Proceedings World Geothermal Congress 2020+1
Reykjavik, Iceland, April - October 2021

Geothermal System of Mount Pancar and Its Significance for Direct Use

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Keywords: geothermal, Mt Pancar, direct use, outflow, upflow

ABSTRACT

Mount Pancar Geothermal System is located in West Java, 60 km from Jakarta. Three surface manifestations are located in Kawah Merah, Kawah Hitam, and Kawah Putih. This study aims to know the geothermal system and its direct use on Mt. Pancar. The research method is divided into several stages, introduction includes the literature study, data collection includes the measurement of temperature and pH in several surface manifestations of Mt. Pancar, and interpretation. The secondary data was retrieved to complete geological information of Mt. Pancar. Mt. Pancar geothermal system includes a convection-volcanic field type and has high relief. The type of manifestation that can be found in Mt. Pancar is a hot spring with neutral fluid type. The fluid temperature of the surface manifestations is about 45 to 67°C with pH 6.8 to 8. The presence of surface manifestation confirms that geological structures trending from Northeast to Southwest, play a significant role to circulate the heated fluid in the subsurface and subsequently to the surface. Mt. Pancar geothermal prospect can be used directly (direct use). The utilization is in the form of the Mt. Pancar area as nature tourism, hot spring baths, camping area, outbound (flying fox), tracking downhill. In addition, recommendations other utilization can be applied by society and stakeholders such as aquaculture. The concept of aquaculture utilizes the manifestation of geothermal with heat exchanger into the fish breeding pond.

1. INTRODUCTION

In terms of geology, Indonesia is a part of the interactions from three tectonic plates, Indo-Australia, Eurasia, and Pacific plate (Amri, 2016). This tectonic activity caused the formation of mountains along Sumatera Island to the Banda Sea and North Sulawesi to Maluku, often called the ring of fire. It has the potential for geothermal energy. According to Peraturan Pemerintah Nomor 7 Tahun 2017 about Geothermal, geothermal is a source of heat energy contained in hot water, vapor, and rocks along with minerals and other gases that can't be separated from the geothermal system. Indonesia has 331 geothermal potential points along Sabang to Merauke (Kementerian ESDM, 2017). This is used for the development of geothermal energy in Indonesia.

The use of geothermal energy is differentiated into direct and indirect use. Direct use is direct exploitation of geothermal energy without the process of converting from heat energy or fluid into other types of energy for non-electrical purposes (Peraturan Pemerintah Nomor 7 Tahun 2017 about Geothermal). Indirect use is heat generated from fluids converted into electrical energy as in geothermal power plants (Ragnarsson, 2014).

West Java has a considerable geothermal energy potential. However, if viewed from an overall point of view, the utilization of geothermal resources are still limited to high entalpy or indirect use. Meanwhile, direct use of low entalpy has not been utilized properly (Mulyana et al, 2017). In this case, if the direct use of geothermal energy sources can be empowered then the energy is expected to improve the welfare of society.

Mount Pancar is one of the geothermal potential points in Bogor, West Java. Three surface manifestation are located in Kawah Merah, Kawah Hitam, and Kawah Putih (Daud et al, 2018). At present, Mount Pancar geothermal potential point has speculative resources of 50 MWe (Kementerian ESDM, 2017). This resource is one of the parameters for determining the utilization of geothermal energy in the area. Therefore, this research aims to determine the geothermal system and its direct use on Mount Pancar.

2. METHODS

2.1 Time and Place of the Research

The research was conducted on November 10, 2018 at Mount Pancar, Bogor, West Java, Indonesia

3.1 Tools and Materials

The tools used in the research include:

a. Compass and Global Positioning System

b. Regional geological map

c. Plastic samples

d. pH meter

e. pH paper

f. Digital thermometer

g. 1-liter plastic beaker

h. Geological hammer

i. Field book and stationery (pencil, pen, and arc ruler)

Materials used in research include:

a. Hot water fluids from Kawah Merah and Kawah Hitam

b. Demineralization aqua

The research method is divided into several stages, the preliminary stage includes the study of literature through previous research (journals, thesis, and others), and regional geology of the research area. The stage of data collection includes taking geological data in the form of rock samples and measuring temperature and pH on the surface manifestations of Kawah Merah and Kawah Hitam. The data processing stage includes analysis of geological data such as surface manifestations, pH, temperature, and is elaborated with previous studies. The last stage is the discussion stage.

3. RESULTS AND DISCUSSIONS

3.1 Geothermal Play

Mount Pancar geothermal system is convection-dominated geothermal play. Particularly, the magmatic geothermal plays-volcanic field. Convection-dominated play is generated by magma activity in volcanic environments (Moeck, 2014). The source of heat that causes the appearance of surface manifestations on Mount Pancar comes from Mount Gede Pangrango (Kementerian ESDM, 2017).

3.2 Geological Structure

The geological structure in the Mount Pancar area is dominated by structures that oriented to the Northwest-Southeast (Daud et al., 2018) and are followed by minor faults that are oriented to the Northeast-Southwest. The orientation of the minor structure controls the emergence of manifestations of Black Crater and Red Crater. This is evidenced by the measurement of strike structures around manifestations that have a value of 20 ° - 35 ° (quadrant 1). The control structure in the form of a dip slip fault is evidenced by the footwall outcrop of a fault. The footwall field has a dip value ranging from 70 ° -90 ° and pitch 60 ° E. The geological structure acts as a pathway for migrating geothermal fluid to the surface.

3.3 Relief Setting

Mount Pancar has a relief in the form of a high relief system. This is supported by the appearance of morphology forming high hills in the area of Mt Pancar. High relief systems are usually associated with volcanic activity.

Figure 1 : Morphology of Mt. Pancar (Private Documentation)

3.4 Temperature, pH, and Surface Manifestations

There are two surface manifestations around Mount Pancar, namely Kawah Merah and Kawah Hitam. Based on the measurement of temperature and pH, both of the surface manifestations have the fluid temperature and pH shown in table 1. Kawah Merah and Kawah Hitam are surface manifestations in the form of hot springs (Wibowo, 2005). The existence of this manifestation is between Mount Pancar and Mount Astana (Irawan, 2007).

Table 1. Temperature and pH Measurement Data

Surface Manifestation	Fluid Temperature	pH
Kawah Merah	67°C	6.8-7
Kawah Hitam	51.5°C	8

3.5 Type and Characteristics of Fluid

Kawah Merah has the brownish fluid and a little vegetation. The manifestation also has a feature of steam, bubble, a slight smell of sulfur, and there are deposits around the manifestations in the form of oxidation in red and brown. Whereas, in Kawah Hitam has greenish-black fluid and has moss vegetation. The manifestation has a small amount of steam and gas. According to the Ministry of Energy and Mineral Resources (in Mulyana 2012), the type of fluid present in Mount Pancar is sulfate-bicarbonate. This is also supported by research conducted by the Ministry of Energy and Mineral Resources (2017) using a plot diagram of $Cl\text{-}SO_4\text{-}HCO_3$. However, the type of fluid found in Kawah Merah is dilute chloride-bicarbonate water. This type of fluid occurs because it mixes with groundwater and is usually in a low-temperature system with pH 6-8 (Nicholson, 1992).

Figure 2 : Kawah Merah (left) and Kawah Hitam (right) (Private Documentation)

3.6 Geothermal Utilization of Mount Pancar

To determine suitable uses for geothermal systems, geological, geochemical, and geophysical data are needed. One parameter that can be considered is the temperature of the reservoir fluid. According to the Ministry of Energy and Mineral Resources (in Mulyana, 2012), Mount Pancar geothermal system has a reservoir temperature of around 85˚C - 96˚C. According to Hochstein (1990) this classification temperature includes low enthalpy geothermal systems.

Temperature calculations using a Na-K-Ca geothermometer produce reservoir temperatures around 170˚C - 210˚C (Lestari, 2015). Other measurements are based on the Na/K geothermometer and show that the reservoir temperature is around 180˚C - 190˚C (Daud et al, 2015). According to Hochestien (1990) classification of these temperatures includes a medium enthalpy geothermal system.

Low enthalpy geothermal system are usually used for direct use, especially in Mount Pancar. Implicity supporting the stipulation of Mount Pancar area as one of natural tourism in West Java. Some of the current tourism potentials that can be found are hot springs, flying fox areas, and mountain bike tracks.

In addition, other utilization recommendations can be applied by the surrounding community and several stakeholders such as fisheries. Bogor is one of regions that has considerable fisheries potential to be developed (Permana, 2007). Therefore, direct use of geothermal energy for fisheries cultivation around Mount Pancar has a good prospect for the society.

The concept of fishery cultivation utilizes the manifestation of geothermal water with a heat exchanger system into fish breeding ponds. The aim is to control the optimum temperature to accelerate growth and increase the productiviy of freshwater fish. However several things need to be considered for the use of fish cultivation using low enthalpy geothermal energy in Mount Pancar:

1. Design a heat exchange system so that the temperature transferred by the fluid from the geothermal source is not too high when it reaches surfae water;
2. Water temperature needs to be controlled because it affects feed consumption, fish metabolism, and fish growth rate;
3. Geothermal water disposal system is carried out to recharge, so that it does not reduce subsurface groundwater.

3. CONCLUSION

Mount Pancar geothermal system is convection-dominated geothermal play. Particularly is the magmatic geothermal plays-volcanic field. There are three geothermal manifestations in Mount Pancar, namely Kawah Merah, Kawah Hitam, and Kawah Putih. The existence of these manifestations is controlled by minor faults oriented to the Northeast-Southwest. The general type of fluid in Mount Pancar is sulfate-bicarbonate. However, for the manifestation of Kawah Merah in the form of diluted chloride-bicarbonate.

The geothermal system in Mount Pancar is suitable to be used for direct use purposes because the reservoir temperature is included in the low-medium enthalpy geothermal system. The utilization makes Mount Pancar be considered as natural tourism. Some of the tourism potentials that can be found are hot springs, flying fox areas, and mountain bike tracks. In addition, it is recommended for other uses such as fisheries.

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