E-PG PATHSHALA IN EARTH SCIENCE-final

Content Writers Template

1. Details of Module and its Structure

Module details	
Subject Name	Earth Science
Paper Name	Earth's Mineral Resources
Module Name/Title	Coal Resources
Module Id	ES15 – 596.
Pre-requisites	Before learning this module, the users should be aware of the origin, formation, properties, classification, chemical composition,and world distribution of coal and Indian distribution coal and lignite.
Objectives	The objectives of learning this module are to understand • Importance and properties of coal • Their origin and formation of coal Their classification and world distribution and Indian distribution of coal and lignite.
Keywords	Fossil fuel, Peat, Lignite, Sub-bituminous coal, Anthracite,Calorific Value, Volatile matter, Vitrain, Durain, Clarian, Fusain, Humification, Coalification

2. Structure of the Module-as Outline : Table of Contents only (topics covered with their sub-topics)

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COAL RESOURCES

Objectives :

The objectives of learning this module are to understand

- Importance and properties of coal
- Their origin and formation of coal

  Their classification and world distribution and Indian distribution of coal and lignite.

After attending this lesson the user should be able to understand the Importance and properties of coal,their origin and formation of coal, their classification and world-wide distribution of coal including Indian coal and lignite.

1.0 Introduction

Planet Earth has thousands of mineral resources. Minerals are the backbone of civilisation. The available mineral resources of any country can propel the economic growth. Minerals have shaped our civilisation from the Stone Age to the modern information age.

Among the naturally occurring mineral resources, we do have mineral fuels including oil and coal resources. Energy is a key input to the economic growth and for the improved quality of life. Coal has been used for several hundred years as a fuel. Currently, coal accounts for about 50% of the commercial energy use and about 24% of total primary energy needs of country. About 70% of the power generated is from coal and lignite.

1.1 Coal as a fuel

The word 'Coal' is derived from the Saxon word 'Cole' from the Sanskrit term 'Kala' and from the English term 'Col'. Coal is considered as a 'rock' as it is a natural solid substance forming one of the units of the earth's crust. It cannot be strictly considered as a mineral as it is not a homogeneous substance. Coal is not of inorganic origin. It does not have a definite chemical composition. In trade and industry, coal is regarded as a 'mineral'.

Coal is one of the chief 'fossil fuels' or 'mineral fuels. It is an important source of heat and energy.
Coal may be defined as vegetal matter that has been subjected to a variety of geological processes and has thereby undergone remarkable changes in physical properties as well as in chemical composition. The changes mainly involve the darkening of color, increase in hardness and compactness, loss of moisture and volatiles such as CO_2 (Carban Di oxide), Hydrogen and Oxygen and an increase in Carbon content.
The scientific definition of coal is given by E.A.N. Arbea that "Coal is a solid stratified rock composed mainly of hydrocarbons and capable of being used as a fuel to supply heat or light or both".

1.2 Varieties and Ranks of Coals

Initially there were two general varieties of coal as humic coal and saprogenic coal.
The Humic coals are the most important and are mainly formed from the remains of the wood and bark of the original plants. The saprogenic coals are formed from non-woody matter as leaves,

spores, enrich of plants and also from organic oozes, algae, fungi. These coals contain less carbon than normal coal and they are massive and on distillation they give Petroleum eg. Cannel coal. The saprogenic coals are considered to be transitory stage between true coal and petroleum. Sometimes they are termed Sapropelites as they are originated from the 'Sapropeliam'.

1.3 Coal in Earth's Geological History

Coal deposits are found in sedimentary sequences of Tertiary and Gondwana periods. Scientists refer to them as tertiary coals and gondwana coals

2.0 Modern classification of coal :

The following varieties of coal were recognized so far based on the extent to which the physical and chemical changes have proceeded in the transformation of vegetal matter into coals.

a) peat c) Subbituminous coal e) Semi-anthracite

b) Lignite d) Bituminous coal f) Anthracite

2.1 Peat: - Peat represents the first stage in the coal formation. It may be defined as a mass of vegetal matter that has undergone a varying degree of disintegration and decomposition. It is a compact fibrous and porous substance varying from light brown to dark brown in colour, in which the remains of original vegetal matter can be seen. It contains high percentage of moisture up to 85%, 10.4% of volatile matter, 4.6% fixed carbon and has a calorific value of about 3500 B.Th.U (British Thermal Units). Peat is not an economic fuel. It is mostly used as a fertilizer or in the manufacture of fertilizer because of its rich nitrogen content (up to 2%).

Important deposits of peat are found in England, Scotland, Virginia, etc. In India, peat beds are reported from Palani and Nilgiri Hills of Tamil Nadu and Kashmir. Submerged beds of peat are recorded from both sides of Hooghly River in Calcutta.

2.2 Lignite: It is also called as 'brown coal' because of its characteristic brown colour. It is generally woody in nature. It contains a high proportion of moisture (25-45%). It burns with a long brown flame and it has a low heating power.

Lignite is used for distillation, combustion, briquetting and gasification (manufacture of gas). Some lignite's are hard compact as in the case of Nyveli Lignite. Lignites are utilized for generating thermal power and also in the manufacture of fertilizers. The calorific value ranges from 11,000 to 12,500 B.Th.U/lb (British Thermal Units per period).

2.3 Sub-bituminous Coal: It is a dull black coal which is intermediate in grade between lignite and bituminous coal. It is practically free of woody matter or plant materials. Some of Lower Gondwana coals and of Eocene coals are of this type.

2.4 Bituminous Coal: This term is derived from the word 'bitumen', through it does not contain bitumen's. It is a common commercial rank coal. It is dense, compact and black in color and free from vegetable material. Usually, it is laminated with alternate dull and bright bands. It burns with a smoky yellow flame similar to that of bitumen. It exhibits dull to resinous luster. It breaks along vertical joints called 'cleats' giving rise to rectangular or cubical blocks.

Bituminous coals are considered as all purpose coals and because of its excellent heating quality it is most extensively used as fossil fuel in the world. It is used for steam raising and heating purposes. Bituminous coals are also used for the production of gas and coke. Bituminous coals are classified into High volatile and Low-volatile coals.

2.5 Semi-anthracite: It is harder than bituminous coal. It burns with a short yellow flame at first and then with a blue flame.

2.6 Anthracite: It is a hard coal with jet black (Iron black) color and semi-metallic luster. It does not soil the finger and breaks with conchoids fracture. It burns with short blue flames without smoke. Hardness varies from 2.75-3 and specific gravity from 1.27-1.7.gm/cc. It has a high heating value. It is used exclusively for domestic heating purposes wherever available. It has no coking property and it is not as common as the bituminous coals.

3.0 Chemical Composition of coal

Chemically, coal consists of a mixture of complex organic compounds along with small amounts of inorganic mineral matter and moisture. Carbon, hydrogen and oxygen are the principle constituents of coal, along with small amounts of nitrogen and sulphur.

The proportion of these elements is as shown in Table-1 from wood to Anthracite (According to Clarke).

	C	H	O	N
Wood	49.65	6.23	43.20	0.92
Peat	55.44	6.28	35.50	1.72
Lignite	72.95	5.24	20.50	1.31
Bituminous	84.24	5.55	8.69	1.52
Coal	93.50	2.81	2.72	0.97
Anthracite				

It is seen from the table that there is a steady increase of Carbon and a corresponding decrease in Oxygen from wood to Anthracite. Hydrogen also decreases very gradually and Nitrogen content remains constant.

The chemical composition of coal is determined either by the 'Proximate analysis' or by the 'Ultimate analysis'. The proximate analysis, consist of determination of the following:

3.1 Moisture Content: Presence of Moisture in coal may be coming due to absorbed water on the external surface of coal or in pores of coal and it is called free water. It is also present as dissolved water or as water resulting from the decomposition of organic compounds and it is termed as inherent/hydroscopic moisture. The inherent moisture can be roughly taken as a measure of the rank of coal. The Tertiary coals have relatively high moisture content than the Gondwana coals.

3.2 Volatile matter: The volatile matter obtained during the analysis of coal, consists of combustible gases, hydrogen, carbon monoxide, methane and hydrocarbon. It also includes tar-vapours and incombustible gases, like carbon dioxide and water vapour. Coals with volatile matter less than

17% or more than 40% are not good coking coals. Therefore the volatile matter controls the coking property and determines the rank of coal.

3.3 Ash Content: The amount of ash content in coal varies widely with reference to different coals. It is below 2% or it may be high as 20-30%. Assam coals contain 8% of ash; Gondwana coals contain up to 10% of ash content. Coals that have high ash content are generally regarded as low grade coals.

3.4 Fixed Carbon: The carbon that has not combined with any other element of coal is referred to as fixed carbon. The amount of fixed carbon increase with the rank of coal and it is highest in Anthracite.

3.5 Calorific Values: Calorific value is also known as the heat-raising capacity or value of coal. It can be expressed in terms of calories in the metric system or in terms of British Thermal units (B.Th.U) according to the English system.
A calorie (a unit of heat) is the heat required to raise the temperature of 1kg of water from 15 to 16 degree Celsius.
British thermal unit is the heat required to raise the temperature of one pound of water from 62 degree Fahrenheit to 63 degree F or B.Th.U. =0.252 calories.

4.0 Ultimate Analysis of coal:
It refers to the estimation of the proportion of ash, carbon, hydrogen, nitrogen oxygen, sulphur and phosphorus. The high percent of oxygen is very undesirable because it reduces the heating value and affects the coking property of coal.

Sulphur is present in all coals and it occur as organic phosphorous representing the constituent of the original plants or it may be present as the inorganic calcium phosphate derived from the intrusive magma. In India, the coal fields of Damodar valley, Phosphorous is derived mostly from highly phosphatic mica-lamprophyre dykes and sills.

Table-2: Average Chemical Composition of Various ranks of coal (After Moore)

Rank	Moisture	Volatile matter	Fixed carbon	Ash content	Calorie value
Lignite	34.55	35.34	22.91	7.20	3939
Sub-bituminous	24.28	27.63	44.84	3.25	5209
Bituminous	3.24	27.13	62.52	7.11	7733
Semi-Anthracite	3.38	8.47	76.65	11.50	7309
Anthracite	2.80	1.60	88.21	7.83	7388

It is seen that in the series of humic coals from lignite to anthracite, both moisture content and volatile matter decreases progressively and fixed carbon will be increased from Lignite to Anthracite. Peat and lignite are low-rank coals and Bituminous and Anthracite are high rank coals.

5.0 Visible Components of Coal

Coal is not homogenous throughout its mass but it is composed of a number of bands or layers. There are two types of bands as **Bright bands and Dull bands.** Indepth examination shows that each of these bands show the presence of two distinct components which are distinguished by their physical characters. The notable bands of the coals are a)vitrain, b)Clarian, c)Durian, d)Fusain.

5.1 Vitrain – is the principal bright component of coal having a jet black color with a brilliant and glassy surface. It occurs in thin bands or laminae. It breaks with conchoidal fracture. It shows vitreous luster.

5.2 Clarian – It is also bright component of coal but it is less brighter than Vitrain. It occurs as bands of variable thickness arranged parallel to bedding plane. It exhibits silky luster and a smooth striated surface when broken.

5.3 Durian – It is the 'dull' component of coal with a dull grayish black color and occurs as thick bands. It is hard and breaks with irregular and rough lusterless surface.

5.4 Fusain – It is also called 'mineral charcoal' and it is the soft black powdery component of coal. It occurs as patches or flat wedges. This is very friable material and charcoal.

6.0 Periods of coal formation

As mentioned earlier, there are two or three principle periods of coal formation in the Earth's History.

The first and most important period of coal formation was during Carboniferous to Permian times. The coal forming processes have first started in the North –Western part of the world during carboniferous period and gradually proceeded South-Easten, so that the coal seams of Northern-Hemisphere, particularly North America and Europe are of Carboniferous age and coal seams of Siberia, Eastern Asia, India and Australia are of Permian age. The major coal fields of the world, characterized by high rank coals, belong to the carboniferous and Permian periods.

The second geological period of coal formation was during upper cretaceous to Miocene times, found in Italy, Austria, Hungary, Japan, Indonesia and India. They are commonly referred to as Tertiary coals. All lignite deposits were formed in this period.

The third geological period which is a less important period of coal formation is Quaternary or Post-tertiary times. All known peat deposits of the world were formed during this time.

The major coal fields of the world have originated either in Swamps or in brackish or fresh water basins starting with, abundant plant material which might have drifted into these basins or grew insitu in swamps.

7.0 Stages in Coal Formation

The transformation of plant debris to coal occurs mainly in two successive stages, as **Bio-chemical stage and Geo-chemical stage**

7.1 Bio-chemical stage or peat forming stage is called Humification process. The changes brought about by the activity of bacteria and other microorganisms in the plant debris during this process are due to decay and decomposition of the chemical substances such as the Lignins, celluloses, proteins, resins etc. which were originally present in plants. The ultimate produces of such decay are some **humic** substances and the result is the transformation of the vegetal debris into a porous fibrous and friable mass called the peat. This stage is the most important stage because it gives the basic material i.e. peat which is subsequently transformed into different types of coal.

7.2 Geo-chemical stage or transformation of peat into higher rank coals. This is called coalification process.

The peat which is formed by humification process is converted into lignite and then to Bituminous coal and finally into Anthracite. All these happened under the influence of the conditions like temperature and pressure prevailing at depths in the earth's crust as well as due to various geological factors. This process is called coalification process. The series, peat-lignite-Bituminous-Anthracite is referred to as 'coalification series'.

8.0 Origin of Coal

Though all verities of coal are originated from vegetable matter, there is a wide divergence of opinions regarding the mode of accumulation of these plant remains in the water basins to give rise to coal seams.

So far.two theories have been put forward to explain the origin of coal seams. They are, Insitu theory and Drift theory.

8.**1 Insitu theory** : The Insitu theory suggests an 'insitu' origin of the coal seams which means that the vegetal grew at the same place where we now find the coal seams and it is said to be **Autochthonous** in origin.

Evidence in support of insitu theory :

1) There are large accumulations of vegetal matter forming in swamps at the present day. Some of them gave rise to coal seams.
2) The purity of coal seams and uniformity in composition indicates that the deposition of the vegetal matter in still waters and from nearly the same source material.
3) The numerous tree trunks were found with their roots firmly fixed in the underlying clays that lie beneath the coal seams. These clays represent the original soils on which the vegetation grew.
4) The underlying clays are generally poor in alkalies and oxides and these materials have been extracted and utilized by plants.

8.2 **Drift theory**: According to this theory the vegetal debris have been transported by water from their original site of growth to the present site of coal seams. This is said to be **Allochthonous** in origin.

Evidence in support of Drift Theory :

1) Large quantities of tree trunks are being transported downstream by present day rivers particularly in regions of forests.

2) Beds of peat have been found in the process of formation at the deltas of some rivers at the present day. . e.g., Delta of Ganga.
3) The presence of marine fossils.
4) The rocks associated with coal are distinctly sedimentary and coal seams themselves behave like sedimentary beds.
5) Tree trunks have been found with their tops headed downwards.
6) Absence of clays and coal seams lie directly on sandstones, shale's or conglomerates.

It is now generally accepted that coal seams of Western Europe are formed by insitu whereas those of India have been formed by drift.

9.0 Distribution of Coals in India:

The coal deposits of India belong to two principal geological periods-

1) The greatest period of coal formations in the Permian. The important coal-bearing formations are together known as Damudas (Damuda group) of lower Gondwana system (sequence). The coals were derived mainly from the Glossopteris flora which flourished in the vast ancient continent of 'Gondwana land' (coal measures of Australia, S. Africa and S. America were also derived from this flora).
2) Tertiary coals of Eocene to Miocene age in Assam, Himalaya (Lignite) hills of Darjeeling district in West Bengal, Tamil Nadu, Pondicherry, Kerala, Rajasthan, and Uttarpradesh and Peat deposits of Tamil Nadu, Jammu and Kashmir of younger Tertiary or (Quaternary) age. In Kashmir, sub-anthracites of Tertiary age were also reported.
3) In other parts of India, as in Kutch and Assam, coal seams associated with rocks of Mesozoic Era (Jurassic-Cretaceous) have been found.

Gondwan Sequence (System)

As the Gondwana sequence is the main source of coal in India, a brief of the Geological history is given here. The name 'Gondwana' sequence refers to a very thick (6000-7000 Mtrs) group of distinct fresh water sedimentary rocks of lacustrine, fluviatile or estuarine origin and ranging in age from upper carboniferous to lower cretaceous periods.

All the coal seams in India are inter-bedded with usually the sandstones and shale's of fresh water origin. The structure of the sedimentary basins in which coal deposits lie indicate that they were lake basins which occupy rift valleys (faulted valleys).

10.0 Coal Fields of India :

10.1 Coal Fields of West Bengal:

Raniganj Coal Field: This coal field is named after the town of Raniganj which is the mining centre.

Raniganj coal field is situated mainly in West Bengal and partly in Bihar and it is about 185 kms. North-West of Calcutta. This coal field is about 1554 Sq.Kms. in area and is one of the largest coal fields of India. The Gondwana formations in this coal field are extended over an area of 1000 Sq.km.

The estimated total reserves (insitu) of coal in the Raniganj field according to the committee on "Assessment of reserves of the coal council of India" are as follows:

1) The proved reserves of Quarriable Coal 376 million tonnes
2) Indicated reserves of Quarriable Coal 44.4 million tonnes
3) Inferred reserves of Quarriable Coal 48.3 million tonnes

10.2 Coal Fields of Jharkhand :

About one-third of the estimated coal reserves are distributed in the coalfields of Jharkhand and Bihar. Jharkhand is one of the leading producer of mineral wealth in the country.

The total reserves of the coal in Jharkhand is of the order 69128 million tonnes which spread over Jharia, Bokaro, Rajmahal, Hazaribagh and Chatra areas of prime coking coal in the country. The availability of prime coking coal in the country is quite meagre.

The State of Jharkhand is endowed with 72.2 Billion Tonnes of coal of all categories. This is distributed in 12 Major Coalfields. . Jharkhand is the only State which is having prime coking coal which with or without washing can be directly fed to Coke oven for making metallurgical coke.

Jharia Coal Field: It is the most important productive of the Indian coal fields and is situated in the heart of the damodar valley mainly along the North of the river in the Dhanbad District of Jharkhand. This coal field is named after the chief mining center 'Jharia' and it is situated about 260 kms N-W (North-West) of Calcutta. It is covering an area of about 450 sq.kms and extending for a maximum of about 38 kms. E-W (East-West) and 19 Km N-S(North-South). The lower Gondwana rocks are very well developed in this field.

The coal seams of the Jharia coal field exhibit a characteristic banding of alternate bright and dull layers of coaly matter. The coal seams are superior which is known as 'Selected grade coal'.

Bokaro Coal Filed: This coal field contains two parts – the East Bokaro coal field (area of 207 Sq.Kms) and West Bokaro Coal field (area of 154 Sq. Kms). All the formations of the lower Gondwana System from Talchir to Panche series occur in this fields. Usually the coals are of coking varieties. In west Bokaro Coal field, about 13 coal deposits occur up to a depth of 609 meters in this field. The coals are high in ash content, low in moisture content and coking varieties.

The Bokaro coal field is situated in the Hazaribagh district and is the second largest coal field in Jharkhand State and it is named after Bokaro River.

Ramgarh Coal field: This is a small coal field occupying an area of 98 Sq.Kms. in Barkars of Jharkhand State. About 20 coal seams are reported from this field. The coals in Ramgarh basin are of high coking variety.

10.3 Coal fields of Chhattisgarh

The state of Chhattisgarh has 16% of the total coal deposits of India. 44483 million tonnes of coal has been estimated in 12 coalfields of the State located in Raigarh, Surguja, Koriya and Korba districts. The state ranks 2nd in coal production by contributing over 18% to the total national production.

Most of the coal deposits are of power grade coal. NTPC & CSEB in Korba are the major producer of thermal power and new a plant of NTPC has been started in Seepat, Bilaspur. Potential for more power generation units exist in the State.

South Eastern Coal Fields, also called as SECL, at Korba of Chhattisgarh is an excellent base from where the mining sector of the state has received major impetus. Since the reserves of tin, iron, dolomite and other similar elements are spread over the huge geographical space of Chhattisgarh, hence it is but natural that mining and production cost are quite low, which in turn brings greater returns economically.

a) North Chhattisgarh Coalfields:

Following are the major coal fields of North Chhattisgharh

1. **Tatapani Ramkola coalfield**
2. **Jhilimili coalfield** .
3. **Sonhat coalfield**
4. **Bisrampur coalfield**

b). South Chhattisgarh Coalfields:

1. **Hasdo-Rampur (Surguja) coalfield**
2. **Korba coalfield**.
3. **Mand- Raigarh coalfield**

10.4 Coal Fields of Orissa

Out of 57 Gondawana & 14 Tertiary coalfields for the national inventory of coal, Orissa state has only two coalfields. Yet its share in the reserve is so far established in the country amounts to 24.78% (58.01 B.T).

In Terms of spatial spread of prognostical coal bearing area, the coalfields of the state of Orissa have about 7.6% area (2723 Sq.Km). This goes to illustrate the high ratio of coal to non coal strata in the two hitherto known coal bearing basins viz. River coalfield and Talcher coalfield. As a sequel to which these coalfields have an added advantage of being accorded most favoured coalfields status by the nature as far as quarriable potentiality is concerned.

10.5 Coal Fields of Bihar

1.Karanapura Coal Field

This is another major coal field of the upper Damodar valley including two separate areas of Gondwana rocks such as Northern area of about 1230 Sq. Km and known as North Karanapura coal field and the southern area of about 195 Sq.Km called the South Karanapura Coal Filed, in the Bihar state. The total area of this coal field is 1, 424 Sq.Km. There are two regions of coal occurrence as

i) **Northern Karanapura Coal field**

ii) **South Karanapura Coal Field**

10.6 Coal Field of Madhya Pradesh:

In Madhya Pradesh the most important coal fields are Singrauli Coal Field.

i) **Singrauli Coal Field:** This coal filed is situated south of the Son River and occupy an area of 2300 Sq. Km. in Madhya Pradesh. This field contains 140 to 160 mts. thick coal seam known as Jhingurdh Seam (which is the second thickest seam in the world) lies mainly in the Sidhi District of Madhya Pradesh with a small area of 80 Sq.Km extending into Mirzapur district of Uttar Pradesh.

The estimated reserves of coal deposits of the field are the order of 10,851 million tonnes

10.7 Coal fields of Andrapradesh

Pranhita – Godavari Valley

The coal – bearing rocks of this valley extend over an area of 9000 Sq.Kms. The lower Gondwana rock comprising of Talchirs (61 Meters), Barkars (610 Meters) and Kamthi beds (45m) are well developed. The Talchir lie unconformity over the vindhayns (lime stone and shales) which lie on crystalline archaeans.

The Kamthi beds (Sandstones) are well exposed over the most part of this region and Barkars are few which indicate that Barkars might have eroded before the deposition of Kamthi beds. The Barkars occupy parts of Adilabad, East Godavari, Kraimnagar, Khammam, Nizamabad, Warangal and West Godhavari districts. Of all these areas, the coal mining is confined to **Singareni, Tandur and Godhavari Area.**

i) Singareni Coal Filed (yellandu)

This coal field forms an outlier of Lower Gondwana rocks occupying an area of 5020 Sq. Km and it lies within the Khammamett (Khammam) district. This coal field is in the form of a long narrow strike with a length of 22. 5 Km and 3.2 to 5 Meters width and it is the most important coal producing field in the Godhavari valley. The coal seams occur in the northern part near Yellanlapad which is also 185 Kms East of Hyderabad.

About 7 coal seams are recognised in this coal field of which the bottom coal seam is known as 'King Seam' which varies in thickness from 1.83 to 2.1 Meters. The coal is of excellent quality of non-coking variety. Another coal seam which occurs above the King seam is referred to as 'thick Seam' which varies in thickness from 9.7 to 30.4 metre. This 'Thick Seam' was also named as the 'Queen Seam'.

11.0 Lignite deposit of India

Important deposits of lignite in India are found in Tamil Nadu, Pondicherry, Rajasthan, Kerala, Manipur, Nagaland, Tripura and Uttar Pradesh. The lignite deposits reserves in India (1983) were estimated as 2, 906 million tonnes of which 2,590 million tonnes are reported from 'Nyveli Lignite field' in the South Arcot district of Tamil Nadu. Therefore, of all the lignite occurrences the Nyveli Lignite field is the most important.

Nyveli Lignite filed (Tertiary Coal seams)

This lignite filed is centred around the Nyveli Station and it is 43 Km west of Cuddalore part and about 241 Km from Madras. The lignite deposits in Nyveli occur in a sequence of clays and Cuddalore Sandstones of Miocene Age. Lignite occurs as a regular seam with a thickness varying from 12 to 24 meters in the main field. No out crops of lignite were noticed but only in drill holes the

lignite was encountered at depth of 43 meters. At present in the Main Quarry the lignite is taken out from depth of 54.86 meters below the surface.

12.0 World Coal and Lignite Industry: Lignite is not traded to any significant extent in world markets, because of its relatively low heat content and other problems related to transport and storage. World coal and lignite consumption is projected to be around 6.8 Billion tonnes in 2020. Coal use in developing Asia alone is projected to increase by 1.8 Billion tonnes. China and India put together are projected to account for 29% of the increase in energy consumption. India is expected to add over 65000 MW (Megewatts) by 2020 based on coal and lignite.

13.0 World Coal Reserves:

Coal is the most abundant amongst the fossil fuels. The latest estimated worldwide coal reserves are given below in Table

Region	Reserves in billion tonnes.
North America	258
Central and South America	22
Western Europe	92
Middle East	2
Africa	55
Asia	292
Former Soviet Union	263
World Total Source: Energy Information Administration(EIA) 2010	**984**

14.0 Indian Coal Resources:

The coal resources of India are available in sedimentary rocks of old Gondwana formations of peninsular India and the younger Tertiary formations of Northern/North-Eastern hilly region. The total coal resource in India stands at 242 billion tonnes.

State-Wise Resources of Indian Coal : in million tonnes, Shown in Table

States	Proved	Indicated	Inferred	Total
Andhrapradesh	8263	6079	2584	16926
Arunachal pradesh	31	40	19	90
Assam	279	27	34	340
Chattisgarh	9373	26191	4411	39973
Jharkhand	35417	30439	6348	72204
Madhyapradesh	7531	8815	2904	19252
Maharashtra	4652	2309	1620	8581
Orissa	15161	30976	14847	60984
West Bengal	11383	11876	4554	27813
Total	92090	116752	37321	246163

15.0 Indian Lignite Resources;

State-Wise and category –wise Lignite reserves are summarised below: in million tones. In table

State	Proved	Indicated	Inferred	Total
Tamil Nadu	2,360.00	9,358.12	18,753.70	30,471.82
Rajasthan	649.89	1,133.09	1,702.01	3,484.99
Gujarat	323.00	465.00	1,027.83	1,815.83
Jammu & Kashmir		20.25	107.59	127.84
Kerala	8.30		100.00	108.30
Total	**3,341.19**	**10,976.46**	**21,691.13**	**36,008.7**

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16.0 Conclusions:

Coal is one of the chief 'fossil fuels' or 'mineral fuels. It is an important source of heat and energy.

Coal deposits are found in sedimentary sequences of Tertiary and Gondwana periods

Coal is not homogenous throughout its mass but it is composed of a number of bands or layers.

Though all verities of coal are originated from vegetable matter, there is a wide divergence of opinions regarding the mode of accumulation of these plant remains in the water basins to give rise to coal seams. All the coal seams in India are inter-bedded with usually the sandstones and shale's of fresh water origin