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Mining Proposal of Khalashpir Coal Field, Rangpur, Bangladesh

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***Abstract* - The reason behind low energy consumption of Bangladesh cannot be identified clearly, moreover there are a number of reasons link between energy availability and consumption. Particularly, the isolation of some potential source of energy fields and entire dependency on some particular options oblique the thwarting initiatives of starvation. Coal is a powerful energy resource that could pacify most of a country's secondary energy needs (electricity) but in case of Bangladesh, this sector is somehow parochial in insight view. Moreover, the insignificant production of Barapukuria coal mine is insufficient to justifying the rising demand, conversely, lacking of long term initiatives, the renovation of highly potential coal field to coal mine has not happened yet. Authors have found out a positive correlation of mining parameters of Khalashpir coal field that can lead to a feasible mining activity. Furthermore in perception of geology, authors have proposed a suitable method for mining operation.**

***Keywords* - Coal, Longwall multi-slice mining, Aquifer induced mollification, Recovery rate, Khalashpir coal field**

I. INTRODUCTION

Bangladesh has huge unmet demand of commercial energy while low availability of this type of energy can be a crucial obstacle of a country's economic development. Thus getting closer to a solution for meeting the future needs of commercial energy is one of the greatest challenge of the government of Bangladesh. As per the cosmopolitan research, there are approximately more than 847 billion tons of proven reserves of coal globally and coal currently supplies around 30% of primary energy and 41% of global electricity generation. In case of Bangladesh, whereas, the contribution of coal on power generation is negligible (about 1.4%) compared to 64% contribution of natural gas.

Bangladesh government is trying to reconcile this predicament but only one coal mine is unable to fulfill the need. In contrast, it is inevitable to explore the coal sector and renovating the economically potential coal field to coal mine.

Moreover, it is an undeniable fact that increases in coal exploitation and using it as a viable energy sector will ease up the stress on the limited gas reserves and it will be benevolent both for the government and energy starved people of Bangladesh.

This article deals with the potential mining prospects of Khalashpir coal field that is the second highest among five in terms of reserve. Khalashpir Coal Field is located in Madankhali union under Pirgonj Upazila of Rangpur district within 25º23'14" N to 25º30' 00" N and 89º09'12" E to 89º15'00" E geographic co-ordination system respectively (fig 1). For detail study, here some lithological data (borehole data, mainly of Gamma ray log data) are collected and conducted through software simulation along with a series of sterling method.

Fig 1: Location map of Khalaspir coal field

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The researcher tried to answer the following questions to define the main objectives of this paper.

A. How many potential coal seams are in that field and how much reserve they contain?
B. In perspective of mining parameters, which type of mining method is suitable for this basin?
C. What are or will be the possible and probable mining problems in that field?

II. GEOLOGY OF KHALASHPIR BASIN

Khalaspir coal basin lies in a region of vast plain land with an approximate topographic elevation of 25m. This area is situated in the Rangpur saddle, a geological subdivision of Bengal Basin. Geophysical survey has shown that the saddle area has severely suffered from faulting of different age. Several faulting along the Jamuna and Ganges rivers downthrown the region make it's a graben type structure corresponding to the horst structure of Shillong Massif and Mikir Hills (Khan, 1991). Networking of this fault, ultimately made up as many as five faults bounded Gondwana basin in the area (Uddin and Islam, 1992; Islam, 1993). The faults observed within these tectonic elements are actually existed during the Gondwana period formed intrabasinal horsts and graben.

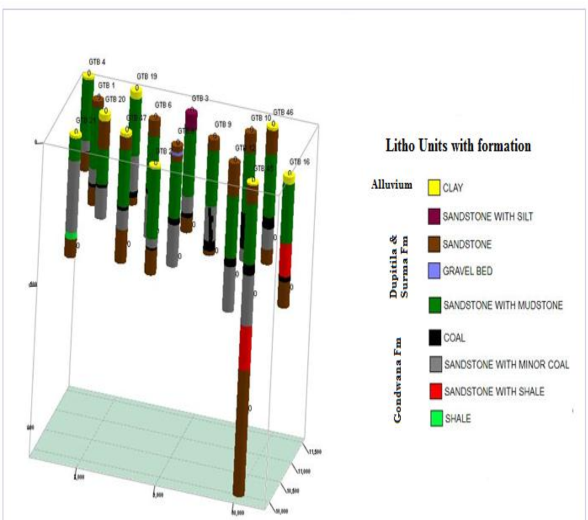

Fig 2: 3D multi-log system showing the major litho units distribution

The surface area of this region is covered with alluvium soil of quarternary period. Stratigraphically, khalashpir coal field is divided among four formations from bottom to top, namely; Gondwana formation, Jamalganj formation (tantamount to Surma formation), Dupitila formation and Barind clay residium (fig; 2.3; table I).

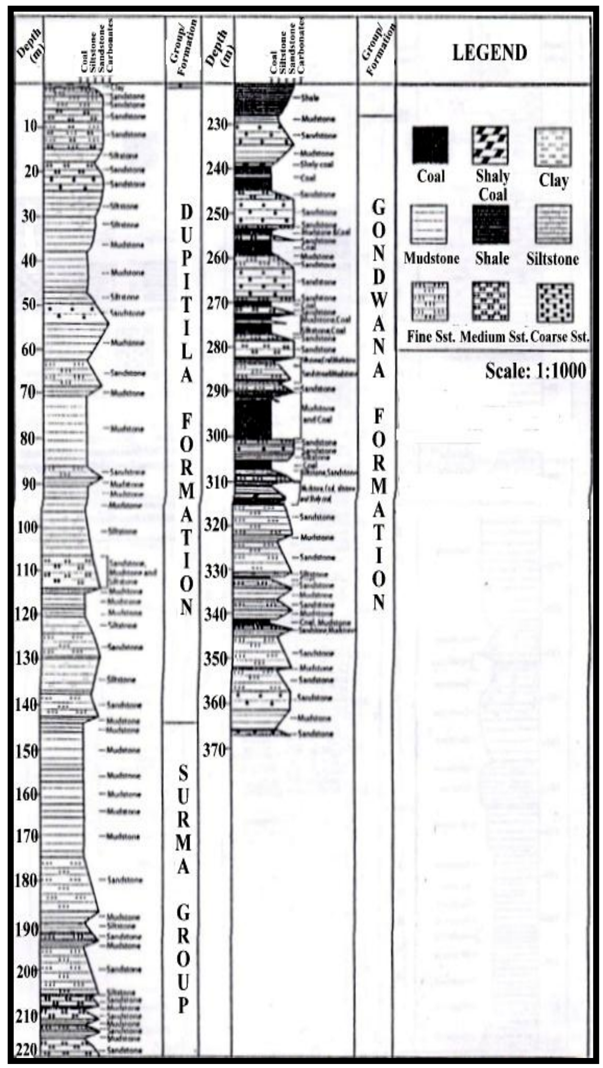

Fig 3: Gamma ray log data interpretation specifying litho units

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Table I:
Stratigraphic Succession Of The Khalashpir Coal Basin, Bangladesh (Islam *et al*., 1992)

Age	Group/Formation	Lithology	Max. Thickness (m)
Holocene	Alluvium	Grey sand and silty clay.	4.26
Pleistocene	Barind clay residium	Yellowish grey silty clay.	6.10
Pliocene	Dupitila Formation	Grey to yellowish grey sandstone with uncommon mudstone.	162.12
Miocene	Surma Group	Grey to dark grey mudstone, sandstone and pebbly sandstone.	184.14
Permian	Gondwana Group	Felspathic sandstone, carbonaceous shale, siltstone, mudstone, coal and conglomerate. Base not seen	814.93 +

III. Method Of Investigation

An innumerable data, mostly are of borehole data, has been collected to process the investigation and also to provide an auspicious elucidation of the basin. In that work, some mining parameters are appraised to propose a proper mining method.

To assess these data, some numerical modelings are computed for envisaging the subsurface litho unit's distribution. The whole work procedure follows a standard research process, illustrated in figure 4

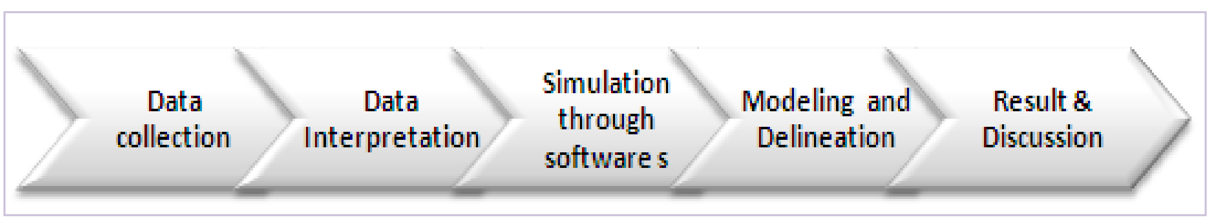


Fig 4: Research work procedure of the study

IV. Parameters Of Selecting Mining Method

Most critical part of a mine is to select the feasible mining method in requisites of some techno-mining parameters; mostly of these are allied to mining while some other engineering factors were brought into consideration. To execute the procedures for detecting the mining method, authors have used these following mining parameters with an association of software simulation.

A. Coal Seam Attributes

Among the eight, I, II and IV are the thickest (table II), whose thicknesses vary erratically; in where the average discrete range is in between 2.35 m to 36.52 m, mostly of these reached towards the Eastern side of the basin. Only these three coal seams pervade throughout the area and the rest seams are meagerly permeated.

On the other hand, the average thickness of residuum seams (III, V, VI, VII, and VIII) is not over 5.60 m. The depth range of these coal layers (seam I to VIII) varies from 215.14 m to 516.50 m (table III).

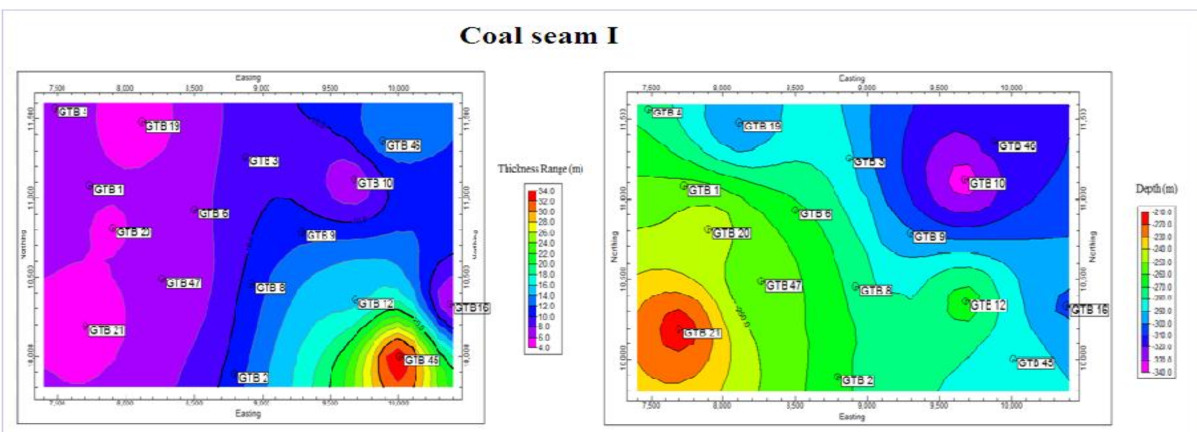
Table II:
Average Thickness Variation of Coal Seams

Coal seam	Avg thickness(m)
I	10.5
II	10.65
III	1.41
IV	13.58
V	2.90
VI	5.60
VII	2.55
VIII	1.48

Table III:
Depth and Thickness Variation of Coal Seam I, II and IV

Coal seam	Depth range (m)	Average Thickness (m)
I	215.14-339.98	10.5
II	225.70-365.01	10.65
IV	260.42-425.12	13.58

All of these seams (I, II, IV) become thicker and shallower towards NE, SE and Eastern side whereas they discrepant almost paradoxically towards NW, SW and Western part of the basin. Some related maps are provided here for better visualization of the distribution of coal seams (fig 5).



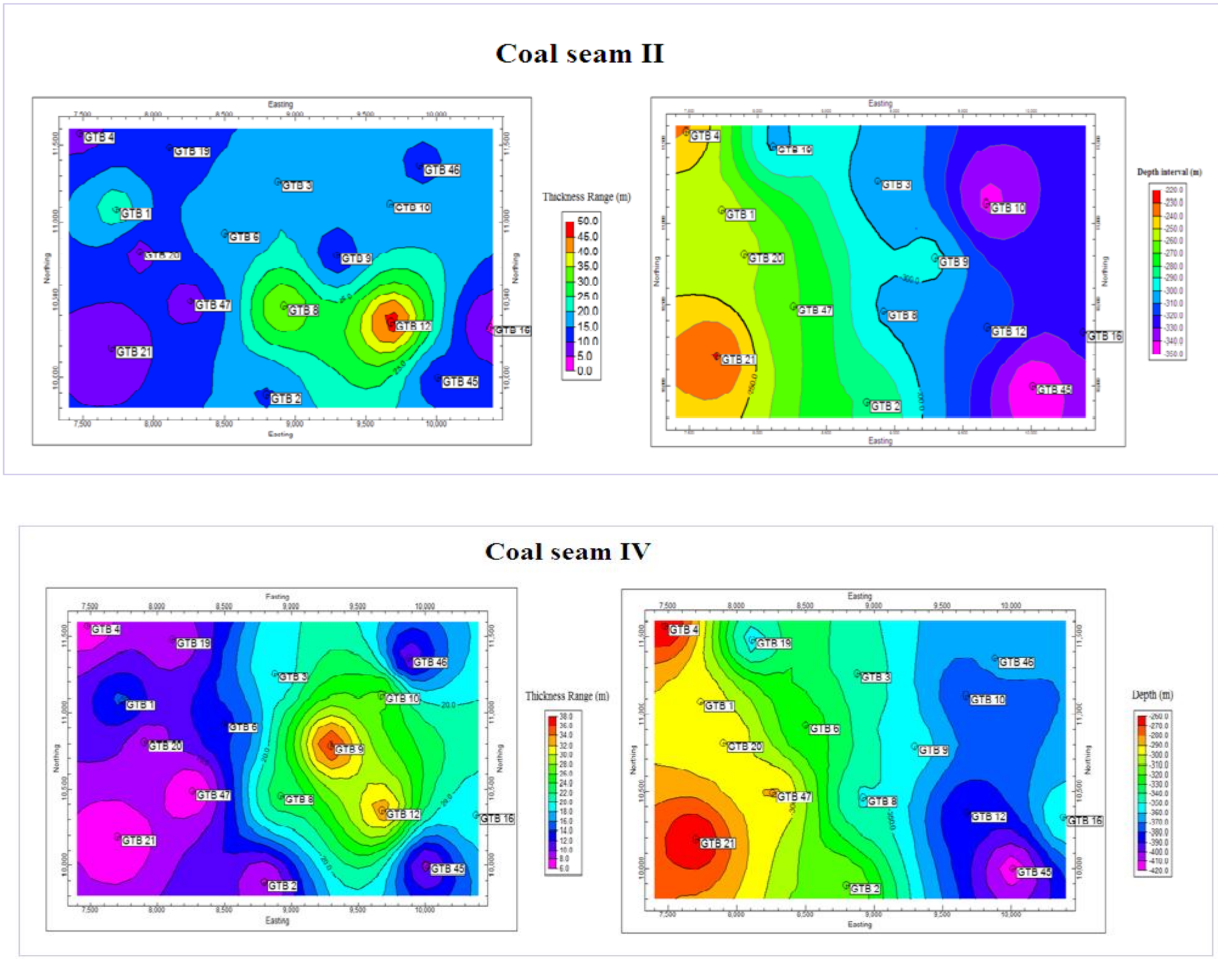


Fig 5: Showing the thickness and depth variation of coal seam I, II and IV throughout the basin (using software Rockware15)

B. Aquifer Characterization

One of the major aquifer, Upper Dupitila aquifer terming as non-pressure water aquifer, overlies the coal seam that will or may beget decimation of future mining activity whilst the effect of underlying Gondwana aquifer will be somehow trivial. However, small amount of water had been found in the Surma formation, shows lower hydraulic gradient (about 0.02 m/day). Hydrological characteristics of Upper Dupitila aquifer is given in table IV.

The thickness of the Dupitila aquifer, as a consequence of perusing a broad scale investigation, becomes lower towards SE and NW side (fig 6) despite the fact that in the rest portion, moreover it varies in between 4m to 14 m. Conversely, the depth record depicts that the aquifer is in the shallowest depth towards western part of the basin.

Table IV:
Hydrological characteristics of Upper Dupitila aquifer

Hydrological parameters	Value
Average thickness	125 m
Hydraulic Gradient	1/1000
Pumping capacity	250 m³/h(GTB 1)
Filtration coefficient/Permeability	32.10-42.40 m/day
Transmissivity	4914-5696 m²/day
Water inflow rate	644-846 m³/day/m

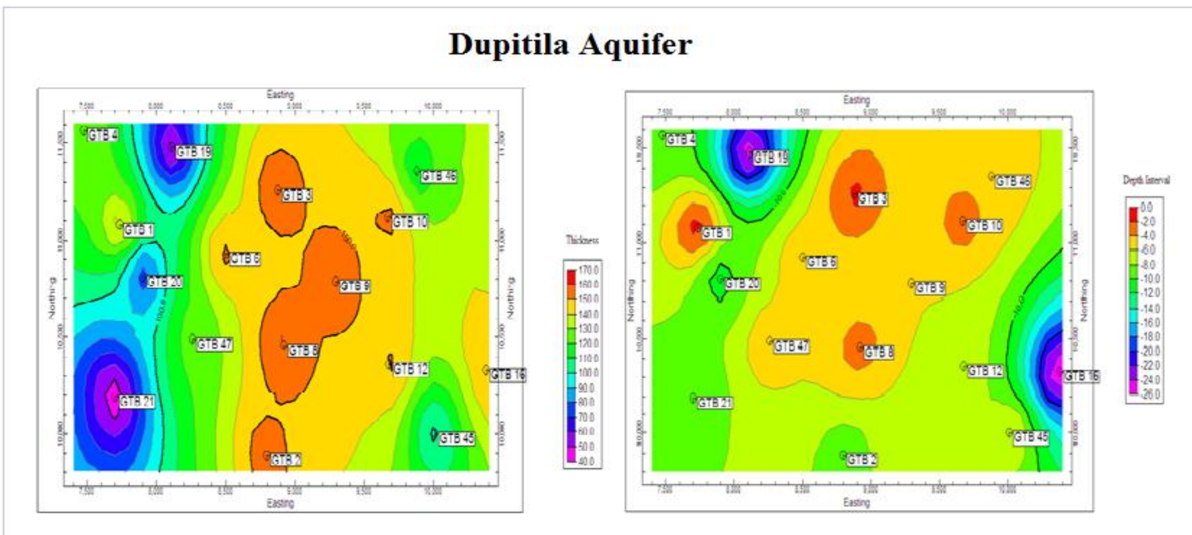


Fig 6: Upper Dupitila aquifer thickness and Depth variation (using software Rockware15)

C. Stripping Ratio

Stripping ratio or strip ratio denoted to the non-tantamount ratio of the volume of overburden (or waste material) required to be handled in order to extract some volume of ore in mining. This ratio should be calculated prior choosing any mining option for the required field that can accelerate the work in perception of money and time.

The stripping ratio in that area varies from 8.85:1to 69.04:1 with average value 38.82:1 (fig7). As up to 10:1 stripping value is suitable for open pit mining, thus the area is not literally feasible for this course of action.

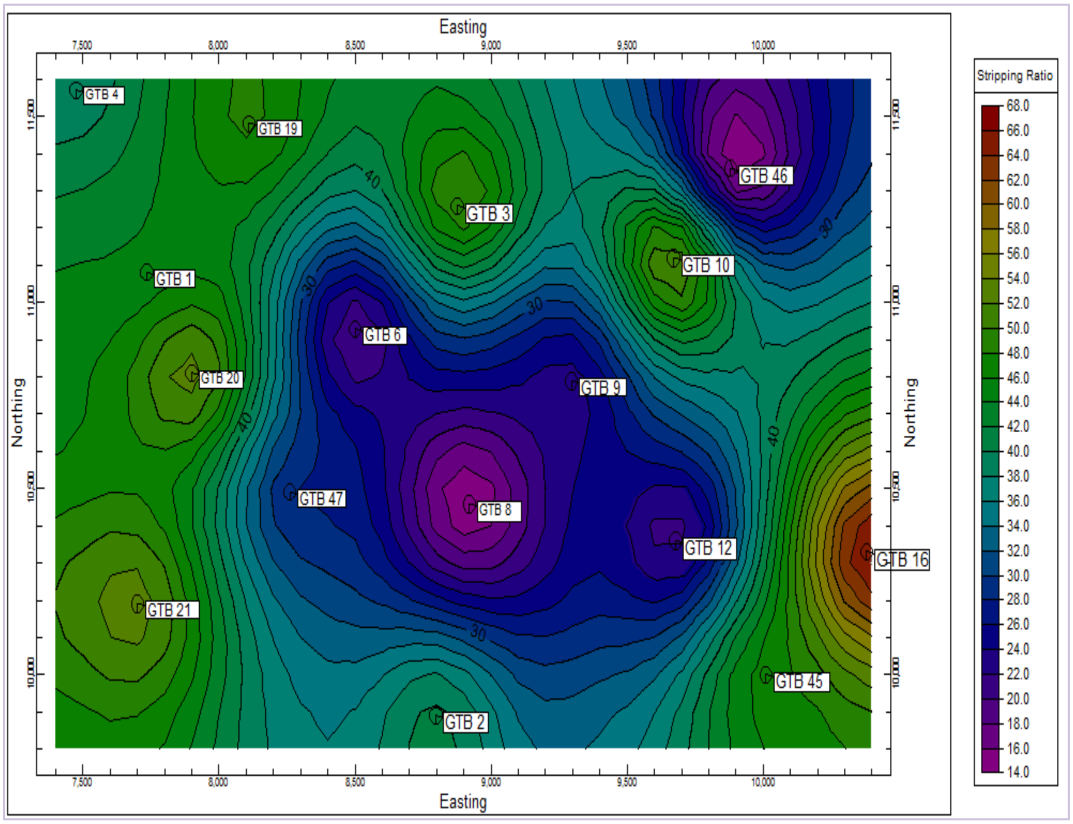


Fig 7: Stripping ratio variation of coal seam I around the basin

V. UNDERGROUND MINING METHOD

Considering the above parameters especially the depth of coal seam and stripping ratio, underground mining method is suitable to apply. In that field, coal seams I, II and IV are thickest, thus mining activity has to be proceeded from, in consequence, I to IV. Over and above that a pre-requisite option for choosing the appropriate underground mining method is the thickness of coal seam. Indeed, more than 2m to less than 50m ranged coal is susceptible for longwall multi-slice mining method, on the other side room and pillar method requires more than 50m. In khalashpir coal field, the shallower depth of coal seam is 215.14m thus inclined shaft with an inclination of roughly 60^0 has recommended to rendering the proposed mining activity (schematic fig 8); additionally in perspective of stripping ratio, top coal caving and backfilling are mandatory to accomplish.

Having the insight view of above points, longwall multi-slice top coal caving with backfill would be volition to apply. Bolting, one of the mining support systems should adapt to support the overburden prior to backfill the area. A schematic underground mine design is shown in the following fig 9.

Although, each and every fossil fuel extraction method is more or less responsible for momentous environment pollution; thus it is substantive to take some safety measures during and before the mining progress. One of the pejorative effects is groundwater handling: groundwater besets the working place rigorously begetting tentative closure prior to its actual date. Here one of the most tenable choices is unremitting pumping out operation that should be commencing at the time of construction phase of mining. Furthermore, regular auditing, substantial EIA program and strictly following up the mining policy are compulsory to put a ceiling on the indirect influences of mine.

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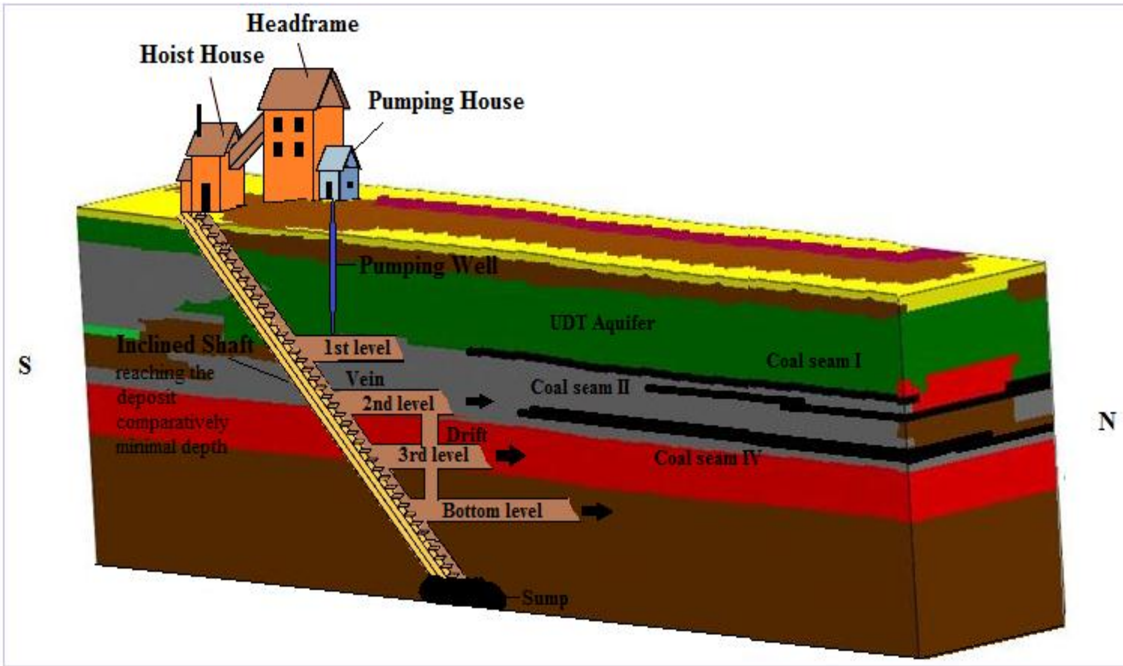

Fig 8: Underground mine system (Longwall)

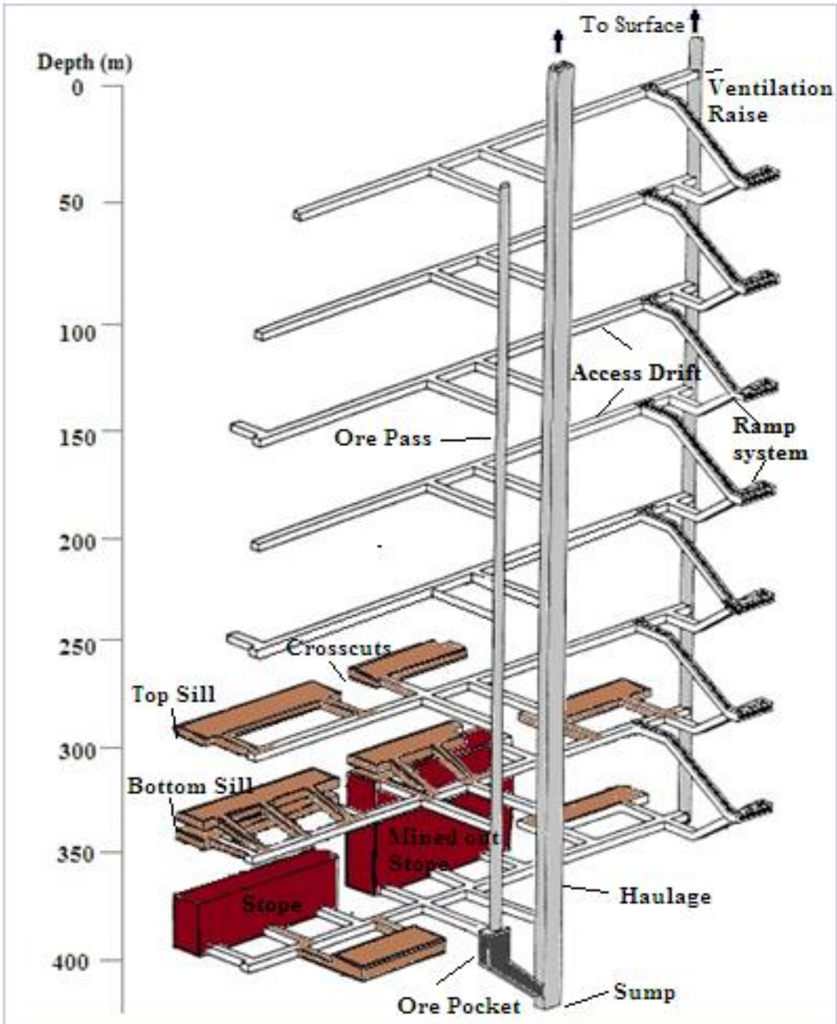

Fig 9: Schematic design of Underground mine for Khalashpir coal field (Coal seam I)

VI. Recovery Rate

The individual coal layer has to be apportioned into 3 distinct multi-layers; thus coal seam I distributed into 3m-3.5m-4m (thickness) zone, coal seam II divided into 3m-3.65m-4m and coal seam IV divided into 4m-4.58m-5m.

According to the proposed mining method, around 45% of total coal can be extracted if the mining operation phases are meticulously implemented. An executive summary of recovery rate per allocated sections are given in table V.

Table V:
Recovery rate after applying underground mining method

Coal seam	Thickness (m)	Reserve (m tons)	Apportioned section (m ton)	Apportioned reserve(m ton)	Recovery (m ton)		Total (m ton)
I	10.5	110.25	3	31.5	14.18	49.62	164.11
			3.5	36.75	16.54		
			4	42	18.9		
II	10.65	111.825	3	31.5	14.175	50.325	
			3.65	38.325	17.25		
			4	42	18.9		
IV	13.58	142.59	4	42	18.9	64.165	
			4.58	48.09	21.64		
			5	52.5	23.625		

VII. CONCLUSION

Among eight coal seams, only three are potential for mining (seam I, II, IV) containing approximately 364 million tons. In accordance with some mining parameters, authors proposed Longwall multi-slice mining method with backfilling for Khalashpir coal field. Nearly about 164 million tons of coal recovery is possible by the proposed mining method. The pejorative influence of aquifer on mining activity can be mollified through ceaseless pumping out operation. The renovation of this coal field to coal mine will be the forward step of Bangladesh for assuaging its energy quandary.

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