

Geothermal Update in Bangladesh

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ABSTRACT

Energy is one of the vital factors for ensuring the sustainable development of a country. At present Bangladesh is experiencing a lot of drawbacks as power demands are increasing at a rate greater than that of production. The power production of the country is mainly depends on its natural gas reserve which is predicted to put an end soon. The country has targets to produce more than 50% power from coal energy which has negative impacts on environment. In this context, geothermal energy can provide a viable solution for Bangladesh to heighten power crisis scenario and ensure a secured future. The Ganges-Brahmaputra Delta, world's largest one has formed the most parts of Bangladesh which also has a large sedimentary basin. Bangladesh due to its geo-tectonic settings and thick sedimentary covers (130 m -20 km) as well as lies close to both the Eurasian-Indian plate boundary and Indo-Burman Ranges, as a result the country is tectonically very active. Only one combined study have been carried out by geologists in abandoned deep wells (which have been done for gas exploration) of northwest region found temperatures of more than 100°C (in the depth of 3 to 4 kilometers) which might be suitable for geothermal energy production. Survey and study of the temperature variable of these investigated wells indicated that geothermal gradient along the southeast part of the Bengal for deep region and along the northwest stable shelf is from 19.8 to 29.5°C/km on average and from 20.8 to 48.7°C/km on average respectively. Besides this paper some descriptive very fundamental studies of geothermal field have been carried out by some researchers where provided suggestion to the government for take necessary action to utilizing the geothermal resources in future specially in that abandoned gas wells. To improve the power crisis in our country geothermal energy can be a vital & useful alternative. Bangladesh is one of the largest deltas which has very good aquifer system and need only sufficient temperature. The main theme of this paper is present status and to emphasize the more research on mentioning abandoned wells as should be needed to detailed study about geothermal energy resource in Bangladesh. The geothermal prospects, geological mapping of surface geothermal manifestations as well as low-temperature surveys are essential to evaluate the geothermal resources in Bangladesh.

1. INTRODUCTION

Bangladesh is one of the lowest per capita energy consumption countries in the world. The country is a facing problem with shortage of energy and depended mainly on the natural gas and imported fossil fuel for electricity generation, industries, vehicles etc. Bangladesh has small reserves of oil and coal, but large natural gas resources. Commercial energy consumption is mostly natural gas (around 70%) followed by oil, hydropower and coal. Electricity is the major source of power for country's most of the economic activities. Bangladesh's installed electric generation capacity was more than 10 GW. The country needs to develop alternate energy resources like renewable energy to meet up the demand. Bangladesh has no volcanic region but tectonically lies in the northeastern Indian Plate near the edge of the Indian craton as well as Eurasian-Indian plate boundary which may associate with high geothermal gradients.

1.1 Geothermal Activities in Bangladesh

There is no mentionable work with respect to geothermal energy in this country till now. Herbert Henkel (Sweden) and Prof. D.K. Guha (Bangladesh) under the funding of KTH (The Royal Institute of Technology Stockholm, Sweden) carried out a study on the geothermal energy probability in Bangladesh (Guha et al. 2005 and 2010) which was concentrated mainly on the abandoned deep wells for gas fields. They studied 50 more abandoned wells in Bangladesh and recommended some steps for geothermal energy production from these wells. On the basis of the Herbert Henkel and Guha study and findings the team proposed a project which was coordinated by Prof. Dr. Badrul Imam of Dhaka University. Finally recommended for a pilot study reopening of the abandoned wells) in at least one of the 3 wells (Singra, Shalbanhat and Sitakund wells) but it was not materialized. Geological Survey of Bangladesh carried out a drilling programme (GDH-65/11) in the area of Thakurgaon district. Drilling concluded at the depth of 586 m and temperature recorded 47°C which is almost normal gradient of Bangladesh. Mohammed Masum (2015), Vivekananda Das (2017) and Asif Bin Karim (2018) have been written three articles where they mentioned that the prospect of geothermal in Bangladesh.

2. GEOLOGY

2.1 Geo-Tectonic Settings of Bangladesh

The geology of Bangladesh is affected by the country's location, as Bangladesh is a riverine country. It is the eastern two-thirds of the Ganges and Brahmaputra river delta plain stretching to the north from the Bay of Bengal. While the eastern part of Bangladesh is the continuation of the frontal belt of the Indo-Burma Range. Bengal Delta is one of the largest deltas in the world. Geological evolution of Bengal Delta is related to the uplift of the Himalaya due to collision of Indian and Asian plates. The Bengal Delta is characterized by enormous sediment supply from Himalaya, rapid sedimentation and subsidence resulting in huge thickness of siliciclastic deltaic sediments. Tectonically Bangladesh lies in the northeastern Indian Plate near the edge of the Indian craton. Stable Pre-Cambrian Platform and a huge geosynclinal basin in the southeast are dominating tectonic features of Bangladesh which are separated by a narrow northeast-southwest trending Hinge zone (Figure 9), currently known as palaeo continental slope (Salt et al. 1986). Stable Pre-Cambrian Platform covers the country to the west and northwest of the Hinge zone and is divided into three

major zones: Rangpur Saddle, Bogra slope and Dinajpur slope (Figure 9). The thickness of sedimentary column on the stable shelf of Bengal Basin varies from less than 200 m to 10,000 m (Alam 1989). Rangpur Saddle connects the Indian Shield with the Shillong and the Mikir Hills Massif resulting in uplifted basement with thin cover of sedimentary rocks. In Madhyapara area the basement is encountered at 130 m depth and overlain by Plio-Pliocene sediments. The northern and southern slopes of Rangpur Saddle are quite gentle and the basement plunges gently from Madhyapara towards the southeast up to the Hinge zone. It separates the Bengal Foredeep and the Himalayan Foredeep. The Northern Slope of Rangpur Saddle is also recognized as Dinajpur Slope, and gently slopes towards the Sub-Himalayan Foredeep. The thick sedimentary basin is subdivided into fold belt in the east and Bengal Foredeep to the west. Bengal Foredeep occupies the vast area between Hinge Line and fold belt of Arakan Yoma Folded System. It comprises a platform region in the west and a folded region in the east. The western platform flank is characterized by several highs and lows namely Faridpur Trough, Barisal-Chandpur High, Hatiya Trough, Madhupur High and Sylhet Trough. The tectonic and geothermal maps of Bangladesh clearly demonstrate a pattern of geothermal conditions in Bangladesh (fig. 1).

2.1.1 Himalayan Foredeep

The Himalayan Foredeep lies south of the Main Boundary Thrust (MBT) all along the foothills of the Himalayas. In this area at the NW tip of Bangladesh the basement occurs at 2,500 m depth as encountered in Salbanhat-1 well (abandoned gas oil Tetulia, Ponchagarh). At this depth 79°C bottom hole temperature is projected. The Neocene of the Siwalik are well developed in the Himalayan Foredeep. Low geothermal gradient (2.25°C/100 m, Figure 8 and 9), barely feasible to explore geothermal energy. In the well GDH-65/11 recorded 47°C temperatures at the depth of 587 m and Shalbanhat well projected temperature 110°C at the depth of 4,000 m which is shown almost normal gradient in this region (fig. 2).

2.1.2 Rangpur Saddle

The Rangpur Saddle represents the Indian Platform and connects the Indian Shield with the Shillong Massif and the Mikir Hills (Figure 8). In the Madhyapara area the basement occurs at only 130 m depth. In the western part of the Rangpur Saddle, a number of graben and half graben structures have been found with Gondwana sediments, some of which contain coal seams. The Gondwana sandstone sequence below the coal seams in Barakupuria coal mine has a temperature of 50°C at a depth of 400 m. The coal seams together have an insulating effect resulting in increased temperature in the basement below. The area is characterized by relatively high surface temperatures reported from some irrigation wells and in coal bearing graben structures and underground hard rocks mine. The geothermal resource is likely located within the uplifted basement and would require hydraulic fracturing methods to create permeability at depth with sufficient high temperature for present technology of electricity generation. Because in the Great Artesian Basin in Australia, the Paris Basin, Molasse Basin in Germany and North China Basin used this energy for power production. Their temperature recorded around 120°C.

2.1.3 Bogra Shelf

The Bogra Shelf represents the southern slope of the Rangpur Saddle. It is a regional monocline plunging gently towards the south east towards the Hinge Zone and marks the transition between the Rangpur Saddle and the Bengal Foredeep from depositional as well as structural point of view. Stanvac Oil Company (SVOC) carried out aero-magnetic and seismic surveys in the mid-fifties followed by drilling two wells at Kuchma and Bogra and their geothermal gradient are 27°C/km and 30°C/km respectively. This area is favourable condition for low-temperature geothermal energy production due to slightly high geothermal gradient (fig. 2). The aquifer of this area is composed of loose water bearing permeable sandstone which is also helpful for geothermal resources. This area may be suitable for power generation utilizing the geothermal energy of abandoned wells like as that of Texas sedimentary basin and Williston sedimentary basin in USA. Beside that during the feasibility study of Madhayapara hard rock, (now hard rock mining going on) geophysical study was carried out among the four drill hole by GSB. They used sonic, Gamma and temperature log. The abnormal temperature anomaly was found in the fourth number of hole where 53°C was recorded in the depth of 300 m. So it should be needed to detailed study in that area for further utilizing the geothermal resources.

2.1.4 Folded Belt

The Folded Belt (or the folded eastern flank of Bengal Foredeep) represents the most prominent tectonic element of the Bengal Foredeep, with general sub-meridional trending hills parallel to the Arakan Yoma Folded System (fig. 1). The Folded Belt is subdivided into a Western Zone and an Eastern Zone according to the intensity of folding and other structural features. The Western Zone is the most important and prospective oil and gas province of Bangladesh with 12 fields from Kailas Tila in the north to Semutang in the south. Hot springs have been observed at Barbarkund and Gobaniya Chara in the Sitakund anticline with temperatures of up to 35°C. (Guha et al. 2005). In the Sitakund well, the geothermal gradient is 28°C/km and recorded temperature is 118°C at the depth of 4,000 m. In the sedimentary sequence to 2.3 km depth, consisting of mainly shales, the gradient is slightly higher, indicating a lower thermal conductivity and hence an insulating effect to warmer and deeper formations. In the Bakhrabad well, the geothermal gradient has been found at 30°C/km. The Eastern Zone includes the more steeply folded and faulted anticline structures. The anticline structures can turn out to be of significance also regarding geothermal energy prospects as there are many dry wells penetrated quite deep and thus may have high temperatures. A small power plant maybe set up in this region based on geothermal energy with the help of abandoned gas wells. The geothermal exploration cost can be reduced by using the existing/abandoned on-shore dry wells where the geothermal gradient is sufficiently high (over 30°C/km) and where porous and permeable reservoir sandstones are penetrated.

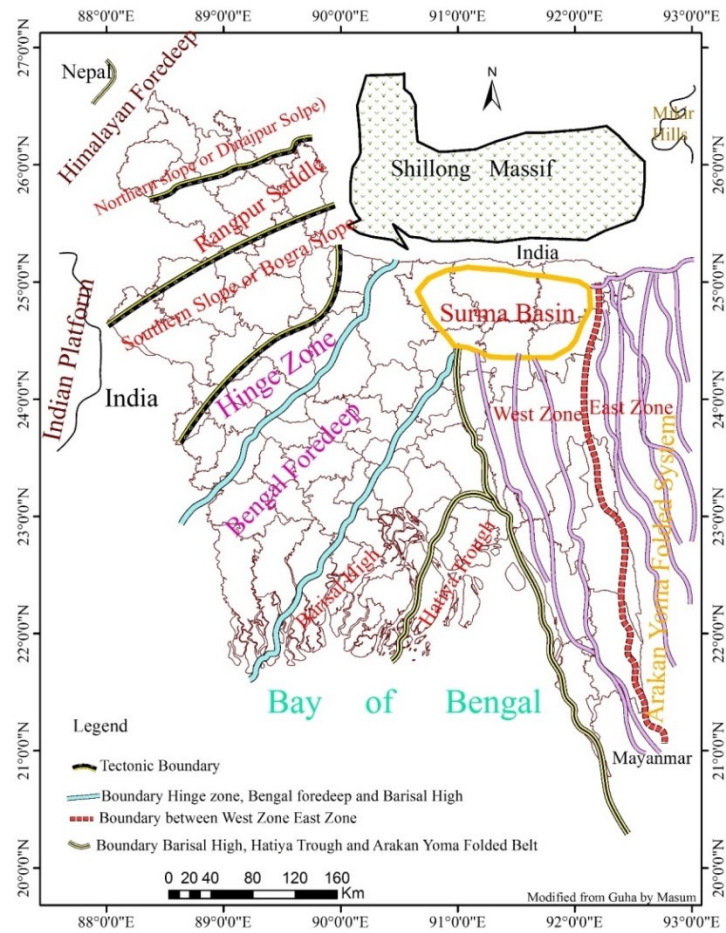


Figure 1: Geo-Tectonic Settings of Bengal Basin and Adjoining Area.

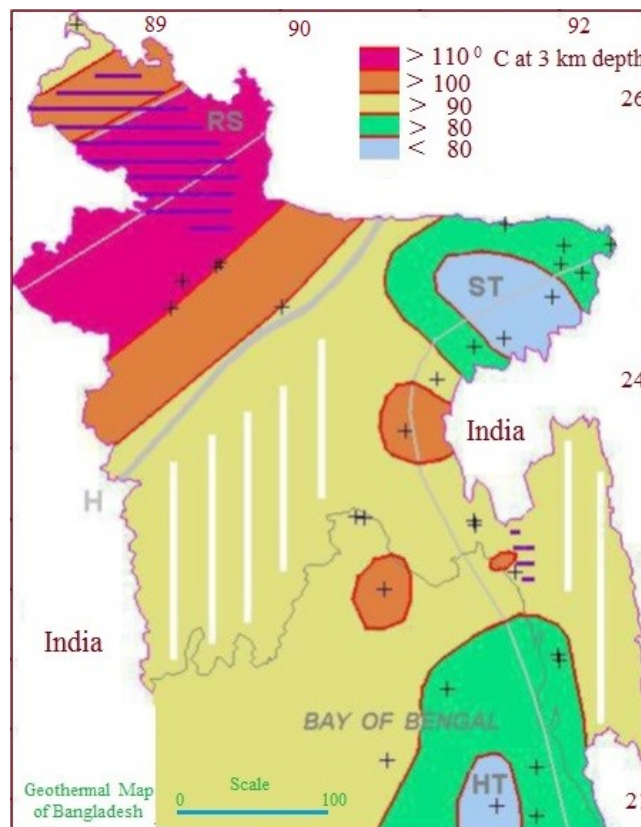


Figure 2: Geothermal Gradient Map of Bangladesh.

3. DISCUSSIONS AND RECOMMENDATIONS

Geothermal studies so far carried out in Bangladesh indicate that the country is ideally suited for further detailed studies to tap the geothermal energy by carrying out concentrated effort to fully explore the potential of the country. Large part of the sedimentary basin in Bangladesh is quite similar to some geothermal dominant sedimentary basins around the world. There are many abandoned gas wells in the basin part of this country where reservoir rock is water bearing sandstone is good sign for geothermal energy production, here only a suitable temperature is needed. Some abandoned gas wells in Texas Basin, USA utilized as geothermal energy production which are quite similar of Bangladesh. They are producing geothermal energy from abandoned gas and oil wells. It is not out of context to mention that there is immense potential to tap the geothermal energy in Bangladesh in particular in Bogra Shelf and Rangpur Saddle as well as the basin part where abandoned gas wells are available. The country is looking partnership, entrepreneur, agencies, NGO's as well as geothermal developed countries that developing the geothermal energy in this country. It should be needed to detail survey of geothermal provinces (Rangpur Saddle and Bogra Self region) and prepare subsurface geothermal map for utilization of the energy. It is suggested that detail work about more prospective abandoned gas wells around the country and should be taken as a pilot project for the extraction of these resources.

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