

Geological, Mineralogical and Petrological Study of the Kalyaneshwari - Maithan Area, Under Raniganj Coalfield : A Case Study

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Abstract: *Geology is the study of the liquid and solid matters that form the earth. The discipline of Geology includes the experiment of the composition, properties, and history of the Earth materials. Geological Process relies on the identification of rocks and minerals and an understanding of the environment in which they formed. These surveys aim to find what rock types occur at or close to the surface and how these rock types are related to each other i.e. their boundaries, ages, and formations. The present work is an effort to highlight the general geology, stratigraphy and different geological structural evidences in the Kalyaneshwari - Maithan area, under Raniganj Coalfield (near the border of Jharkhand & West Bengal). The investigation also focuses the different types of identity and characteristics of rocks and minerals to the study area to end with the map of 'Coal Seams under Raniganj Coalfield' and 'Rocks and Minerals map' of the study area.*

Key Words: *Geology, Earth Materials, Geological Process, Rocks, Minerals, Stratigraphy.*

1. INTRODUCTION:

A 'Geological survey' is the systematic research of the geology beneath a given piece of ground for the purpose of creating a geological map or model. Geological surveying employs techniques from the traditional walk-over survey, studying, outcrops and landforms, to intrusive methods, to the use of geophysical techniques and remote sensing methods, such as aerial photography and satellite imagery. Such surveys may be undertaken by state, province, or national geological survey organizations to maintain the geological inventory and advance the learning of geosciences for the benefit of the nation. A Geological report can provide a description of the geological characteristics of a specific area or region. Geological reports may be very detailed or brief, depending on the project and its level of complicity. Professional geologists write reports about observations and investigations. Geographers can also demonstrate their findings about an experiment or field survey. The present paper is an attempt to study and clarify the Geology of the area, the collection of rocks and minerals specimens from the field along with their characteristics and identification procedure.

2. OBJECTIVES:

The Major Objectives of the Study Area:

SL. No.		THE CORE OBJECTIVE
1	To Study	The general geology and stratigraphy of the area.
2	To Recognize	Different geological structural evidences in the area.
3	To Collect and Identify	Different types of rocks and minerals from the area and learn their characteristics.
4	To Know	About the coal seams of the area.

3. RESEARCH METHODOLOGY:

Field study requires certain processes and methods within this and should be systematically followed in order to have an organized field report. The three stages include-

Pre-field Work: This involves an idea about the place before visiting it, with location, topography, geology etc. from secondary data sources. It also involves the collection of base map (*Mouza Map*) and Topographical Sheets collected from the SOI (Survey of India) and other secondary information from Geological Survey of India handbook (2013).

Field Work: It involves the collection of both primary and secondary information from the field. I've collected many

types of rocks and minerals from the study area.

Post-field Work: It is the most vital part of the work. I used the 'QGIS' software for Creation 'False Color Composite (FCC) map' of the Study Area. I have analyzed about the geological, mineralogical and petrological characteristics from collecting both primary and secondary database and at last I also used 'Google Earth' application for creating the 'Rocks and Minerals map' of the present area.

4. BRIEF LAYOUT OF THE STUDY AREA:



The area under review is located in the extreme Western part of the Paschim Bardhaman District at Kulti Municipality under Asansol Sub-Division and located near the border Jharkhand District in the West. The rationale behind the selection of the study area is very crucial. As the area experienced a define geological structure from historical period it was assumed that the area will be stratigraphically suitable also for the elementary geological study with ample of sedimentary and metamorphic rocks. The latitudinal and longitudinal extension of the area is $23^{\circ}46'05''N - 23^{\circ}47'12''N$ & $86^{\circ}49'22''E - 86^{\circ}50'33''E$ respectively. Total geographical area coverage is of the **3.27 Sq Kms**. The average altitude of the area is **100.6** meters from the sea level.

Average annual rainfall of the area is 1420 mm. The maximum and minimum temperature is $45^{\circ}C$ and $10^{\circ}C$ respectively. There are two Nalas, among which one is flowing to south-east, and another towards south to join Damodar river in the south.

Figure 1: Location Map of the Area (Compiled by Author)

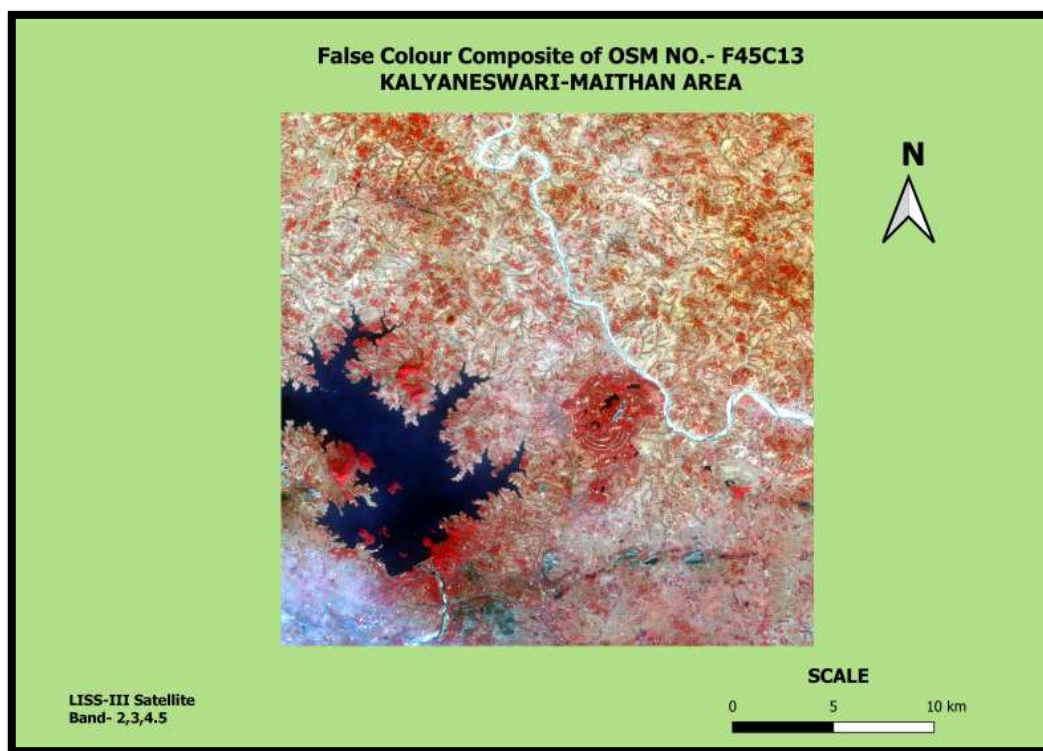


Figure 2: FCC of the study area (Compiled by Author)

5. BACKGROUND:

The entire area is mainly comprised of lower Gondwana group of rocks, underlain by Archaean Metamorphics, which are mainly formed of granitoid and schistose. The Archaean Shields are uncovered outcrops in North-West (NW) of Asansol Sub-Division (*mainly near the Salanpur and Barabani blocks*) intermingled with rounded hillocks from the Pre-Cambrian Eon. (*Sengupta, 1970: 1*). Genetically, the Archaean structure is composed of both sedimentary and igneous origin. The sedimentary structure is of Gondwana and Upper Tertiary are, consolidated sediments of Sandstones, Shales, Limestones etc, are metamorphosed to produce Schists, Gneisses including Quartzite, Phyllite, Hornblende-Schists etc. (*Hunday and Banerjee, 1967: 30-31*). The area is covered by sedimentary rocks (85%), but

metamorphic rocks found here are also important. The metamorphic rocks include Banded Amphibolites type. The entire area has fault and the dip of the rock beds are in NW-SE in direction with 10° - 12° of dip angle.

The area is an extended portion projected out from the Western Chotanagpur Plateau characterized by infertile, exposed and undulating terrain with occasional laterite cover. The whole land is covered with **Sal** (*shorea robusta*) and **Palash** (*Butea Monosperma*) forest with scattered hillocks.

6. GENERAL GEOLOGY AND STRATIGRAPHY:

The rocks found from the field area belong to Gondwana Supragroup. This is the most important stratigraphic horizon because of the presence of Coal in this horizon. The study area belongs to Raniganj coalfield, which is the eastern most coalfield of Barakar River Valley. The Raniganj coalfield, particularly the study area found to overlie unconformity over the metamorphic rocks belonging to the Pre-Cambrian age in a block faulted and gneissose structure. Sedimentary rocks belonging to Gondwana Supragroup are mostly isolated.

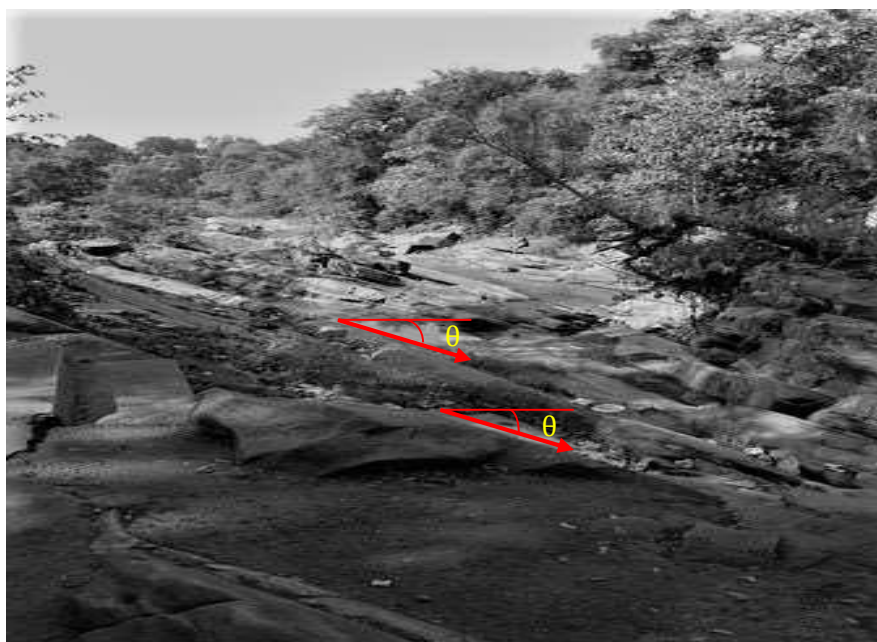


Figure 3 : Upper portion of layer and Dip of Rocks (Backside of Kalyaneshwari Temple)



Figure 4 : Joints of Rock (Near the Kalyaneshwari Burning Ghat)



Figure 5 : Sill formation and strata of rocks (Near the Kalyaneshwari Pahari Baba's Temple)

Stratigraphic sequence: The general stratigraphic sequence of the area of investigation is given below;

Lower Gondwana Sequence
Supra Panchet (Upper Jurassic)
-----Unconformity-----
Panchet (Upper Triassic)
-----Unconformity-----
Raniganj Formation (Upper Permian)
Iron Stone Formation (Upper Permian)
Barakar Formation (Lower Permian)
Talcher Formation (Lower Permian)
-----Unconformity-----
Archaean Basement

Two distinctly different types of rocks occur in the present study area. In the Northern part particularly in the North of Kalyaneshwari Temple, the rock types are metamorphic and are represented by Amphibolites and Granite, where in the Southern part of the area, mostly sedimentary rocks like Sandstone, Shale, Conglomerate, and Coal are found.

Metamorphic rocks occurring in the Northern part belong to Pre-Cambrian age. The most dominant metamorphic rock is the Amphibolites, Pyroxenite, occur as minor variant within their group. Pegmatite is found as concordant intrusive body within both Amphibolites and Granulite. Quartz veins are also present with variable thickness and orientation within the host metamorphic rocks. Pyroxenite rock body mostly occupies the hillocks of area, e.g. the **Bhander Hill**.



Figure 6 : Quartz Vein (Kalyaneshwari Area)

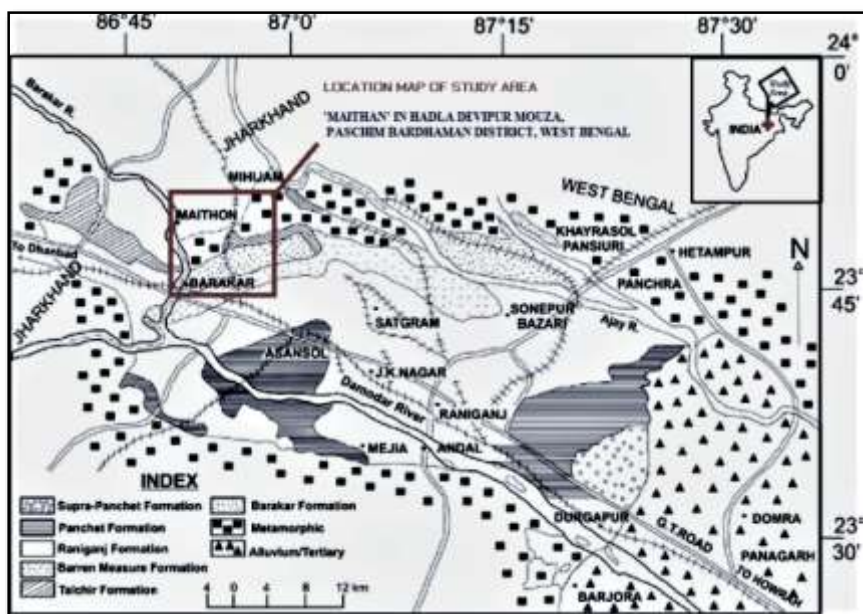


Figure 7 : Geological Map of the Western Part of Bardhaman District

This rock is massive, pitch black in color, fine grained, hard and compact. Quartzite occurs as this to moderately thick band within massive Amphibolites. Its outcrops are found on the Western side of Kalyaneshwari temple along the Barakar River. It is hard, massive, buffalo white in color, medium in grain size. The Pegmatite is very coarse grained massive hard and compact rock. Pegmatite and Mica were found in the vicinity of **Purundi village**. The dominant minerals are Quartz, Feldspar, both alkaline and plagioclase and muscovite.

Raniganj formation is very important. It consists of fine Sandstone, carbonaceous Shale and Coal seams. Sandstones are fine grained. Shale contain well preserved plant fossil. Near, Maithan, in the Eastern flank of the Barakar River valley well exposed Sandstone beds are found. The Barakar Sandstone is characterized by the presence of cross bedding. The rock beds are dipping towards North-west (NW) at an angle of 10° . The most important economic rock found here is Coal which occurs in Barakar formation of Lower Gondwana. Mining are conducted here and the important centre is **Ramnagar Opencast Project**. The coals are mostly semi-bituminous with 85% - 90% carbon content. Ash content is high. Coal occurs as tabular bedded types with a varying dip of 4° - 5° towards South. The coal seams occur in between Shale and Sandstone.

7. COLLECTION OF ROCKS AND MINERALS SPECIMENS FROM THE STUDY AREA AND IDENTIFICATION PROCEDURE:

Minerals:

i) Quartz

Collected from, Latitude- $23^{\circ} 47' 00''$ N, Longitude- $86^{\circ} 49' 55''$ E, Altitude- 122 m.

Identification-1. Form: Hexagonal, 2. Color: Milky, Pink, Ash, 3. Hardness: 7, 4. Cleavage: Absent, 5. Streak: Colorless, 6. Specific Gravity: 2.65.



ii) Feldspar (Plagioclase)



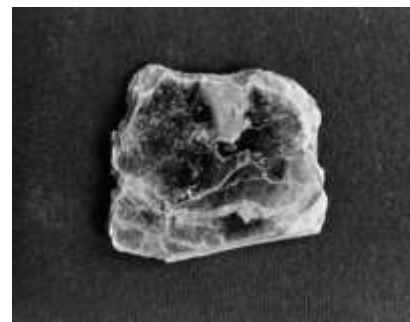
Collected from, Latitude- $23^{\circ} 46' 44''$ N, Longitude- $86^{\circ} 49' 40''$ E, Altitude- 113 m.

Identification- 1. Form: Stacked, 2. Color: White & Ash, 3. Hardness: 6-6.5, 4. Cleavage: Perfect, 5. Fracture: Even, 6. Specific Gravity: 2.60-2.74.

iii) Biotite (Mica)

Collected from, Latitude- $23^{\circ} 46' 38''$ N, Longitude- $86^{\circ} 50' 09''$ E, Altitude- 141 m.

Identification- 1. Form: Thickness, 2. Color: Dark -Blackish, 3. Hardness: 2.5-3, 4. Cleavage: Bright & Perfect, 5. Fracture: Plain, 6. Specific Gravity: 2.71-3.1.



Rocks:

i) Sandstone (Sedimentary)

Collected from, Latitude- $23^{\circ} 46' 32''$ N, Longitude- $86^{\circ} 49' 31''$ E, Altitude- 100.6 m.

Identification- 1. Formation: Rich in silica, iron oxide or lime. Also made up of Quartz and Feldspar, 2. Color: Ash, Yellow, Brown, 3. Texture: Fine grains, 4. Specific Gravity: 2.5, 5. Form: Layered.



ii) Banded Amphibolite (Metamorphic)



Collected from, Latitude- $23^{\circ} 46' 58''$ N, Longitude- $86^{\circ} 49' 32''$ E, Altitude- 176 m.

Identification- 1. Formation: Contains amphibole, especially the species hornblende and actinolite, as well as plagioclase, 2. Color: Dark & dense, 3. Structure: Foliated, 4. Texture: Coarse grained.

iii) Pyroxenite (Ultramafic Igneous)

Collected from, Latitude- $23^{\circ} 46' 58''$ N, Longitude- $86^{\circ} 49' 31''$ E, Altitude- 188 m.

Identification- 1. Formation: Consisting essentially of minerals of the pyroxene group, such as augite, diopside, bronzite, 2. Color: Dark & dense, 3. Structure: Uneven, 4. Texture: Coarse grained.



iv) Pegmatite (Plutonic Igneous)

Collected from, Latitude- $23^{\circ} 46' 38''$ N, Longitude- $86^{\circ} 50' 09''$ E, Altitude- 141 m.

Identification- 1. Formation: Contains quartz and feldspar and also contains minerals like fluorite, lepidolite, mica, etc, 2. Specific Gravity: Medium, 3. Structure: Uneven, 4. Texture: Coarse grained.

v) **Granite (Igneous)**

Collected from, Latitude- 23° 47' 00" N, Longitude- 86° 49' 33" E, Altitude- 142 m.

Identification- 1. Formation: Contains of minerals- quartz, feldspar (Orthoclase & Plagioclase), & Mica, 2. Color: Light pink, with white and black spots, 3. Specific Gravity: 2.63-2.75, 4. Texture: Coarse to medium grained, 5. Form: Crystal shape.



vi) **Gneiss (Metamorphic)**



Collected from, Latitude- 23° 47' 00" N, Longitude- 86° 49' 33" E, Altitude- 142 m.

Identification- 1. Formation: Contains of quartz and feldspar and also Ferromanganese minerals with banded character, 2. Color: White-Pink & Greenish Black, 3. Form: Bulky.

vii) **Quartzite (Metamorphic)**

Collected from, Latitude- 23° 46' 27" N, Longitude- 86° 49' 59" E, Altitude- 134 m.

Identification- 1. Formation: The sandstone is transformed into quartzite, 2. Color: White, Ash, Green, & Red, 3. Form: Bulky, Hardy, 4. Texture: Fine to coarse grains, 5. Fracture: Cone like.



viii) **Shale (Sedimentary)**



Collected from, Latitude- 23° 46' 44" N, Longitude- 86° 49' 26" E, Altitude- 108 m.

Identification- 1. Formation: Contains of silt and clay minerals, 2. Color: Brown, green, Ash, Slightly yellow, 3. Form: Layered, 4. Texture: Fine grains, 5. Odor: If soaked by water, then the smell of mud is found.

ix) **Conglomerate (Sedimentary)**

Collected from, Latitude- 23° 46' 40" N, Longitude- 86° 49' 53" E, Altitude- 128 m.

Identification- 1. Formation: Being mostly of fluvial origin, this consists of typical mud-free gravels or their lithified equivalents (i.e., grains of quartz, jasper, feldspar, and rock fragments of various sizes, shapes and colors), 2. Texture: Very rough grains, 3. Form: Bulky, 4. Specific Gravity: Moderate to high.

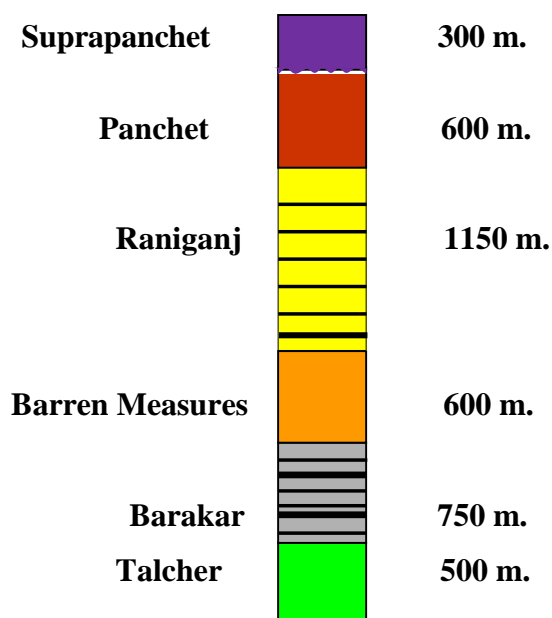




Figure 8 : Rocks and Minerals Map of the Study Area (Hadla-Devipur Mouza, West Bengal)

8. COAL SEAMS UNDER ‘RANIGANJ COALFIELD’ (RELATED TO MY STUDY AREA):

Raniganj coalfield covers an area of about 1530 sq kms with a coal reserve of 27,655 million tons upto a depth of 800m with an annual production of 24.03 million tons (CMPDIL). The coal deposition of the portion of Raniganj coalfield developed mainly in the series under the Gondwana System in geological time scale. Most of the coal of Gondwanas is found in the Damuda (Damodar) system, this is both in Barakar and Raniganj series, the former being the more important one. This area is rich in coal deposits promoting coal mining as a principal activity and surrounding the areas have grown a number of iron-steel and engineering industries wherein a large number of workers are engaged to earn their livelihoods. There are 23 seams measuring over 1.2 meters in thickness of these 11 are located in the Raniganj and 12 in the Barakar measures.



The Barakar measures occur as an irregular belt roughly parallel to the northern boundary of the coalfield and cover nearly 155kms (*Gaz, Burd. 1994:32*). The Barakar consist of conglomerates, sandstones, shales and coal seams of a somewhat irregular character thinning out at short distances. Above the Barakar group in the Raniganj coalfield and a few other coalfields of the Damodar valley, there is found a great thickness of coarse and fine sandstones, mostly false bedded and felspathic, with shales and coal seams, which are frequently continuous over considerable Areas. The coarse white felspathic grits and conglomerates, very common in the Barakar measures (*Peterson, J.C.K. 1910:17*). The Panchets consist chiefly of thick beds of coarse felspathic and micaceous sandstones often of a white or greenish white color with subordinate bands of red clay. All these groups have yielded plant fossils; the Panchet rocks contain, in

addition, reptilian and fish remains. This series is composed mainly of alternations of fine red clays and coarse sandstones. The rocks of the Panchet series are exposed in the vicinity of Asansol and southwards across the Damodar river over an area of 240 kms (*Gaz, Burd. 1994:34*).

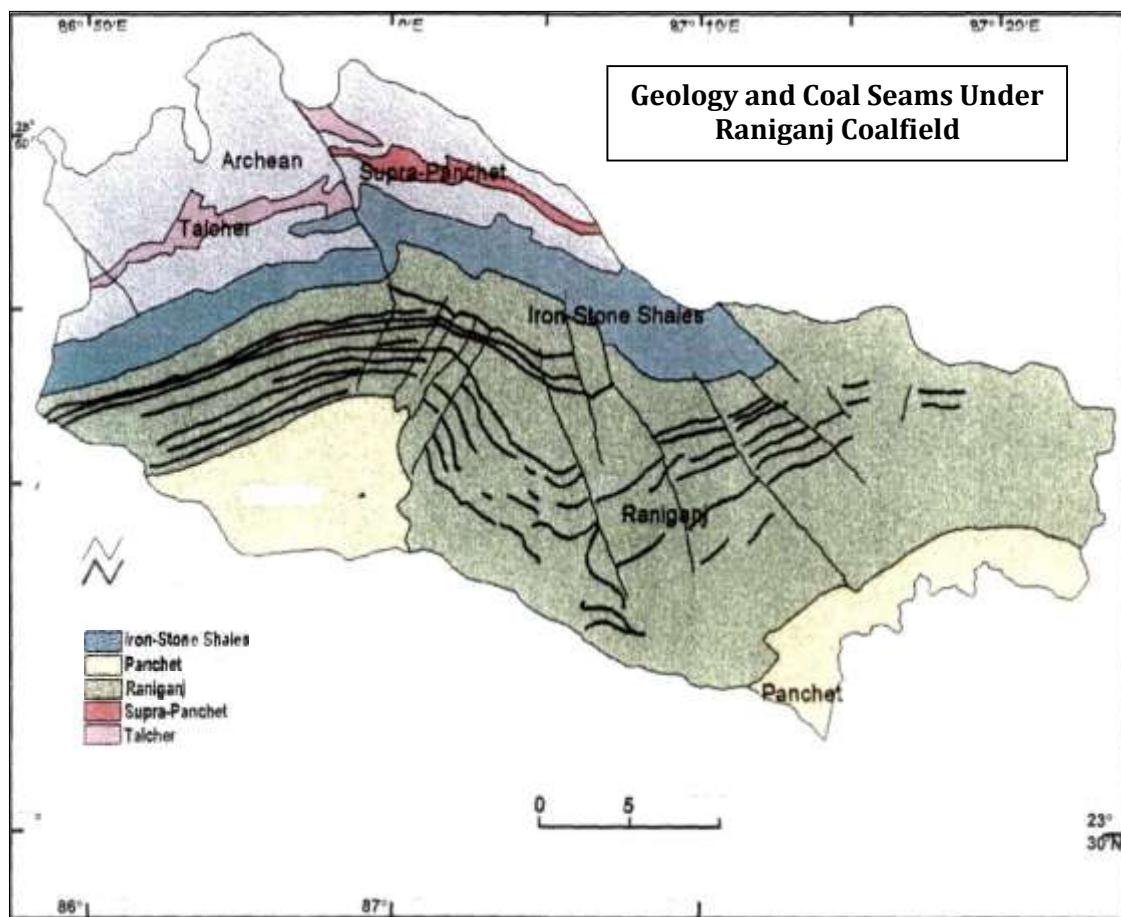


Figure 9 :Map of Coal Seams Under "Raniganj Coalfield"

Ironstone stage comprising mainly of carbonaceous shales with clay ironstone nodules. Its alternative name is 'Barren Measures' due to the absence of any workable coal seam (*Gaz, Burd.1994,:32*). Rajmahal series are exposed in the south-eastern portion of this region and the Durgapur beds are Rajmahal series, which consists of lava flows with intercalated carbonaceous and siliceous shales and clays. The Raniganj measures crop out along the southern half of the Raniganj coalfield. The Raniganj stage consists of sandstones and shales. The coarse white felspathic grits and conglomerates are absent in the Raniganj stage (*Gaz, Burd.1994:33*). These areas contain coal seams ranging up to about 12.5 m in thickness. Reserves of coking coal in this coalfield have been conservatively estimated at 82 million tons up to 1,000 ft. and 250 million tons up to a depth of 2,000 ft. In addition, there are vast reserves of superior non-coking and inferior quality coals. The Raniganj coalfield also contains large reserves of iron ore, occurring chiefly as nodules in the ironstone shales. Formerly these ores used to be smelted at the Kulti Iron Works. Coal seams are developed in practically all the areas where the Barakar series occurs. Raniganj series coal is most important only in the Raniganj coalfield though found also in Jharia, Bokaro and a few neighboring fields.

The general characters of coal of the Barakar and Raniganj series are as follows;

TABLE 1: The General Characters of Coal of the Barakar and Raniganj Series

Barakar Series	Raniganj Series
Low Moisture (1-3 per cent)	High Moisture (3-8 per cent)
Low Volatile (20-30 per cent)	High Volatile (30-36 per cent)
High fixed carbon (56-65 per cent)	Medium fixed carbon (50-60 per cent)
Excellent steam coal and often excellent coking coal	Generally poorly coking through some are moderately so; good gas coal and long flame steam coal

Source: Krishnan, 1966

I have tabulated below the information obtained of coal seams in my study area. I have collected this information from the Source of the Mining Block, Kalyaneshwari.



Figure 10: A Map of Coal Reserved of the Present Area (Kalyaneshwari Coal Block)

TABLE 2: Kalyaneshwari Coal Block Summary

Features	Details
Location	
Coal Block	East of Damagoria (Kalyaneshwari) Coal Block
Latitude	23°46'05"N - 23°47'12"N
Longitude	86°49'22"E - 86°50'33"E
Coalfield	Raniganj Coalfield, Paschim Bardhaman District, West Bengal
Area	
Geological Block Area	3.3 Km ² (approximate)
Exploration	
Status	Explored
Total Number of Boreholes with meterage	46 nos., 11373.41m. (Project Area) & 11 nos, 1978.06m (Adjoining Area)
General Dip of Seams	Dip- 4° to 7° southerly
General Strike Direction	NE-SW to E-W

TABLE 3: Coal Seams Details (Kalyaneshwari Block) As Per Geological Report

Coal seams details (As per Geological Report)	Kalyaneshwari OCP Summaries Reserve Table of Coal (Mt.)		
	GEOLOGICAL RESERVES (Mt.)		
COAL SEAMS	Coal	Coal+Jhama	Total
Ramnagar	0.59	0.36	0.95
Laikdih Top	0.16	-	0.16
Laikdih Middle	0.53	0.07	0.60
Laikdih Bottom	2.01	2.14	4.15
L-10	2.30	-	2.30
Salanpur- D	2.26	1.94	4.20
Salanpur- C	8.11	3.32	11.43
L-9	2.63	-	2.63
L-8	2.12	-	2.12
L-7	2.60	-	2.60

L-6	4.01	-	4.01
L-4	0.94	-	0.94
L-3	1.98	-	1.98
L-2	2.77	-	2.77
Salanpur- B	13.32	2.45	15.77
Salanpur- A	5.84	38.46	44.30
<i>Total</i>	<i>52.17</i>	<i>48.74</i>	<i>100.91</i>

Source: Mining Block, Kalyaneshwari

TABLE 4: Kalyaneshwari OCP Jhama Reserve (Mt.)

Seams	Full Jhama Zone		Sub Total	Jhama in Coal + Jhama Zone		Sub Total	Grand Total
	Volatilised	Devolatilised		Volatilised	Devolatilised		
Laikdih Bottom	-	0.1	0.1	0.35	0.3	0.65	0.75
Salanpur-D	0.2	-	0.2	0.72	-	0.72	0.92
Salanpur-C	0.06	-	0.06	0.52	-	0.52	0.58
Salanpur-B	-	-	-	0.54	-	0.54	0.54
Salanpur-A	-	-	-	9.54	-	9.54	9.54
<i>Total</i>	<i>0.26</i>	<i>0.1</i>	<i>0.36</i>	<i>11.67</i>	<i>0.3</i>	<i>11.97</i>	<i>12.33</i>

Source: Mining Block, Kalyaneshwari

TABLE 5: Ranks and Coking properties of four top most reserved coal seams of the present area

Name of the Seams	Rank	Coking property
Salanpur- D	High Volatile Bituminous	Moderate to well coking
Salanpur- C	High Volatile Bituminous	Moderately good coking
Salanpur- B	Medium Volatile Bituminous	Moderate coking
Salanpur- A	Medium Volatile Bituminous	Coking to non-coking

Source: Chanda, 1990

9. CONCLUDING REMARKS:

The area under study is an extended part of the Chotanagapur Plateau formed of Pre-Cambrian metamorphic rocks. Most of the rocks are Amphibolites, Gneiss and Granite originated in Pre-Cambrian basement. The basement of this area was uplifted due to the tectonic activity which led to the formation of a basin. Further this basin helped in sedimentation and de-genesis of sedimentary rocks due to large time extension during the tectonic upliftment. Thus the sediments are part of the Gondwana group of rocks, underlain by Archaean Metamorphics.



Figure 11 : Asymmetric Kink Fold at the Backside of Kalyaneshwari Temple

The sedimentary depositions are characterized by layers which correspond to a definite time period of geological history. The light green Limestone found here is a part of *Talcher* boulder bed. The coal seams situated in the south belongs to the Barakar formation. Geologically and stratigraphically the area under review is very much well-defined as various types of geological structure such as Isoclinal folds, Chevron folds, Joints, line of unconformity, and ample presence of different types of sedimentary and metamorphic rocks and minerals (Quartz, Mica, Coal etc.). The study therefore has an impact as it is widening the geological knowledge base of the pupil as well as puts impact on their decision making in the identification process of rock and mineral specimens.

Finally, it may be concluded with the satisfaction that the research study has fulfilled all the objectives undertaken and the study has been successful in realizing the Geological, Mineralogical and Petrological characteristics of the area under study.

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