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Limestone Deposits and Its Economic Importance at Panchbibi Area of Joypurhat District, Bangladesh

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Abstract: The study area is located at Panchbibi upazila of Joypurhat District which is in the south-western part of Bangladesh. Tectonically the area lies in the southern slope of Rangpur saddle within the stable Precambrian platform. The investigation work carried out by an exploratory drilling operation with the help of wire line drilling rig. Core samples were collected and subsequently analyzed during the drilling activity. Three limestone layers have been encountered at different depth of this drilling hole which is in between 450 meter to 530 meter below the surface. This limestone is light grey in colour, fossiliferous, sandy in nature, moderately hard and compacted. The outer surfaces of core samples are not smooth. It Composed of mainly (>40%) calcium carbonate ($CaCO_3$). The average chemical property of limestone is 44% CaO, 10% SiO_2, 1% Fe_2O_3 and 2% Al_2O_3. The thickness of limestone is varies from layer to layer where first layer is about 8 m thick and the total thickness of the limestone is about 13 m. The physical and chemical properties of limestone indicated that the quality of limestone is medium to good. Composed of calcareous sands, both skeletal and oolitic, with lesser volume of fine carbonate mud and reef rocks which indicated that the condition of deposition of this limestone is shallow water deposits. It is the most important and widely distributed carbonate rocks which used in many industrial purposes. The limestone deposit of the studied area may utilize at different purposes after extraction like as mainly in manufactures of cement clinkers in the cement factory. Besides it is also used as different construction materials. It should be suggested that more exploratory drilling hole detail geophysical investigation might be done to evaluate the real picture of this deposits.

Keywords: Calcareous, Carbonate, Deposits, Fossiliferous, Limestone, Rock

1. Introduction

The research paper has been prepared based on drilling programme (GDH-66/12) at Agair village of Panchbibi upazila, Joypurhat district. Panchbibi upazila is bounded by Joypurhat district town in the south; Hakimpur upazila of Dinajpur district in the north; Naogaon district and India in the west and Gaibandha district in the east (Figure 1). The drilling location lies between 25°10’40” N latitude to 88°55’45” E longitude. The surveyed area is located about 7-10 km southwest from the Joypurhat town. Joypurhat district is well connected with the Dhaka-Dinajpur highway which across the Panchbibi upazila town. The drilling prone area is 4 km –5 km southeast from Panchbibi upazila town.

2. Methodology

Drilling operation has been carried out by using LF 90 Core Drill (Wire line) of Boart Longyear (Plate 1) drilling rig. Moreover, Mud pump has been used to reduce the subsurface pressure by mud flow at the time of drilling activity. During the drilling operationcored an non-cored flush samples were collected. After collection of each flush sample, itwas washed with fresh watert properly to remove circulatory mud and other impurities from the samples. Each of the samples were labeled and examinedwith hand tools then kept them on open air for dry. The dried samples then preserved in polythene bag with proper labeling which in

turn again put in a canvas bag to protect the samples from mechanical loss. Core drilled started from the depth of about 141 m and continued until the drill hole closing which is at the depth of 552 m. Finally selected samples were stored and labeled properly for preseved. Some sampls are also collected for laboratory analysis. Collected samples were analyzed in the laboratory of GSB and map of the area have been prepare by using different software. Finally, the research report has been prepared on the basis of samples analysed and other related data.

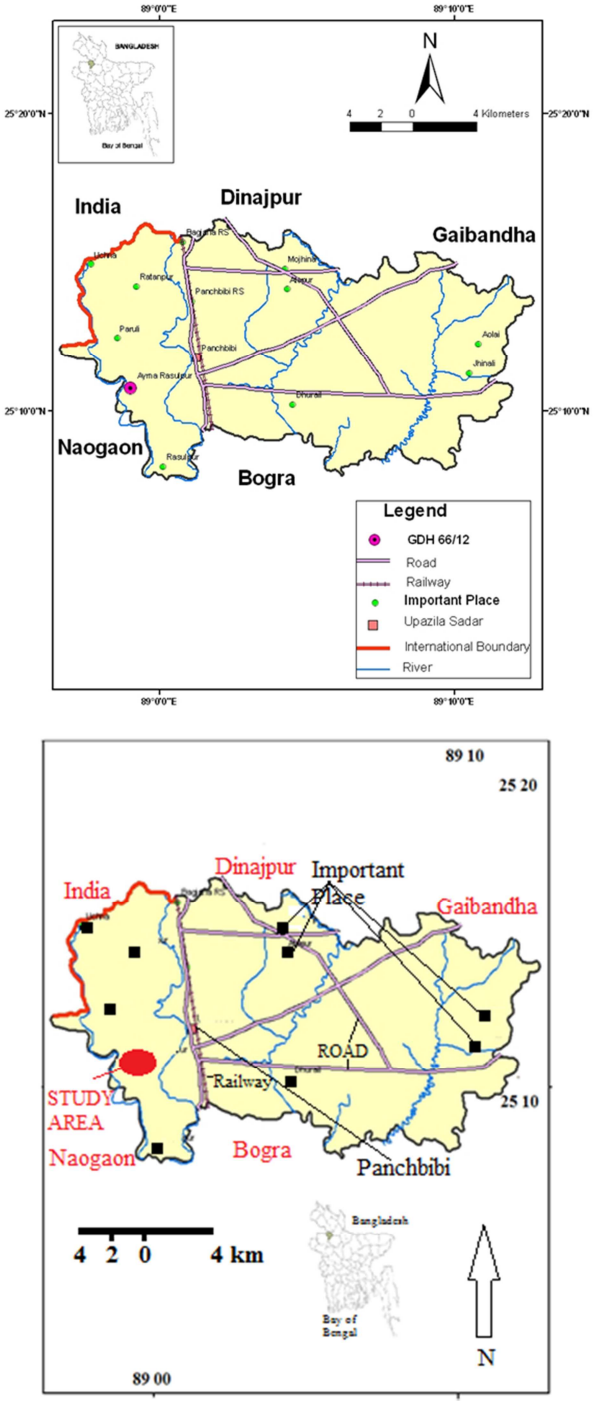

Figure 1. *Location map of GDH-66/12, Agair, Panchbibi upazila, Joypurhat District, Bangladesh.*

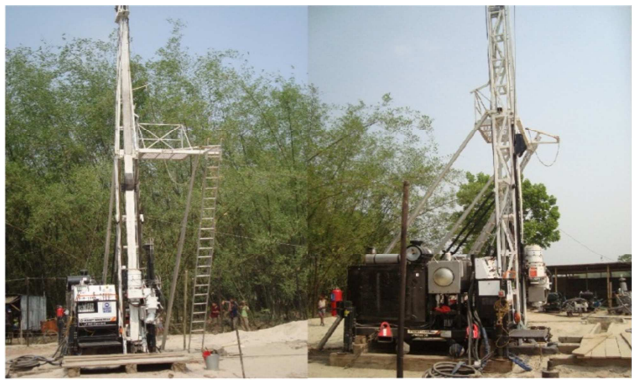

Plate 1. *Photograph of the drilling Rig, LF 90 Core Drill (Wire line), Boart Longyear (front and side view), Agair, Panchbibi, Joypurhat.*

2.1. Geo-Tectonic Settings of Area

The Bengal basin demonstrates a board spectacular combination of three special geological systems and draws individual interests for its relation to the world's largest organic system the Great Himalayan range, the world 's largest fluvio-deltaic system; the Bengal delta (present Bengal Basin) and the world's largest submarine fan system the Bengal deep sea fan. The Bengal basin is essentially an Oligocene to Recent sedimentary depocentre (Salt, et. Al 1986). The evolution of the basin started in the early Cretaceous with the rifting of the Indian plate away from Antarctica. However, the basin did not become a major depocentre until the northward drifting Indian plate collided with the Eurasian plate resulting in the initial uplift of the Himalayan (Lindasy et. Al 1991). The Bengal basin is bounded by the Precambrian Indian shield to the west and north and by the Indo-Burman orogen to the east and it is open to the Bay of Bengal to the south up to Swatch of No Ground (figure 2). The tectonic framework of the Bengal basin have studied by various authors such as Bakhthine (1966), Curry et al (1982), Salt et al (1986), Murphy (1988), Guha (1978), Lindasy et. al (1991), Reimann (1993), Shamsuddin and Abdullah (1997), etc. Salt et al (1988) interpreted the basin as a rifted passive margin which is currently being subducted beneath the Indo-Burman ranges in the western Mayanmar. Mitchell (1993) classified the Bengal basin as a Remnant Ocean Basin. The structural configuration of the Bengal basin is characterized by compression wrench folds in the east and by the blocked-faulted, unfolded attenuated continental crust in the west (Murphy, 1988). Northern part of Bangladesh (Roughly Rajshahi Division) is the region of interest of the paper, forms the Indian platform. It is subdivided into a) Dinajpur Slope (Northern Slope of the Rangpur Saddle) b) Rangpur Saddle c) Bogra Slope (Southern Slope of the Rangpur Saddle) d) Hinge Zone.

The Hinge line connecting Calcutta-Pabna-Mymensingh forms approximately the boundary between the platform and Bengal Foredeep. To the south of this line basement complex dips sharply towards south-east. Rangpur Saddle is a possible connection between Indian platform and Shillong massif and bounded by N-S tending faults. The width of the saddle is

about 60 miles. It slopes both ways towards north and south and forms an oval shaped body. The northern slope of the Rangpur Saddle (Dinajpur Slope) slopes northwest and is about 40 miles wide. Basement dips sharply towards Sub-Himalayan Foredeep. The nature and contact between the Dinajpur Slope and Sub-Himalayan Foredeep is not known. The type of the sedimentary deposits is also unknown as no geological work has so far been done in this area. Southern Slope of the Rangpur Saddle (Bogra Slope) is about 40 to 80 miles wide and extends up to the Hinge Zone. The inclination of the basement is gentle upto Bogra which increases further south eastwards. In this area Gondwana sediments were deposited in the faulted troughs or subducting basins in the basement complex. Hinge Zone is transitional zone between Southern Slope and Rangpur Saddle and Bengal Foredeep. It is a narrow zone of the about 15-20 miles. Depth of the Sylhet limestone increases from 6000 to 13000 feet within this narrow zone (M. A Jaher and Anisur Rahman, 1980). Geology of the area has been interpreted on the basis of drilling (GDH-66/12) data. The drilling prone area of Panchbibi upazila is covered the Bogra Slope which is the Southern Slope of the Rangpur Saddle. This is the part of stable platform characterized by moderate thickness (1770 ft) of sedimentary rocks above the Precambrian basement rock. Thinnest sedimentary cover was encountered in the Rangpur Saddle at Madhyapara and in the north basement dips sharply towards sub-Himalayan fore deep and at the Bogra shelf basement dips gently to the south. In general, all bore holes drilled in the Bogra, Joypurhat and Rajshahi region including GDH-66/12 are located on the stable shelf of the Bengal basin.

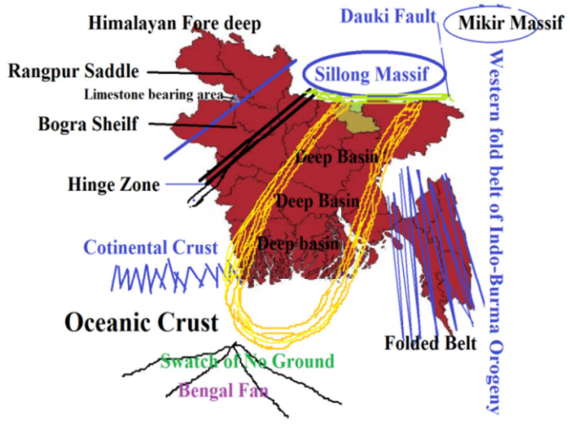

Figure 2. *Geo-tectonic settings of the study area.*

2.2. Description of the Limestone Deposit

Limestone is a bedded sedimentary deposit consisting chiefly of calcium carbonate ($CaCO_3$) which yields lime when burned. It is the most important and widely distributed of the carbonate rocks and is the consolidated equivalent of limy mud, calcareous sand, or shell fragments (Glossary of Geology). It is a sedimentary rock which composed of mainly $CaCO_3$ and strongly effervescence with HCl. The limestone is of Eocene age bearing similarity with Sylhet limestone of Takerghat in the Sylhet district both of physical and chemical characteristics and fossil content. This limestone is so highly fossiliferous that it looks like an assemblage of foraminifera and other invertebrates bound together by the broken pieces of fossils (Plate 2). Most of foraminiferal assemblages have been found as *Nummulites* (Plate 3) in this limestone. Other sediments like sandstone and shale are so significant that they do not alter in any way the basic characteristics of the limestone (khan, 1991). Marine transgression took place in this area during the Paleocene to Eocene times, when the Sylhet limestone and Kopili formations were developed. In this exploratory borehole, limestone encountered at the depth of 453 m (figure 3) which are three layers as first layer is about 10 m thick; Second layer is about 1 m thick and third layer is about 2 m thick, so the total thickness of limestone is 13 m. Overlying by the three more formations as Kopili?, undifferentiated Surma?, Dupi Tila and Alluvium Formations.

Plate 2. *Photograph showing the limestone core samples of Panchbibi area, Joypurhat.*

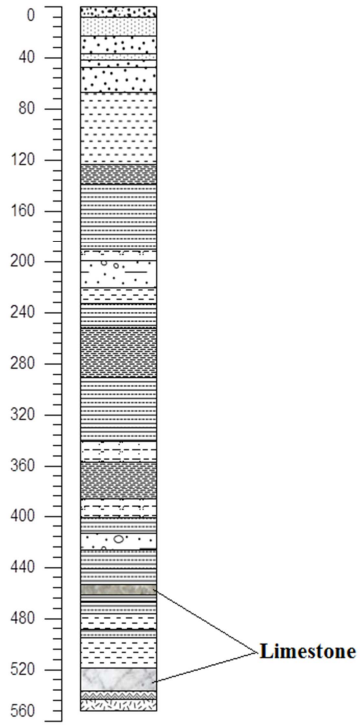

Figure 3. *Figure showing the limestone in the subsurface condition of Panchbibi area, Joypurhat.*

2.3. Geological Position of Investigated Limestone

Generally, Sylhet Limestone Formation of middle Eocene age unconformably overlies the Tura Formation of lower Eocene age. The limestone of Panchbibi area is alternation of shale and sandstone. There are two types of limestone observed which are arenaceous and fossiliferous and strongly effervescence with HCl. Limestone mainly composed of $CaCO_3$ and also contains some sand size particles. In shale alternation of sandstone sequence, shale is about 65%-70% and dark grey (N3) to medium dark grey (N4) colour, medium hard, fissile, soapy to feel, slakes in water. Sandstone is about 35%-40% and is medium light grey colour (N5), sub angular to sub rounded, poorly sorted, fine to medium grained. This sandstone composed mainly of quartz which may more than 60%, mica, rock fragments some pebble size particles are also observed. The above characteristics of limestone have been observed within the Sylhet limestone formation. So, the investigated limestone of the study area is in the Sylhet limestone formation with respect to the geological point of view.

2.4. Depositional Environment of Limestone Deposits

Plate 3. *Limestone core samples showing the fossil (Nummulites), Panchbibi area, Joypurhat.*

Tectonically the drilling area lies in the southern slope of the Rangpur Saddle (Bogra Slope). Sedimentary depositional history of that area unveil that several marine transgressions and regressions occurred in Eocene periods. Many geoscientist and paleontologist conducted micropaleontological study of encountered core samples in and around the area to unveil the paleo-environmental condition of Sylhet limestone Formation. Biswas (1963) suggested that Sylhet Limestone is almost barren of palynomorphs but contains many hystrichospherids. Ismail (1978) conducted paleontological investigation on limestone in Kuchma-X1. He found out the assemblage of larger foraminifera in limestone like *Nummulites, Assilina and Discocyclina.* Khan and Muminullah (1988) also suggested that larger foraminifera common in the Sylhet Limestone of Bangladesh include *Nummulites, Assilina, Discocyclina, and Alveolina***.** Khan M. R carried out paleontogical studies of the rock sample of the Sylhet limestone Formation and suggested the limestone might have been deposited in warm, open marine, littoral to neretic shelf condition. The encountered limestone of Panchbibi area can be divided into two categories. Those are arenaceous and fossiliferous. The type of limestone represents marine transgressive and regressive events. In fossiliferous limestone, *Nummulites Sp, Astrocyclina Sp, Alveolina Sp* fossils are common. These benthic foraminifera indicated that the limestone deposited in shallow marine & warm climatic condition and accumulated on the open shelf.

2.5. Classification of Limestone

In general, there are five groups of modern carbonate deposits/ limestone on the basis of their deposition. Such as shallow water carbonates/ limestone, Deep sea carbonates/ limestone, Evaporitic carbonates/ limestone, Fresh water carbonates/ limestone and Eolian carbonates/ limestone. They are describing below (Source- Sedimentary rocks, F. J. Pettijohn).

1) *Shallow water deposits:* This type of limestone have accumulated in several distinct sub environments like reef, tidal flat, Thalassia meadows, open bank or shelf and sub aerial dune. Mud accumulated in the tidal flat and Thalassia meadow environment; the sands accumulated on the open shelf and in dunes. Composed of calcareous sands, both skeletal and oolitic, with lesser volume of fine carbonate mud and reef rocks.
2) *Deep sea deposits:* This type of deposit is derived from reefs, banks which transferred to deep water environment by turbidity flows. This carbonate is most abundant in lower latitudes and their distribution seems to correlate with the salinity of the surface water; deposits are most abundant where surface salinity is highest. This limestone is both of basinal deposits and pelagic deep-sea deposits.
3) *Evaporitic deposits:* It is associated with arid calcium, calcite is the most widespread. This deposit is found in the soils of semi-arid regions. Capillary action draws lime-bearing waters to the surface, where by evaporation, lime-rich calcite is formed.
4) *Fresh water deposits:* Deposited in the freshwater lakes where lime deposits are forming by evaporation of some spring and river water.
5) *Eolian deposits:* Small deposits of carbonate sand-debris from offshore reefs- accumulate on beaches and in dunes associated with these beaches. Calcareous eolianites occur in Islands.

It should be mentioned here that marine transgression took place in the Paleocene to Eocene times, when the Sylhet Limestone was deposited. The limestone of Panchbibi area is equivalent to the Sylhet limestone. Composed of calcareous sands, both skeletal and oolitic, with lesser volume of fine carbonate mud and reef rocks. So, this limestone is shallow water deposits.

2.6. Physical and Chemical Characteristics of the Limestone

Limestone of Panchbibi area is very light grey (N8)

coloured, hard and compacted. It is thickly bedded to massive, fractured conchoidally and irregularly. The limestone is medium to fine grain. It also contains some sand and unidentified particles. The limestone is two types which are arenaceous and fossiliferous. Arenaceous limestone is thin. In fossiliferous limestone, Nummulites Sp, Astrocyclina Sp, Alveolina Sp fossils are common. It is strongly effervescence with HCl. Three samples are analyzed in the analytical branch of GSB and the result shown in the following table-1. The analyzed result shows that CaO content in limestone ranges from 43.4 to 46.4 with an average of 44.8. Al_2O_3 percentage of the sample varies from 1.76 to 4.12 having an average of 2.74. From the chemical composition of the limestone it appears that it is moderate in quality.

Table 1. *Chemical properties of limestone, Panchbibi, Joypurhat District.*

SI No	Sample No	GSB Lab no	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	MnO %	Loss of ignination %
1	GDH-66/	4171 (1)	12.88	4.12	1.34	Nill	43.40	1.54	0.04	0.28	35.40
2		4171 (2)	8.25	2.34	2.15		44.80	2.80	0.16	1.27	37.60
3		4171 (3)	9.40	1.76	2.04		46.20	1.40	0.07	0.31	38.40

2.7. Uses of Limestone

Limestone can be used in many industrial purposes. It is very common in architecture specially in building materials. Limestone is the main ingredient of cement clinkers (Clinkers- 78% limestone + 4% Gypsum + 16% clay). It can be vigorously used in cement factory. Train stations, banks, other structures are normally made of limestone. It is used as a facade on some skyscrapers. Limestone is also used in Ceramics industries. Many types colour are made of limestone. The present requirement of limestone in the industries other than the above is as Steel mills, Lime manufacturing, Paper mills, Tripple Super Phosphate, D. D. T factory, Tanneries and Sugar mills etc.

2.8. Reserve of Limestone

Reserve calculation is one of the most important criteria for exploration and mining. Only one drillhole is not sufficient for calculaling the reserve of any economic deposit. The total thickness limestone is about 13 m. Several drillhole needed for calculating the real extension and thickness of limestone. According to the geophysical survey (Gravity and Magnetic) the drilling area is a basin which about 13 km long and 9 km wide. Total aera of this basin is about 100 square km. Limestone might has extends over the whole area of proposed basin which is evident from drilling and geophysical data. The thickness of this limestone might have varies from place to place within the basin. So it should be needed to done five more exploratory drilling in this area to detect the detail reserve of this limestone.

2.9. Economic Aspects of the Deposit

Drilling program of GDH-66/12 in Panchbibi upazila, Joypurhat district encountered some economic deposits as limestone, white clay and crystalline basement rocks which may have important economic worth. The total thickness of limestone is about 13 m which encountered at the depth of about 456 m. Total thickness of white clay is about 19 m of which started from the depth of 518 m and crystalline basement rocks encountered at 543 m depth. Limestone white clay and crystalline basement rocks have different uses. Bangladesh has a great demand of limestone as it used for cement manufacturing. At present, mining of the white clay, limestone and crystalline basement is a challenge for its greater depth but it might be feasible for mining in future.

3. Discussions

The limestone dominant Panchbibi area is delinated by the gravity and magnetic interpretation and finally an exploratory drilling. It is thought to be a basin that has linked with the south Joypurhat near the village of Jamalgonj, surrounding area of Joypurhat town and is likely to be prospective for economic deposits (Coal or limestone). But recent survey has concluded that the basin content mainly limestone and white clay that totally lack of Gondwana sediments. This basin is formed by faulting in the crystalline basements that created firstly troughs/gravens and later the basin reshaped. The basin marginal adjastments took place by subsequent faulting and time to time Himalayan upheavals. During the upper miocene/ pliocene time the depositional environmen has changed chiefly into fluviatile system mainly due to the newly created Himalayan in the north and nearby elevated shield areas and their subsequent erosion. The depositional history of the basin is mainly based on the borehole lithilogy of the sediments encountered and their internal sedimentary structure, like fining upward sequence etc. The depositional environment of this basin flanked chiefly by fluvial dominated. Three broad facies sandstone, pebbly sandstone and pebble bed are considered as Dupi Tila Formation. During the different phase of deposition the basin was flanked by vegetated and swapy overbank. The mudstone reflects low lying flood plain deposit. This would be formed by the vertical accretion of low to moderately vegetated overbank deposits. The thick mudstone facies indicates a back swamp flood basin surrounded by flood plain. This also indicated that the source area was no far away. Marine transgression took place in this area during the Paleocene to Eocene times. The basin subsidence or the basin margin upliftment was high during the deposition of the facies. The Archean period witnessed a wide spread development of basement complex of metamorphic and meta igneous rocks in adjoining area of Joypurhat as well as panchbibi area

which is likely that the basement complex in this area was subjected to sub areal weathering or subsidince during the paleozoic era (Zaher. M. A, 1986).

Only one drillhole in this basin of Panchbibi area is not enough to predict much of the basin although on the available data it may be postulated that the basin is promising in terms of economic aspects. In this drilling hole three layers of limestone encountered. The basement complex is also important because it has some potentialities of economic mineral deposits.

4. Conclusions and Recommendations

The limestone bearing Panchbibi and adjoining area is characterized by flat topography with plain land covered. Drilling operation has been carried out by using LF 90 Core Drill (Wire line) of Boart Longyear drilling rig. Total depth of the hole was 5520.5 meters. Limestone of the hole is in three separate layers and total thickness of limestone is about 13 m in which first layer encountered at the depth of 455.67 meters. Total thickness of white clay is 18.3 meters which started from the depth of 518 meters. Crystalline basement rocks encountered at 542.9 meters depth. According to the geophysical survey the basin area is about 100 square km. Both limestone and white clay might have extends over the whole area of proposed basin. Only one drillhole in this basin is not enough to predict much of the basin in terms of economic aspects. Finally it is concluded and recommended that integrated geological, geophysical studies and more drillhole should be done for better understanding of the basin.

References

[1] Alam, M., K., et al, (1990): Geological map of Bangladesh, Published by, GSB. Bangladesh. Bangladesh Journal of Geology, Vol. 14, P. 1-14.

[2] BMEDC Report, 1976, Economic Feasibility Reports on Limestone Mine, commission of Bangladesh. Exhibition on Petroleum and Mineral Resources of Bangladesh, P. 35-40.

[3] F. J. Pettijohn, (1984): Sedimentary Rocks, Third edition, CBS Publishers and Distributors, Delhi, India

[4] Fried. Krupp Rohstoffe, Find report, First phase, Joypurhat limestone project.

[5] Imam. Badrul, (2005): Energy Resources of Bangladesh. University Grant Commission.

[6] Islam, M, N, (1985): White clay deposits of Bijoypur area, Netrokona district, Bangladesh, Government of the People's Republic of Bangladesh.

[7] Islam. M. N, (1985): White clay deposits of Bijoypur area, Netrokona district, Bangladesh, Government of the People's Republic of Bangladesh. Jaypurhat and Limestone Mining & Cement Plant, Jaypurhat, Bogra.

[8] Khan F. H, (1991): Geology of Bangladesh. The university press limited.

[9] Khan, M. R and Muminullah, M., (1980): Stratigraphy of Bangladesh, Seminar and project, Dinajpur, Bangladesh.

[10] Reimann, K. U., (1993): Geology of Bangladesh, Gebruder Borntrager, Berlin.

[11] Reineck. Singh, 1980, Depositional Sedimentary Environment, Springer-Verlag Berlin Heidelberg New York.

[12] Statistical Yearbook of Bangladesh.(2011): Bureau of Statistics, Government of the people's Republic of Bangladesh.

[13] Uddin, M. N., (1995): Foraminiferal Assemblages and Paleoecology of the Kopili.

[14] Wardell Armstron (1991): Techno-economic feasibility study, Barapukuria coal. Dinajpur.

[15] Zaher, M, A et, al. 1986, Subsurface Geology of the Limestone Deposits of Joypurhat Area, Joypurhat District, Bangladesh, Records of the Geological Survey of Bangladesh., Vol. 4, Part. 4.

[16] Zaher. M. A, Alam. M. K, S. I Chowdhury, (1986): Subsurface geology of the limestone deposits of Joypurhat area, Joypurhat district, Bangladesh, Government of the People's Republic of Bangladesh.