwana comprises of two series that is Panchet series and Mahadeva series whereas the upper Gondwana comprises of three series that is Rajmahal, Jabalpur and Umia series. Lithologically, the lower Gondwana consists of rocks of basal part of this division are shales.

and green, soft sandstone of talchir sandstones which contain undecomposed felspar grains that are suggestive of their fluvio-glacial origin. In the upper stages like Barakars, Barren Measures and Raniganj stages the rocks are sandstones, grits and shales which are very frequently traversed by coal seams except in Barren Measures forming these rocks as most important coal bearing strata in the Indian stratigraphy. Middle Gondwana rocks composing this group comprise of great thickness of coarse, massive red and yellow

colored gritty sandstones, altogether devoid of coal seems. Whereas the upper Gondwana, this division is almost similar in lithology to the middle Gondwana, differing from them in two important respects. The first is some coal seams are developed in it and at places extensive outcrops of limestones and volcanic rocks are also developed.

Most of the lower Gondwana rocks are traversed by igneous intrusions like dikes and sills. Fossils in the Gondwana rocks, you can see the gondwana rocks have yielded a good assemblage of plant and animal remains, of which the former dominate in the lower subdivision. Among the most common groups of plant fossils, the Pteridosperm, the ferns and the 'equisetums' dominate Of these, the "Gangamopteris" and "Glassoptris" flora are most characteristic of Lower Gondwana. Highly developed forms like those of cycades and conifers are typical of upper Gondwana.

A good number of animal remains both of vertebrate and invertebrate groups have been found in the middle Gondwanas. These include the representatives of crustacea, fishes, amphibia, crocodile and reptiles. Important economic mineral deposits of Gondwana is The Gondwana rocks constitute a storehouse of rocks and minerals of economic importance. Some of the sandstones of Gondwana age are used commonly as building stones.

There also occur extensive deposits of clay which are used as refractories and in the manufacture of bricks and pottery. The barren measure stage contains deposits of iron ore. The economic importance of the Gondwana rocks lies principally with the deposits of coal contained in them. The Barakar and Raniganj stages of the Damuda series constitute the most important coal-bearing horizons of the Gondwana succession. Now let us summarize the lecture.

First, we have discussed about the Mesozoic group. The Mesozoic age is known as the age of reptiles, characterized by significant geological and biological changes, including the dominance of dinosaurs and breakup of Pangaea. Then we have discussed about Mesozoic of Kashmir which is of Triassic system. The Triassic rocks of Kashmir are well developed in the Panjal, Zanskar, and Tethyan zones consisting of marine limestones, sandstones and sands. These formations indicate a shallow marine environment and contain abundant fossils of the ammonites and brachiopods.

Then we have discussed about the Mesozoic of salt range belonging to the Triassic system. The Triassic system in the salt range consists of the Mianwali, Tredian, and Kingriali formations mainly composed of sandstones, sails and limestones. These

formations mark a marine depositional environment with fossil evidence of ammonites and bivalves. Then we have discussed about the Jurassic system of the Mesozoic group. The Mesozoic era in India spanning the Triassic, Jurassic and Cretaceous period is marked by marine transgressions, diverse sedimentary formations, and rich fossil records, including ammonites, belemnites, corals, and dinosaur remains.

Key regions like Kashmir, the Salt Range, the Kutch and Spiti preserve evidence of deep sea and shallow marine environments, while the Cretaceous is dominated by Deccan Traps, Lametta Beds, reflecting significant volcanic activity and faunal evolution. Lastly, we have discussed about the Gondwana group and Deccan traps belonging to the Cretaceous period. Lastly, we have discussed the Gondwana group and Deccan traps belonging to the Cretaceous system. The Gondwana group and Deccan traps represent significant geological formations of the Cretaceous period in India. The Gondwana rocks consist of sedimentary rocks rich in coal deposits.

while the Deccan Traps are extensive volcanic basaltic flows formed by massive eruptions around sixty six million years ago. Thank you very much to all.