DIRECT UTILITIES OF GEOTHERMAL ENERGY POTENTIAL IN PANGI'S AREA OF BONE BOLANGO REGENCY, GORONTALO BASED ON GEOPHYSICAL ANALYSIS

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Abstract *Pangi is one of the areas in Bone Bolango Regency of Gorontalo which is have a geothermal manifestation point such as hot springswith surface temperature of 47-56°C. Geothermal manifestation here is not utilize yet. The purpose of this research is to use geophysicalanalysis of the electrical cross section of resistivity using Schlumberger configuration and Wenner configuration to design the utilities of geothermal energy in Pangi's geothermal areas. The surface data gather in the field that is about the geothermal manifestation data. The subsurface data gather by using the resistivity meter with Schlumberger configuration as sounding and Wenner configuration as mapping that focus on the manifestation point. Processing data use IPI2win and Res2dinv software. The result show that there is 7 layers type of lithology which are Alluvial, Sand, Clay, Volcanic Breccia, Andesite, Granodiorite, and DioritePorphyry. The cap rock layer of Pangi's geothermal areas is an Alluvial and the reservoir layer is aSand layer. Pangi's geothermal manifestation is potential for the direct use in agriculture sectors, aquaculture sectors, and in the medical sectors.*

Keywords :*Pangi, Geothermal, Geophysics, Direct Utilities.*

1. Introductin

1.1. Background

Indonesia is the one country whichis have many geothermal potential energy. Around 40% geothermal energy potential is in indonesia underground. Based on [1] there are 256 areas that have geothermal prospect in Indonesia and about 7 location (2,64%) which's has used. Some Country in our world using geothermal energy for direct used. Direct use is in non-electric sectors for example industry sectors, agriculture sectors, and other's.

Gorontalo have some point geothermal manifestation which is hot springs. The hot springs point is founded in Bone Bolango regency especially in Lombongo, Libungo, Pangi, Pancuran, danHungayono. [1]

Partially population in Gorontalo is corn farmers, rice farmers and coconut farmers. The problem that faced by farmers is the time of drying the agriculture product which is taken too many time for dry. The impact from this problem is the agriculture product in Gorontalo will decreased and will make the fund decreased to. The Government must give their attention for the alternative energy which is helping the production process to increase.

One energy that includes renewable energy is geothermal energy. The utilization of geothermal energy begins with geothermal exploration. Exploration can be done by interpreting the surface and subsurface data. Geothermal exploration is important to know the amount of geothermal resources to be utilized.

Geothermal exploration consists of geology exploration, geophysics exploration, and geochemistry exploration. Geophysics research used resistivity method [5,6,7,8]can make the subsurface of geothermal area.

Based on research [2] conducted in Suwawa area of Bone Bolango district, Gorontalo. The resulting data is still not able to explain the potential that can be developed by knowing the geothermal system in Suwawa area so that further research is needed by using other geophysical methods to obtain more in-depth and more accurate information. So it can know how big the potential of geothermal energy in an area.

1.2. Problem

a. How is the geothermal energy potential of the research area?
b. How to design the geothermal energy utilization of the research area?

1.3. Purpose

The purpose of this research is to know the potential of geothermal energy area of pangi area by using geophysical method which then become reference for design of utilization of geothermal energy potential in research area.

2. Location and Geology of The Study Area

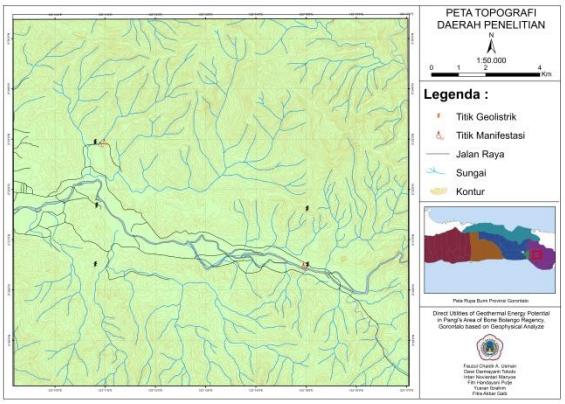

Fig 1 Topography Map of Bone Bolango Regency

The research location lie in Bone Bolango regency especially at Lombongo's geothermal manifestation and Pangi's geothermal manifestation. The geophysical Data retrieval is taken in 5 point in Bone Bolango Regency that is at Lombongo 1 point, Bonde Raya 2 point and Pangi 2 Point.

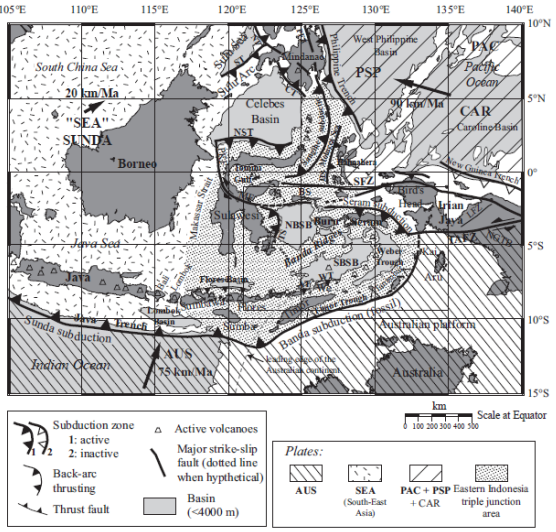

Fig. 2 Map of Tectonics plate movement

Based on regional geology, the rock unit of study location is Qpl, TQpv, Tmb, Tmbv, danTmt.The geological structures in the field based on remote sensing images interpretation are faults and folds. The normal fault are irregularly oriented, but in western part they tend to be oriented approximately east – west. The lateral fault are paired, oriented in NNW – SSE direction (right-handed faults) and NNE – SSW direction (left-handed faults). The biggest lateral fault is the Gorontalo fault that is based on analysis of the accompanying joints suggesting right-handed movement. Thrust faults dipping approximately 30^{o} were found in some places, Particularly in the BilungalaVolcanics. The area has been subjected to more than one compressional tectonic periods. Boulders of silicified rock up to 5 m sized that were found in some places in the upstream area of DutunaIya, and are supposed to be derived from the Tinombo Formation, depict at least two generations of folding. The older fold is isoclinal, and is refolded by the younger, tight to open, folding. Based on strike and dip measurement along the S. Sogitia Kiki, S. Tombulilato, and S. Bilungala. It could be recognised an open folding with the limbs dipping up to approximately 30o and nearly east – west oriented axes. The pillow lava found in S. Sogitia Kiki is also openly folded [13].

Sulawesi island lie in the midst of complex tectonics region that is assembly of 3 plate which is indo-Australian plates, Philippine-Pacific and Asian plates[9][11]. According from the geodynamic reconstructions Sulawesi island is subdivided to three main geological province which is West Sulawesi, Central and South-East Sulawesi, and West Sulawesi [10][12]. Gorontalo is lie in west Sulawesi region especially in North Arm of Sulawesi Island which is magmatics arc area [10][12].

3. Method

This research was conducted on geothermal area in Bone Bolango district, Gorontalo Province. Data collection is focused on several points around the Pangi geothermal manifestations.

The method used in the research design the utilization of geothermal energy potential in Pangi, Kab. Bone Bolango, Gorontalo Province is doing data collection and interpretation of research data. Field data retrieval is divided into 2 data that is surface data and subsurface data. Surface data retrieval is geothermal manifestation data. The subsurface data is collected by using geolistrik method of resilience of schlumberger configuration type and wenner configuration.

Stages of research include:

3.1. Preparation

The preparation stage includes preliminary activities prior to field data retrieval. The preparation stage consists of several sub-activities, namely:

a. Stage of administration

Administration stage is about Correspondence as a research need such as Research Task Letter.

b. Stage of preparation

The preparation phase of this tool will be used in field research. Tools for supporting research including infrared thermometer, litmus paper, geological compass, geological hammer, roller meter, GPS Oregon 55, 1 set of resistivity, camera, materials used in the study are base map, sample bag, pH paper and notes.

3.2. Stage of field data retrieval

These stages include surface data retrieval and subsurface data. Surface data in the form of geothermal manifestation data. The subsurface data was obtained by measuring the geological resistance of the Schlumberger configuration type and the Wenner configuration using the resistivity meter tool.

3.3. Stage of analysis data

Data generated from data processing will then be analyzed according to the potential so that it can be known what kind of design will be made.

4. Result and Discussion

a. Manifestation

The research location is in 2 point of geothermal manifestation at Bone Bolango that is Lombongo's and Pangi's geothermal manifestation. The first manifestation is in Pangi's manifestation. This manifestation is not far from the settlement of citizens and lies on the side of the Boneriver. At this location there are 2 geothermal manifestation points. At the first point, this geothermal manifestation is a hot springs with a temperature of 56°C, PH 7 (neutral). The second point of the manifestation distance ± 10 m from the point of the first manifestation. At this point the geothermal manifestations of heat are at 47 ° C., PH 7 is neutral.

The second location is in Lombongo's geothermal manifestation. This location there 2 hot springs. The first point is in coordinate N 00º32 '56.7 "E 123º10' 52.7". Physically the manifestations water is clear water, odorless and tasteless pH 7 (neutral) with surface temperature 48ºC, the deposition is iron oxide. The second point is incoordinate N 00º 32' 59.9 " E 123º10' 59.9". The surface temperature is 42°C with pH 7 (neutral), this manifestation is not smelling, water clear and tasteless. The deposition is iron oxide and travertine.

b. Interpretation geophysical data

1. Schchlumberger configuration

Based on geophysical data analysis with schlumberger configuration at 5 data processing point that have been processed by using IP2WIN, got:

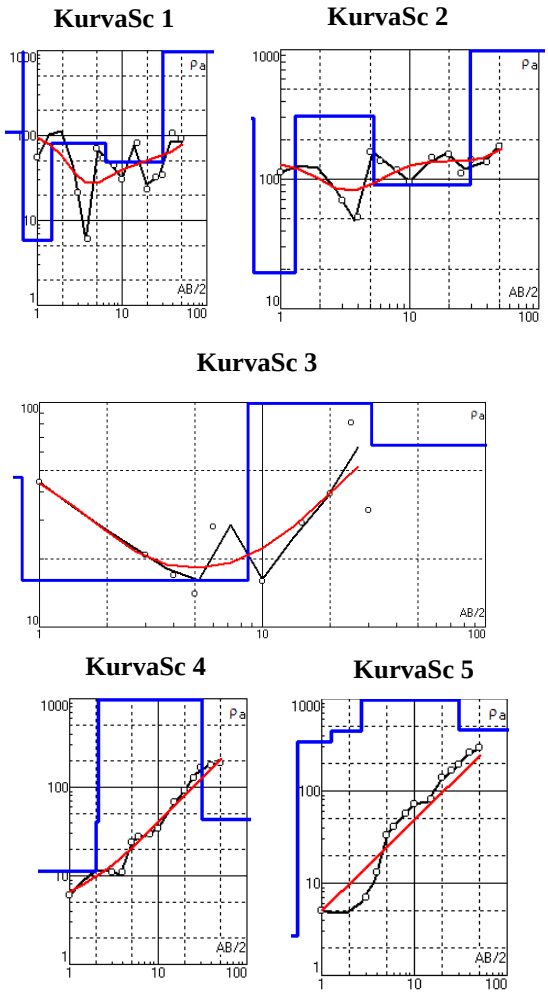

Fig 3 Curve of the geophysical data

Based on the data curve above obtained 5 layers based on differences in the value of rock resitivity in each layer, the results of interpretation of geophysical data are:

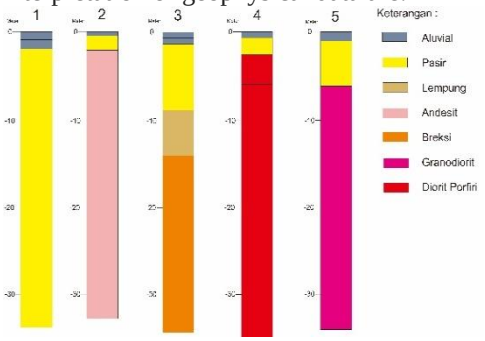

Fig. 4 The Schlumberger Section

- Sc 1

Sc 1 is at the coordinate point N 0 ° 31 '40.6817 "; E 123 ° 10' 49.8683" at elevation 50 mdpl. There are 5 layers of Enda-pan Alluvial and Sandstone.

In the first layer with thickness 0.675 meters and at a depth of 0.675 meters lithology at this point there is the Alluvial Ends. Then in the second layer, at a depth of 0.688 meters is the Alluvial Deposition with a layer thickness of 0.013 meters. In the third layer, at a depth of 1.47 meters is a layer of Sandstone. Where this layer has a thickness of 0.787 meters. Then in the fourth and fifth layer is a sandstone layer. In the fourth layer Sandstone on this layer is located at a depth of 6.38 meters with a layer thickness of 4.91 meters and then in the fifth layer Sandstone on this layer has 23.9 meters at a depth of 30.3 meters.

- Sc 2

Sc 2 is at the coordinate point N 00 ° 31 '36.6408 "; E 123 ° 15' 01.4172 " at elevation 5815, 52 mdpl There are 5 layers consisting of Alluvial Deposits, Gravel, Sandstones and Andesites.

In the first layer with te-bal 0.235 meters and at a depth of 0.235 meters lithology at this point is alluvial deposits. Then in the second layer, at a depth of 0.615 meters is a pebble with a thick layer of 0.38 meters. In the third layer, at a depth of 1.3 meters is a layer of sandstone with a layer thickness of 0.683 meters. Then in the fourth and fifth layers is a layer of andesite rock. Andesite rock in the fourth layer has a thick 3.97 meters at a depth of 5.27 meters. While in the fifth layer, andesite brick in this layer has a thickness of 24.2 meters at a depth of 29.5 meters.

- Sc 3

Sc 3 is at the coordinate point N 00 ° 30 '30.2687 "E 123 ° 10' 48.3501" at elevation 125,972 mdpl. There are 5 layers consisting of Alluvial Sludge, Sandstones, Clay and Breccias.

In the first and second layer, is a layer of sandstone. In the first layer has a teal of 0.161 meters at a depth of 0.161 meters. While in the second layer has a layer thickness of 0.674 meters at a depth of 0835 meters. In the third layer is a sandstone with 7.77 meters thick and there is a depth of 8.6 meters. In the fourth layer, is a layer of claystone 5.18 meters thick at a depth of 13.8 meters. In the last layer is a layer of breccia rock. This strip has a thickness of 17.1 meters at a depth of 30.9 meters.

- Sc 4

Sc 4 is at the coordinate point N 0 ° 30 '29.7214 "; E 123 ° 15' 01.7233" at an elevation of 78.136 mdpl. There are 5 layers consisting of Sandstone, Alluvial Deposition, and Diorite Porphyry.

In the first layer is alluvial deposits with a thickness of 0.278 meters at a depth of 0-0.278 meters. In the second layer is the sandstone layer. This layer has a thick 1.71 meters at a depth of 1.99 meters. In the third layer has a thickness of 0.122 meters at a depth of 2.11 meters. Then in the fourth and fifth layers is a layer of diorite poriri. In the fourth layer at a depth of 5.63 meters has a thickness of 3.52 meters. On the fifth layer, at a depth of 31.1 meters the porphyry diorite layer has a thickness of 25.5 meters.

- Sc 5

Sc 5 is at the coordinate point N 0 ° 32 '56.1412 "; E 123 ° 10' 48.0959" at an elevation of 81.74 masl. There are 5 layers consisting of Alluvial Deposition, Sandstones, Gravel and Diorite Granodiorite.

In the first layer is a layer of alluvial deposits with 0.542 meters thick at a depth of 0.542 meters. The second and third layer pads are thick sandstone layer on the second layer of 0.723 meters at depth 1.26 meters while in the third layer, has thickness 1.4 meters depth 2.66 meters. In the fourth layer is a layer of gravel with 2.96 meters thick, 5.66 meters in the man-mane. Then, in the fifth layer is a layer of

granodiorite with a thickness of 24.6 meters at a depth of 30.2 meters.

Based on the above interpretation results, the cap rock layer is an alluvial layer in which this layer has a resistivity of 1-100Ωm. Alluvial material has im-permeable properties (can not pass water). The reservoir layer is a sand layer. Sand has a high porosity level that can capture water.

2. *Wenner Configuration*

Based on geophysical data analysis with Wenner configuration on 2 data retrieval point that has been processed by using RES2DINV, obtained:

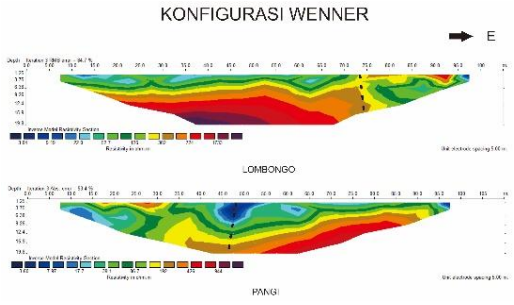

Fig. 5 Wenner cross section

Based on these cross-sectional layers the accumulation of groundwater and hot water coming from the reservoir is in the sand layer (yellow on the lombongo and orange cross section of the pangi cross section) with a 300 µm resistivity for the caprock layer is the alluvial layer (dark blue-green on the lombongo cross- And dark blue-yellow on pangi cross section) with a 1-100 Ωmresitivity. In pan-ampang is interpreted there is a cesarean structure that moves animate, this structure is a way out of manifestation in the research area.

3. *Potential and design of utilization*

Fig. 6 The location for design of direct use

Based on the research, geothermal manifestation temperature of the research area is 56 ° C which is included in the geothermal with low enthalpy (20-150 ° C) [3]. Based on this, the potential that can be developed is by utilizing the direct utilization of the utilization in the Agricultural sector, Aquaculture sector and Health sector [3]. Utilization in agriculture sector is by utilizing geothermal energy for drying the agricultural produce of the district for example rice, corn, and cocoa (copra). By utilizing geothermal energy of 80-100 ° C with a capacity of 200 kg of drying time of about 11 hours. [4]

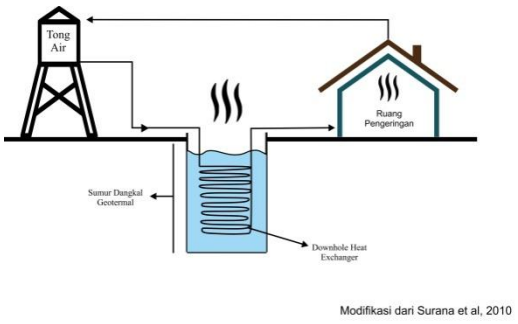

Fig. 7 Design of Dryer (Modification of Surana et al. 2010)

In the aquaculture sector (freshwater fish cultivation), geothermal energy is utilized to help keep water temperatures stable. So that can minimize the occurrence of hatching hook. In the health sector, geothermal energy is used to cure skin diseases by making therapy pools.

In addition to surface data, the results of geoelectric section analysis show that the reservoir layer is a sand layer which is a container where the accumulation of hot water is at a depth of 2 meters. So it can be easily utilized without great cost.

5. Conclusion

Based on the analysis of surface data and subsurface data, it can be concluded that the geothermal energy manifestation of Pangi Bone BolangoGorontalo Province Province has potential to be utilized. Potential utilization of Pangi geothermal energy can be utilized

directly in agriculture sector (agriculture), aquaculture sector, and health sector.

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