OVERVIEW OF GEOTHERMAL RESOURCE EVALUATION OF BANG-LE THUY-QUANG BINH

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Introduction

Vietnam is the country in the Asian Southeast region, has been seen the market economy since Vietnamese Government implements it' policy to open. In general, Vietnam likes many countries all the world, has been experienced a shortage of energy in recent years. Many renewable resources such as hydro plant, solar, wind, wave, biomass and geothermal etc., have been planned to develop in the coming 10 years economic development plan. Geothermal resource of Bang in Quang Binh has been seen the potential geothermal resource to develop the pilot binary cycle geothermal power plant in Central Part of Vietnam. Many investors have carefully considered if they should invest into the pilot binary cycle geothermal plant in the Central province or not, because Vietnam has not got any renewable energy laws. Germany experts advise this geothermal resource should be directly used by installing the pipe line from Bang to the coastal Sun Spar Resort of Dong Hoi city. View of geothermal water direct use has been strongly supported because it has been used for bathing, tourism, canning rightly in Quang Binh.

Geothermal resource of Bang

Bang geothermal resource is rightly located in Kim Thuy commune, Le Thuy district, Quang Binh province. In 1977 – 1980, Survey Institute of Water Resource Design of Water Resource Ministry investigated the hydrogeology, geology- engineering characteristics of this geothermal resource in detail. Institute drilled to reach up the depth 50m and measured the temperature and the water flow of borehole. In 1995 – 1998, Research Institute of Geology and Mineral Resources of Ministry of Resources and Environment implemented the project to do survey Bang geothermal resource and calculated the temperature of host reservoir by geothermometry method. In 2006, geothermal experts of J-Power of Japan and Research Institute of Geology and Mineral Resources of Vietnam did survey and reported to show up Vietnamese Government.
Bang geothermal resource is occurred in many points to run along the stream valley on the left of Kien Giang river. The valley widens about 100 m and runs 2km.

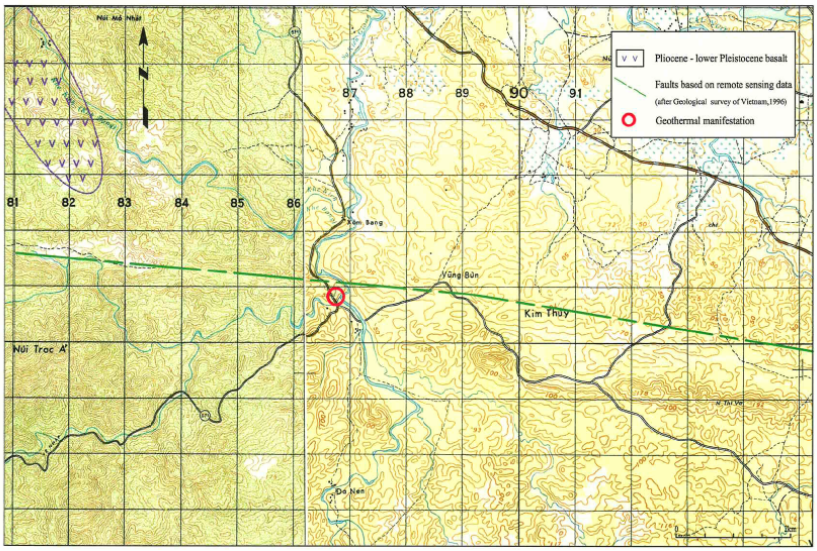

Figure1: Red circle is the location of Bang geothermal resource, will be intended to explore (according to data of J-Power).

Geological characteristics

Stratigraphy:

Upper Ordovician- under Silurian formation (O_3-S_1*ld*): includes sandstone, siltstone, clay stone and shale imbedded each other, some time interbedded in the old extrusive. The formation accounts for more than 90 % area of Bang geothermal resource around.

Quaternary formation (Q): includes the density massive, dark- brown colored basalt strongly sheared to distribute in the Northwest direction of Bang geothermal resource, far from the resource mentioned above about 6 – 10 km. Some geothermal experts confirm the resource can be related to the young basalt.

Deluvial mixed soil (el Q_{III-IV}) is distributed on the hill escarpment to thicken up 1-3m

Alluvial (a Q_{IV}) includes of sand, grit and pebble distributed along the stream terraces and the valley.

Fault system: On the area of Bang geothermal resource to exist two faults developed according to North West – East south and North south direction.

North West – East south fault is developed to cut across the hot water occurred area of Bang geothermal resource to form the quartz breccias containing sheared zone widened up 15m to run along the valley. This fault has been seen the geothermal resource related one of Bang.

North south fault is seen the minority one to cut across the Bang area to create the favor condition of the development geothermal resource.

Geothermal manifestation of Bang geothermal resource.

The geothermal water – containing zone in the sheared zone is distributed along the stream valley to lengthen 250 m to form three small areas with many silica and travertine dunes. The dunes have diameters about 1-1, 5 m.

The first area: The hot water that is occurred in many continuously linked points distributed equally in the area 350 m^2.

The second area that is near the firs area has 17 hot water points occurred in the stream bed in the area 300m^2.

The third area has only the hot water occurrence point. The hot water is strongly discharged and has the higher temperature than other areas.

The hot water and gas have H_2S sulfur gas, neutral pH. Total minerals degree gains 530mg/l, has been listed Na-HCO3.Total flow of hot water is measured about 50l/s. There is the borehole to reach up the depth 24 m. The temperature in the borehole is measured to reach up 105^oC.

Photo 1: The geothermal water exploitation borehole location of Quang binh Coservo Company.

Photo 2: The location of geothermal water and gas discharge in the breccias zone in the stream line.

Geochemical characteristics of Bang geothermal resource

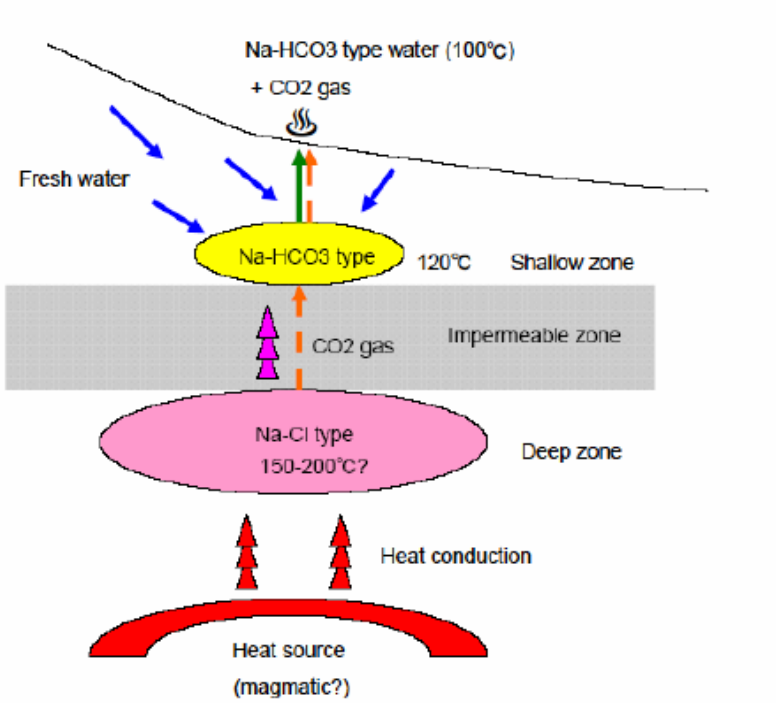

Figure 2: The geochemical modeling of Bang geothermal resource (according to data of J-Power).

Hot water of Bang geothermal resource that has low total mineral degree to be mixed with ground water and surface water. In chemical composition of hot water that includes Na content 157mg/l to account for 90% e. Content K accounts for 4% e, content Ca^{2+} to change about 2%. HCO_3 has tmd 405g/l to account for 83% e. Content Cl^- and SO_4^{2-} is very small only to account for 10% e. Content Li has highly relative (0,02 mg/l). Content B is 0,15mg/l. Based on the hot water analyzed results to show up the estimation of Bang geothermal reservoir at two different levels; the depth from 200 m to 300m to

has temperature about 120 – 130^{o}C including Na- HCO3 mainly. The under part of geothermal reservoir (the more depth level) has the depth from 450 to 700m, to be estimated to has temperature from 138,1 to 214,0 (based on geothermometry of Quartz and Fournier & Potter 1982, Na-K-Ca of Fournier & Potter 1979). The under part of geothermal reservoir has been seen the objective to develop the pilot geothermal plant of Vietnam in Central Part.

Table 1: Calculation table of three elements Cl- SO_4 – HCO_3

No	Location name	K- Na-Mg			Cl-SO_4 – HCO_3		
		Mg (%)	Na/1000 (%)	K/100 (%)	HCO_3 (%)	Cl (%)	SO_4 %
1	Bang	71,65	16,26	12,09	93,54	1,95	4,50

Primary potential estimation.

Estimation method.

There are many calculation methods applied to the exploration stages of geothermal resources raised up in order to estimate the geothermal resource energy reserve of Bang in Le Thuy- Quang Binh. We have used the estimation method of geothermal energy reserve for Bang geothermal resource that has been used by US (UGS, 1979).

The calculation elements for the reservoir mass, area, thickness, permeable degree of Long Dai formation, temperature have been shown up. Every calculated element has been calculated in minimum, in average, in maximum based on the survey data, the exploration data in the past and modeling of the geothermal resource.

Potential calculation.

The calculation methods include:

- The reservoir temperature: It has been calculated based on the geothermometry: Minimum: 138, 1 ^{o} C; Maximum: 214,0 ^{o} C.
- The reservoir area: There is no any sounding data of geophysics measured in the geothermal resource. There are some boreholes drilled in Bang but their borehole depth from 40 m to 55m. The purpose of boreholes to collect the geothermal water for COSERVO Mineral Water Company. The data mentioned above can not be used to calculate the reservoir area. The reservoir area of Bang has been calculated based on the geology data, the geological structure data, the topography data and the compared geothermal manifestation in all Vietnam.

Minimum: (70m x 50m x 600m) 1/3 + (30 x 10 x 600m) 1/3 = 0,76km^2.
In average: (70m x 50m x 600m) 1/2 + (30 x 10 x 600m) 1/2 = 1,14km^2.
Maximum: (70m x 50m x 60m) + (0 x10 x 600m) = 2,28km^2.

- The reservoir thickness: The thickness is the important parameter to estimate the geothermal resource. There is no the depth drill data in this area, the reservoir thickness has been calculated based on the geological data, the structure geology data and the compared data of some geothermal resources in Vietnam. Minimum: 600m, Maximum: 800m.
- The rock porosity: The rock porous value is generally used: Minimum: 3%, Maximum 7%.
- The recover factor: United State Geological Survey (USGS, 1979) has used the recover index to estimate the circulation system reserve of geothermal resource: 0, 25. Minimum: 10%, Maximum: 25%.
- Specific Heat of Matrix and Density of Rock Matrix. Both values are used based on representative values: 0,972 kj / kg ^{o} C and 2500 kg/ m^3.
- Rejection temperature: It is used based on the average annual ambient temperature (25^{o}C).

- Utilization factor: about 0,4 for the binary cycle modern geothermal power generation system is used from USGS (1979)
- Plant Capacity Factor: 0,9 are used for the typically modern geothermal power plant all the world.
- Plant Power Life: 25 years are used in the general standard

From the mentioned calculation above, we can invest to build the pilot binary cycle geothermal power plant in Le Thuy – Quang Binh with minimum capacity: 4,129 MW (90% probable), maximum capacity: 13,678 MW (50% probable). The calculated results have been raised up as the same as the J-Power calculated results in 2006.

Conclusion and recommendations

Conclusion.

Bang geothermal resource is closely related to structural features like faults and fractures that they cut across Long Dai formation.

The Quarternary basalt rock mass on the NW direction is seen too old to heat the geothermal resource.

The geothermal manifest ions in Bang like hot grounds, sinter mounds, sulphur gas and some alternated zones have shown up that this geothermal resource temperature is not so high and is only suitable with the small binary cycle geothermal power plant.

The primary calculated results has shown up that this geothermal resource needs to explore in detail by deep drill boreholes to decide the reservoir volume, the temperature, the pressure and the discharge.

Recommendation.

Before drilling the detailed exploration wells in the Bang area needs to measure the geophysics sounding to decide the reservoir.

Based on the geophysics data to decide the exploration drill wells how to cut across the reservoirs. The faults in the Bang area have been estimated to cut across the reservoir in subsurface. The exploration drill wells needs to drill rightly on the faults.

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Nguyen Tien Hung was born at date of 15-8-1968, at Thai Nguyen province- Vietnam. In 1998 he gained a University Degree from Hanoi Uinversity of Geology and Mining. In 2001 he got a scholarship award of United Nations University in Iceland for Post graduate Geothermal Training Programme. In 2005 was awarded a Degree of MSc in Geology and Environment in Joint Training Programme of Hanoi University of Science (Vietnam) and University of Greifswald (Germany). He has worked for the Research Institute of Geology and Mineral Resources in Hanoi-Vietnam from 1998 to 2005. From 2005 to 2008 he works for Hanoi University of Science and Mechanics Institute in Hanoi-Vietnam.