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Geological Analysis of Zakiganj Upazila and Feasibility Study of Available Geo Resources

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Abstract This paper has been being written in pursuit of analyzing geology, evaluating existing mineral, oil & gas reserves and feasibility study of prevailing geo-resources in Zakiganj Upazila, one of the resourceful Upazilas in Sylhet region. Surma & Kushiyara River along with the Zakiganj deposit a large amount of sand every year which is usually used as raw materials of the nearest bricks factory. However, sand deposit is not extracted commercially but it would be prospective resources of our country to minimize the construction cost. This study usually entails sufficient information on extracting, processing, metallurgical, economic and other relevant factors.

Keywords: *geology, feasibility study, Zakigonj, sand deposit*

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1. Introduction

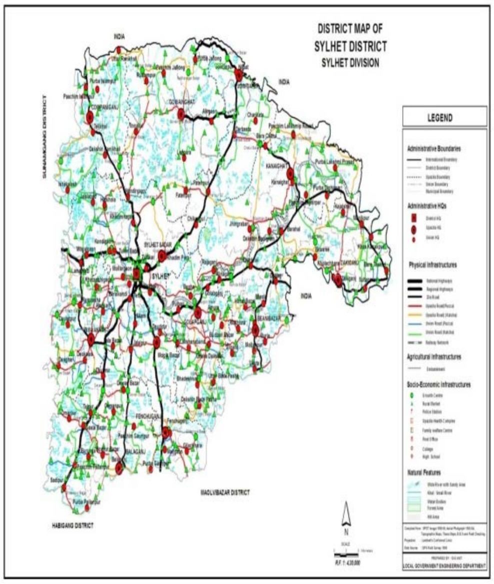

Figure 1. Sylhet district [1]

Sylhet district is located at 24.8917°N 91.8833°E 24.8917; 91.8833, in the north eastern region of Bangladesh. Geologically, this region is complex having diverse geomorphology; high topography of Plio-Miocene age such as Khasi and Jaintia hills and small hillocks along the border. At the centre there is a vast low laying flood plain, locally called Haors. Available limestone deposits in different parts of the region suggest that the whole area was under the ocean in the Oligo-Miocene. Because of the geologic Structure most of natural resources such as gas, oil, hard rock, and limestone and so on are accumulated in Sylhet. According to these geologic positions it's highly recommended that Zakiganj is highly probable of geo resources contents.

1.1. Geography of Zakiganj

It is located between 24°51' and 25°00' North latitudes and between 92°13' and 92°30' East longitudes. The Upazila is bounded on the North by India and Kanaighat Upazila, on the East and South by India and on the west by Beanibazar and Kanaighat Upazilas.

Figure 2. ZakiganjUpazila [3]

1.2. Some Features of Zakiganj Upazila

Zakiganj (Town) consists of 10 wards and 23 mahallas. The area of the town is 13.32 km^2. It has a population of 10465; male 50.31%, female 49.69%; density of population is 786 per km^2. Literacy rate among the town people is 34.1%.

Administration: Zakiganj Thana was established on 27 August 1947 and was turned into an Upazila in 1983. The Upazila consists of one municipality, 9 union Parishads, 119 Mouzas and 286 Villages.

Population: 174038; male 50.55%, female 49.45%; Muslim 86.48%, Hindu 13.47%, Buddhist, Christian and others 0.05%.

Land use: Arable land 20743.47 hectares, fallow land 604.21 hectares, grassland 1097.39 hectares; single crop 25%, double crop 60% and triple crop land 15%.

Communication facilities:

Roads: Pucca 124 km and mud road 1005 km; waterways 11 Nautical Mile.

River: Kushiara & Surma are along the border of the Zakiganj & divided India & Bangladesh which would be the probable reserve of sand deposit.

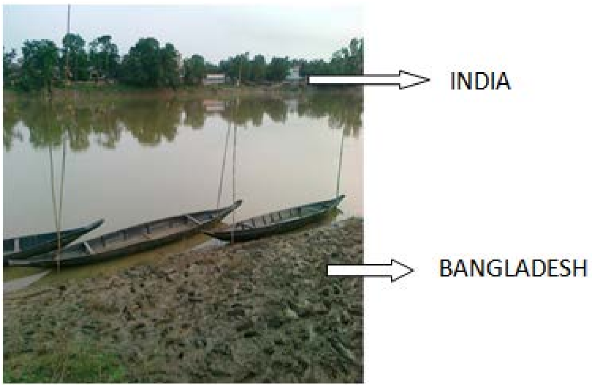

Figure 3. River Bed of Zakiganj Upazila [4]

1.3. Feasibility

A Project Feasibility Study is an exercise that involves documenting each of the potential solutions to a particular business problem or opportunity. Feasibility studies aim to objectively and rationally uncover the strengths and weaknesses of the existing business or proposed venture, opportunities and threats as presented by the environment, the resources required to carry through, and ultimately the prospects for success. In its simplest terms, the two criteria to judge feasibility are cost required and value to be attained. A feasibility study allows project managers to investigate the possible negative and positive outcomes of a project before investing too much time and money. The results of the feasibility study determine which, if any, of a number of feasible solutions will be developed in the design phase [2].

2. Methodology

The comprehensiveness of the study is to evaluate feasibility of the geo-resources amongst the available all geo-resources in Zakiganj Thana was done by questionnaire method. Before evaluating the feasibility it was important to know the geology of Zakiganj Upazila and this is done by reviewing different paper and books about the geology of Bangladesh. Study of feasibility of prevailing resources in the area of interest begins with locating the geo-resources, identifying the geo-resources, performing qualitative study on the identified resources, introducing different possible methods of extraction, calculating & performing a qualitative study of the economic value of the studied geo-resources and finally assessing the feasibility of the prevailing resources. Geological concepts and concise basics about rocks and minerals helps identify the located geo-resources. Qualitative study on the identified geo-resources involves the characteristics study of the identified geo-resources. When a huge body of geo-resources is located and identified then the one thing one should come up with is the proper method to extract the identified resources. Evaluating the economic value of the identified resources basically focuses on the market demand, market value and other relevant factors. For a preliminary feasibility study on prevailing geo-resources, doing a qualitative cost/benefit analysis on the proposed project helps to obtain the preliminary feasibility. If the total project cost outweighs the total project benefit we call it Economically not feasible, otherwise this is feasible.

3. Geological Condition of Zakiganj

3.1. Sedimentation and Tectonics of the Sylhet Trough

The Sylhet trough, a sub-basin of the Bengal Basin in North-Eastern Bangladesh, contains a thick fill (12 to 16 km) of late Mesozoic and Cenozoic strata that record its tectonic evolution. The Sylhet trough occupied a slope/basinal setting on a passive continental margin from late Mesozoic through Eocene time. Subsidence may have increased slightly in Oligocene time when the trough was located in the distal part of a foreland basin paired to the Indo-Burman ranges. Oligocene fluvial-deltaic strata (Barail Formation) were derived from incipient uplifts in the eastern Himalayas. Subsidence increased markedly in the Miocene epoch in response to Western encroachment of the Indo-Burman ranges. Miocene to earliest Pliocene sediments of the Surma Group was deposited in a large, mud-rich delta system that may have drained a significant proportion of the eastern Himalayas.

Subsidence rates in the Sylhet trough increased dramatically (3-8 times) from Miocene to Pliocene-Pleistocene time when the fluvial Tipam Sandstone and DupiTila Formation were deposited. This dramatic subsidence change is attributed to south-directed overthrusting of the Shillong Plateau on the Dauki fault for the following reasons. (i) Pliocene and Pleistocene strata thin markedly away from the Shillong Plateau, consistent with a crustal load emplaced on the northern basin margin. (ii) The Shillong Plateau is draped by Mesozoic to Miocene rocks, but Pliocene and younger strata are not represented, suggesting that the massif was an uplifted block at this time. (iii) South-directed over thrusting of the Shillong Plateau is consistent with gravity data and with recent seismotectonic observations. Sandstone in the Tipam has a marked increase in sedimentary lithic fragments compared to older rocks, reflecting uplift and erosion of the sedimentary cover of the Shillong Plateau. If the Dauki fault has a dip similar to that of other Himalayan overthrusts, then a few tens of kilometers of horizontal tectonic transport would be required to carry the Shillong Plateau to its present elevation. Uplift of the Shillong Plateau probably generated a major (~300 km) westward shift in the course of the Brahmaputra River.

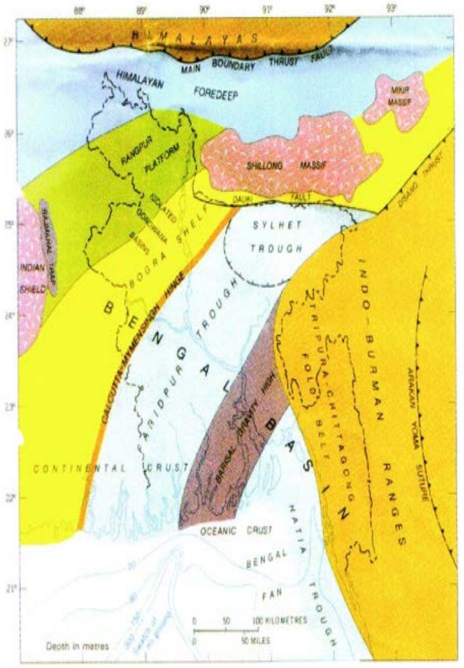

Figure 4. Geologic map of Bangladesh[5]

3.2. Structural Framework

The tectonic framework of Bangladesh is broadly divided into two main units : i) Stable platform in the North-West and ii) Deep (geosyncline) basin to the South-East. The deep geosynclinal basin is further subdivided into two parts-

- Fold belt in the East
- Foredeep in the West.

Our study area Zakiganj is located in the Eastern fold belt which is the most prolific natural gas province and has been the center of exploration activities in Bangladesh. The fold belt is characterized by series of meridional to submeridional folds and extends into the Indian territory of Assam, Tripura, and Mizoram to the east. Also known as frontal fold belt, this province represents the western and outermost part of the Indoburman origin. The fold belt shows sign of diminishing intensity of structures towards the West in which direction it gradually fade away and merge with the central foredeep province. Its boundary with the foredeep is therefore gradational, indistinct and arbitrary [6].

3.2.1. Characteristics of Eastern Fold Belt

Source Rock: The source of natural gas found in the province is believed to be the shale beds of Jenum Formation (Barail Group) of the Oligocene age. The shale have total organic carbon (TOC) of 0.6% to 2.4% and have attained thermal maturity with vitrinitereflectance of 0.65% at total depth indicating marginal maturity but would be fully mature in adjacent generative depression. It has been suggested that gas has been generated at depths between 6000 to 8000 meters below the surface and migrated up through multi kilometer sand-shale sequence for a long vertical distance before being accumulated in the Mio-Pliocene sand reservoir [6].

Some geologists believe that lower Miocene shale in the lower part of Surma group may also have generated some gas. Generally Miocene shale have low (<0.5%) TOC content and are thermally immature to generate gas in the drilled structures. But some shale in the lower Miocene Bhuban Formation may have the required TOC and thermal maturity (when within generative depression) to generate some gas [6].

Reservoir Rock: The reservoirs of the gas in the fold belt province are all of Mio-Pliocene age sandstones generally occurring in the depth between 1000 to 3400 meters. These sand layers belong to Bokabil and Bhuban Formations. The sandstone reservoirs are generally excellent in quality with respect to porosity-permeability values.. The sands are generally medium to fine grained, sublitharenite in composition and texturally mature with little clay content. The sand reservoirs originated in the shallow marine to deltaic depositional conditions [6].

Trap: The traps of fold belts are formed by the anticlinal folds with shale seal. The anticlinal structures provide excellent traps for gas accumulation rendering the fold belt a rich natural gas province. The anticline in the fold belt range from simple gentle and concealed undulation in the subsurface in the western part of the fold belt to high amplitude strongly faulted ones with highly rugged surface topography towards east. Accordingly, the fold belt is divided into two zones-

- The western zone consists of the low to moderate amplitude simple anticline structures. The structures are not very strongly affected by major faults and show simple four way closures. The intensity of deformation and folding gradually decrease to the west in the zone. In fact the anticlines bordering the foredeep lack surface expression. Some of the large gas fields like Titas, Bakhrabad, Bibiyana etc. are located in this zone.
- The eastern zone is characterized by high relief, tighter folds with thrust faults as expressed in the surface by rugged topography. The lengths of the individual folds range up to 150 km. The intensity of faulting generally increases towards east. Recent LANDSAT imageries and field surveys suggest that the eastern zone is part of the fold-thrust belt related to the east dipping Bengal subduction. Many of these anticlines in the eastern zone have been intruded by clay diapirs associated with overpressured shale in the deeper subsurface. Because of thrusting and massive faulting associated with intense tectonic deformation many of these structures are breached and their hydrocarbon prospects have been downgraded [6].

3.3. Stratigraphy of Deep Basin

Stratigraphy of the deep basin including foredeep and foldbelt to the South-East is characterized by enormous thickness of Tertiary sedimentary succession. This is a record of rapid subsidence and sedimentation. It has been suggested that Bangladesh has the thickest accumulation of sedimentary deposit in the world [7].

The sequence of the rocks encountered in the deep basin area is Oligocene to Recent in age as described below.

Tertiary (2 to 65 million years): During Tertiary period of the Bengal Basin as it is started to take shape. It is during this time that the major part of the very thick sedimentary succession of Bangladesh has been deposited. In the deep basin area no rocks older than Oligocene age are encountered in the surface or by drilling although their presence is suggested beneath the drilled section. Rocks older than Oligocene age are deeply buried [6].

Oligocene: The Oligocene is represented by the Barail Group, named by Evans (1992) after the Barail range in nearby Assam, India where the unit has its type locality. The Barail Group is composed of alternating sandstone, shale, siltstone and occasional carbonaceous rich layers. In the neighboring Assam, about 3000 meter of Barail sediments are recorded and the unit is divided into three units from bottom upward, an arenaceousLaisong Formation, an argillaceous Jenum Formation and an arenaceousRenji Formation [6].

Miocene: The Surma Group of Miocene-Pliocene age overlies the Baril Group with an unconformity. The Surma Group, named after Surma valley by Evans (1932), has a thickness of about 3500 to 4500 meter and is composed of monotonous alteration of subequalportion of sandstone and shale with siltstone and some conglomerates.

The Surma Group is divided into two formations, a lower sandier Bhuban Formation and an upper more argillaceous (clayey) Bokabil Formation. Both the Bokabil and Bhuban Formations show extensive lateral facies change as well as vertical variations in sand to shale ratio from place to place. The Surma sediments are poor in diagnostic fossil and therefore their age designation is often difficult.

The Surma Group is the most important stratigraphic unit in Bangladesh in terms of thickness and economic importance. It is represented by great thickness in all the wells drilled in the deep basin and also forms the backbone of the eastern hilly areas of the country including Sylhet and Chittagong hill where it is extensively exposed. The unit is traditionally believed to be deposited in Deltaic to shallow marine environment (Holotrop & Keiser 1970, Jonson & Alam 1991). All the reservoirs discovered so far in the Bangladesh are housed in the Surma Group [6].

Pliocene-Pleistocene: Following the filling up of the basin by deltaic deposits, a broad front of river plain environment was established under which sand dominating (arenaceous) units was deposited. This is called **Tipam Group** which is divided into three formations from bottom upward, Tipam sandstone Formation, Girujan Clay Formation and Dupitila Formation (Holotrop& Keiser 1970) [6].

Tipam Sandstone Formation, of Pliocene age, is typically consists mainly of gray brown medium to coarse grained, cross bedded to massive sandstone with minor intervals of clay beds. It unconformably overlies the Surma Group in marginal part of the basin, but in the basin center the contact is conformable. Like the Surma Group it is extensively exposed along the hill ranges of the fold belt. The Tipam Sandstone Formation is about 1200 to 2500 meter thick and indicates deposition under river plain environment [6].

The overlying **Girujan Clay Formation** is a clay unit with thickness of 100 to 1000 meter. The unit has local extent and represents deposition in Lake Environment. The unit is conformably overlain by sand dominating DupiTila Formation; however where the Girujan Clay unit is missing, the Tipam Sandstone Formation would not be distinguished from the DupiTila Formation and their boundary became vague [6].

The **DupiTila Formation** of Pliocene-Pleistocene age, has been named after Dupigaon hills in Sylhet (Evans 1932), the only place in Bangladesh given a type locality status in Tertiary stratigraphy. It is a sand dominating unit with minor interbedded clay stone. The sandstone is red to brown, medium to coarse grained, loosely compacted, cross bedded, occasionally pebbly and contain petrified wood in several places. The unit was deposited under fluvial/river plain environment. The thickness of the unit varies from 500m in Sitakund anticline to over 3000m in Sylhet trough (Reiman 1993). DupiTila Formation is the major groundwater aquifer in Bangladesh [6].

Quarternary (Present to 2 million years ago): The Quarternary rocks are represented by Modhupur Clay Formation of Pleistocene age. This unit is composed of reddish to brownish clay with subordinate silt and typically occurs in the uplifted terraces as well as in the subsurface (Morgan and Mclntyre 1959, Monsurrt al 2003). The above is covered with about 100 meter of sandy, silty and clayey sediment of Bengal Alluvium of Recent (Holocene) age [6].

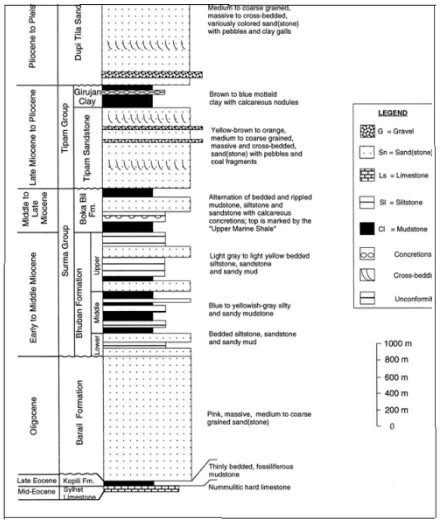

Figure 5. Stratigraphy of SylhetTough [6]

4. Location Observing Data

Surma & Kushiyara Sand Deposit

The Surrna and Kusliiyara Rivers are the bifurcated channels of the Barak River from Amalshid. The Surma has an average slope of 50 mm/km from Amalshid to Kanaighat. The Surma River is approximately 150m wide at bankful1 stage. It is 11m deep at Amalshid, and then decreases to 8.3m at the junction of the Lubha. From Lublha, the river bed falls for the next 16km downstream, lowering to 13.8m below the bank level. The Surma above the Lubha towards Amalshid is not significant and carries only a small portion of the Barak flow. The Kushiyara

River is approximately 150m wide when full and the average depth is about 12m.

Soils

Soils in the project area were developed in alluvial sediments laid down by the Surrma and Kushiyara Rivers. Because both rivers originate from the Barak River, parent materials of the soil are similar. Eight soil series have been identified so far.

Heavy clay soils occur in the deeply flooded basins and cover about 5916 ha (20 percent) of the cultivated area. Silty clay soils occur on low, smoothed out ridges and edges of basins, and cover about 7277 hectares (26 percent). Silty clay loams are found primarily on ridges on about 10.462 hectares (37 percent) while medium texture soils (loam to silt loam) occupy the highest topographical positions and cover about 4400 hectares (16 percent).

Fine texture soils (silty clays and clays) are poorly to very poorly drained, grey to dark grey in color and have low available moisture holding capacity. Moderately fine textured (silty clay loam) and medium textured (silt loam) soils are olive brown to grey in color, imperfect to poorly drained and have high to moderately high available moisture holding capacity. The natural fertility of these soils is moderate and they are capable of producing fairly good crops with very little fertilizer. Agricultural production, however, can be increased by applying mixed fertilizers.

5. Result

We got that the percentage of sand both in Surma & Kushiyara is high enough with respect to other minerals. This sand is mostly used in the bricks factory.

Besides this the thing is to say that most of the sand extracted from the sand deposit of Surma&Kushiyara river bed is used in the bricks factory near to Zakiganj as raw materials.

6. Conclusion

The main thing we have to locate & consider to analysis the feasibility of any area that the proven or already found geo-resources. But the main fact is that there has not arranged yet any survey or extraction data through we could determine or calculate the feasibility of my respective area. On the other hand another possibility is highly appreciable that if we analyze the structural framework of the Sylhet region, we find Zakiganj is also be a probable area for geo-resources as we have already found different types of geo-resources in different location of all over the Sylhet which is lying in the same geological area. As of now the current situation clearly state that Zakiganj does not possess any kind of mineral resource which is extractable or has any prospect of contributing to the economy of Bangladesh. All the survey data readily available also point us to the same direction. The unavailability of resources also indicates to the point that inadequate survey in the Zakiganj area, which may be the main reason of not finding any kind of geo-resources in the corresponding area. Beside this the region is on the Surma Basin of Sylhet which geologically and stratigraphically possesses a significant amount of features suitable for probable reserve of available geo-resources. Though the area has good prospect; from my investigation, collected data & all other present estimate of the respective upazilla there has not yet been discovered any reserve of geo-resources. Accuracy & inaccuracy determination of the presently collected data is highly important for further analysis and development of the feasibility test.

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