Temperature Analysis Of Tinggi Raja Geothermal Reservoir, Simalungun District

by Togi Tampubolon

PAPER • OPEN ACCESS

Temperature Analysis Of Tinggi Raja Geothermal Reservoir, Simalungun District

To cite this article: Lestari Sinaga Domini and Togi Tampubolon 2020 *J. Phys.: Conf. Ser.* **1428** 012049

Temperature Analysis Of Tinggi Raja Geothermal Reservoir, Simalungun District

Domini Lestari Sinaga[1], Togi Tampubolon[1]
[1]Department of Phisycs, State University Of Medan, Indonesia

Email :topartam@gmail.com

Abstract Reservoir temperature measurements have been carried out using the empirical geotermometer method at the High Raja Geothermal Simalungun district in order to determine the value of the High Raja geothermal reservoir temperature. The study was conducted using the Na-K geotermometer method, the Na-K-Ca-Mg geotermometer, a Na-K-Ca-Mg geotermometer to obtain the temperature value of the geothermal reservoir. The results of the study Based on the empirical Geotermometer equation show the surface temperature of hot water at three points showed that at the point I obtained hot water surface temperature of (65.0 ± 0.5^{o}C) with a surface pH of 5.2 hot water, point II the hot water surface temperature of (65.0 ± 0.5^{o}C) with a large surface pH of hot water 5.8, and point III the surface temperature of hot water is (63.0 ± 0.5^{o}C) with a large pH surface of hot water 5.8. The average concentration of chemical elements contained in hot water samples include Ca for (255.33 mg / L), K for (150 mg / L), Mg for (43.63 mg / L), Na for (34, 13 mg / L) and the average temperature of the reservoir that can be received using the Na-K-Ca Geotermometer is a temperature of 182.89921^{o}C

Keywords: Geotermometer, Geothermal, Geothermal Reservoir

Introduction

North Sumatra is one of 33 provinces in Indonesia, has total area of 181,860.65 km^2 which consists of 71,680.68 km^2 or 3.73% of the total area of the Republic of Indonesia. Geographically, North Sumatra Province is located at 1 ° - 4 ° North Latitude and 98 ° - 100 ° East Longitude. North Sumatra Province consists of 25 districts and 8 cities, 421 sub-districts and 5828 villages. One of the districts in North Sumatra is Simalungun.

Geologically, Indonesia is located on three plates namely the Eurasian Plate, the Indo-Australian Plate and the Pacific Plate causing Indonesia to have abundant mineral reserves, has many active volcanoes that have the potential to cause eruptions and cause areas that are often subject to earthquake, tsunami and ground movement or the so-called landslide. Thus, North Sumatra is very prone to disasters both from volcanic and tectonic activities. While climatologically, located around the equator will cause changes in weather.

Geothermal water source in Simalungun Regency, geographically located between 02036'00 "-03018'00" North Latitude and 98032'00 "- 99035'00" East Longitude. Based on what happened at the Tinggi Raja geothermal source, there was a change in the environment due to the transfer of hot water sources that caused changes in temperature. Then it is necessary to re-measure the temperature of the geothermal reservoir which will then be analyzed the impact of changes in the temperature of the geothermal reservoir.

Indonesia has a great wealth of environment and natural resources, but people tend to underestimate it and regard it as reasonable. Understanding the environment that all objects and conditions, including humans and their activities, are contained in the space in which humans are and affect the survival and well-being of humans and other living bodies. Massive environmental damage in various places in almost all parts of the country shows that the ability of the Indonesian people in managing the environment or common property resources is very weak. This also shows that from the national to the communal level there has been damage to cultural values. The various human activities ultimately indicate an increase in land requirements which also has an impact on the reduced level of existing vegetation. According to the Environmental Protection Agency (2009) in 2005, this effect is a major problem in every developing city in the world towards global warming. Geothermal is one of the alternative renewable energy sources and has the potential to be produced in Indonesia, this is because Indonesia has a circle of volcanic belts along more than 7000 km which has a large geothermal potential. The heat energy that comes from inside the Earth will come to the surface and will be collected in parts of the Earth's crust. The Earth's crust is composed of various types of rock that have different melting points. Rocks that cannot stand the high temperatures of the Earth's core will melt and become a liquid called magma. This energy directly comes from terrestrial heat sources which are basically endless under the Earth's crust and do not depend on direct solar energy. Temperatures under the Earth's crust which are relatively thin can reach 1300 ^{o}C.

Geothermal (geothermal) is a natural resource in the form of hot water or steam that forms in the earth's reservoir through heating underwater surface by hot rocks. Geothermal system is one of the systems that occur in the geological process that runs in the order of hundreds or even millions of years which today brings benefits to humans both exploited by making manifestations for tourism and their use for agriculture and animal husbandry.

Geothermal method is one method for calculating the temperature of a reservoir that is in a heat source by using a thermometer as a comparison tool and the object of measurement is the content of chemical elements present in the water. How to explore the geothermal system has been done a lot. From geotermometer measurement data can be measured hot water chemistry such as Na, K, Mg, Ca. Based on these geothermometer measurements, the results for reservoir temperatures are based on chemical elements present in hot water, which can ultimately be formulated into the geothermometer equation.

The research is important because the geothermal temperature measurement data can change due to natural changes. Therefore we need new data to observe changes from the previous data. Research on determining the temperature of the geothermal reservoir using empirical geotermometer equations have been carried out such as in the Rianiate geothermal area of Pangururan District producing a reservoir temperature of around 100,480 C and Dolok Marawa geothermal area in Simalungun Regency with a reservoir temperature of around 125,100 C. However, the source displacement occurred hot water in the area, the authors are interested in re-measuring reservoir temperatures using the empirical geothermometer equation.

With this description so the author chose the title: Environmental Analysis of the Impacts of Temperature Changing of the Tinggi Raja Geothermal Reservoir in Simalungun Regency, to determine the impact of changes that occur in the geothermal reservoir.

Journal of Physics: Conference Series **1428** (2020) 012049 doi:10.1088/1742-6596/1428/1/012049

2. Method

2.1. Place and Time of Research

Geographically, North Sumatra Province is located at 1 ° - 4 ° North Latitude and 98 ° - 100 ° East Longitude. This research was conducted on 27th of February 2019 to 7th of May 2019.

2.2. Tools and Materials

2.2.1. Research Tools

Stationery, thermometer, pH meter, bottle.

2.2.2. Research Materials

Hot water sample from Tinggi Raja thermal in Simalungun.

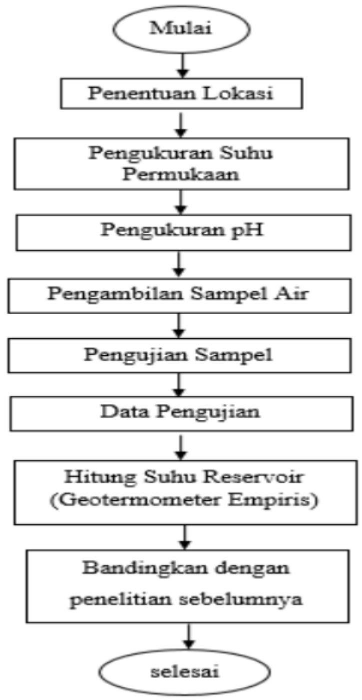

Figure 1. Research implementation Flowchart

3. Result and Discussion of Research

Result and discussion of research Empirical geothermal

Table 1. The data taking of hot water sample from the thermal

Titik	Letak Geografis	Ketinggian dpl (m)	Suhu Permukaan (^{0}C)	pH
1	47N 0476673 UTM 0348563	442	65	5,2
2	47N 0476216 UTM 0348120	437	64 65	5,8
3	47N 0476300 UTM 0347903	416	61 63	5,8

3.1. Sample Testing Result

Sample testing is carried out in the Medan Industrial Research and Development Agency testing laboratory, namely testing the chemical elements Na, K, Ca, and Mg on the sample. Samples were taken from the three observation points where each point was taken as much as one sample of hot water. The results obtained can be seen in the table below.

Table 2. Measurement result at point 1

No	Parameter Ukur	Satuan	Hasil	Metode
1	Natrium (Na)	mg/L	33,8	AAS
2	Kalium (K)	mg/L	253	AAS
3	Kalsium (Ca)	mg/L	170	AAS
4	Magnesium (Mg)	mg/L	43,6	AAS

Table3. Measurement result at point 2

No	Parameter Ukur	Satuan	Hasil	Metode
1	Natrium (Na)	mg/L	34,2	AAS
2	Kalium (K)	mg/L	257	AAS
3	Kalsium (Ca)	mg/L	133	AAS
4	Magnesium (Mg)	mg/L	43,7	AAS

Table4. Measurement result at point 3

No	Parameter Ukur	Satuan	Hasil	Metode
1	Natrium (Na)	mg/L	34,4	AAS
2	Kalium (K)	mg/L	256	AAS
3	Kalsium (Ca)	mg/L	147	AAS
4	Magnesium (Mg)	mg/L	43,6	AAS

3.2. Calculation Result of Reservoir Temperature

To find out the reservoir temperature in the study area, it will be analyzed using the Na-K geothermometer equation, Na-K-Ca geothermometer, and Na-K-Ca-Mg geothermometer. From the measurement results using the equations of each empirical geothermometer the temperature results are as follows:

Table 5. The result of reservoir temperature with empirical geothermometer

No	Titik	Sampel	T (Na-K)°C	T (Na-K-Ca)°C	T (Na-K-Ca-Mg)°C
1	I	1	1726,01	99,78	3782,40
2	II	2	1820,59	206,09	3673,89
3	III	3	1717,78	242,83	3731,49
Suhu Rata-Rata			1754,79	182,89	3729,27

3.3. Empirical Geothermometer Discussion

Based on the table, the temperature for the Na-K geothermometer equation obtained at 1754.79oC, while the temperature used with the Na-K-Ca geothermometer was 182.89oC. Whereas with the Na-K-Ca-Mg geothermometer a temperature of 3729,27°C obtained. Compared with the data from the previous research conducted by Adelina Tambunan in 2010 with the results of the study using a Silica geothermometer of 125,10°C, with the Na-K geotermometer equation of 336.69°C, and with the Na-K-Ca geotermometer equation of 1240.30°C.

3.4. Empirical Geothermometer Discussion

Based on the table, the temperature for the Na-K geothermometer equation obtained at 1754.79°C, while the temperature used with the Na-K-Ca geothermometer was 182.89°C. Whereas with the Na-K-Ca-Mg geothermometer a temperature of 3729,27°C obtained. Compared with the data from the previous research conducted by Adelina Tambunan in 2010 with the results of the study using a Silica geothermometer of 125,10°C, with the Na-K geotermometer equation of 336.69°C, and with the Na-K-Ca geotermometer equation of 1240.30°C.

References

[1] Ainy, Cherish Nurul, (2012), Pengaruh Ruang Terbuka Hijau Terhadap Iklim Mikro Dikawasan Kota Bogor [skripsi]. Departemen Arsitektur Lanskap, Fakultas Pertanian IPB.
[2] Badan Perencanaan diharapkan pengembangan Nasional (Bappenas), (2013), Profil Pembangunan.
[3] Badan Pusat Statistik, (2014), Letak Geogarfis Kabupaten Simalungun, http://simalungunkab.bps.go.id (Diakses 13 September 2018).
[4] Barbier, E. (2002), *Geothermal Energy Technology And Current Status: An Overview. Renewable And*

[5] Darsono, Valentinus. 1995. Pengantar Ilmu Lingkungan. Yogyakarta: Universitas Atmajaya Press.
[6] Ghomshei, M.M. (2010). *Canadian Geothermal Power Prospects*. *World Geothermal Congress 2010*. Bali,Indonesia.
[7] Howard, J. A., (1996), *Penginderaan Jauh untuk Sumber Haya Hutan*: Teori dan Aplikasi, Gadjah Mada University Press, Yogyakarta.
[8] Kolar, J.L. (2000), *Alternative Energy Technologies*. *Environmental Quality Management* 10(2):45–54.
[9] Lillesand, T.M., dan F.W. Kiefer, (1979), *Penginderaan Jauh dan Interpretasi Citra*, Yogyakarta, Gadjah Mada University Press.
[10] Limas, A. V, Perdana, A., & Tannady, H. (2014). Pembahasan Mengenai Efek Urban Heat Island dan Solusi Alternatif Bagi Kota Jakarta. J@TI Undip, IX, 29–34.
[11] Nuha, M.U., Yulianto, T., dan Harmoko, U., (2014), Interpretasi Bawah Permukaan Daerah Air Sumber Panas Diwak-Derekan Berdasarkan Data Magnetik, *JurnalFisika* **3**: 129-134.
[12] Sundoro, H.: Lim, D; Setiadarma D., dan Sulaeman, B., (2006), Penyelidikan Geologi Dan Geokimia Di Daerah Panas Bumi Dolok Marawa, Kabupaten Simalungun. Kelompok program penelitian Panas bumi. http://www.bag.lapan.go.id. (Diakses 20 September 2018).
[13] Tambunan, Adelina., (2010), Perhitungan Suhu Reservoar Dengan Menggunakan Persamaan Geotermometer Empiris Daerah Panas Bumi Dolok Marawa Kabupaten Simalungun.
[14] Togi.T, Rita.J, Evan, (2017). Environmental change Analysis in Nias Island Using remote Sensing technique. International journal of Computer Science and Technologi, vol 8,Issue 2, pp 134-139.
[15] Togi. T, Juniar. H, Randy. WS. (2017).,Identification of Environmental Change With NDVI and LST Parameters in Pakpak Bharat Regency by using Remote Sensing Technique., The International Journal of Engineering and Science, Vol 6,Issue 10, pp 89-9.
[16] Winarsih, F. P., (2014), *Identifikasi Litologi daerah Manifestasi Panas Bumi Parangwedang Kabupaten Bantul DIY dengan Metode Magnetik*, Skripsi Fakultas Sains dan Teknologi, Uin Sunan Kalijaga, Yogyakarta.

Temperature Analysis Of Tinggi Raja Geothermal Reservoir, Simalungun District

ORIGINALITY REPORT

19%	12%	8%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Muslihudin Muslihudin, Eko Hendarto, Rin Rostikawati, Rili Windiasih, Tyas Retno Wulan. "Relationship between Environmental Damage and Corruption Cases in Indonesia", E3S Web of Conferences, 2018 Publication	2%
2	Submitted to Universiti Sains Malaysia Student Paper	2%
3	papers.ssrn.com Internet Source	2%
4	www.abacademies.org Internet Source	1%
5	fmipa.unima.ac.id Internet Source	1%
6	Submitted to Universitas Tadulako Student Paper	1%
7	De Gennaro, M.. "Geochemistry of thermal waters on the island of Ischia (Campania, Italy)", Geothermics, 1984	1%

Publication

8	repo.unima.ac.id Internet Source	1 %
9	www.ijcst.com Internet Source	1 %
10	nlist.inflibnet.ac.in Internet Source	1 %
11	docplayer.net Internet Source	1 %
12	Arnorsson, S.. "The chemistry of geothermal waters in Iceland. III. Chemical geothermometry in geothermal investigations", Geochimica et Cosmochimica Acta, 198303 Publication	1 %
13	www.ideals.illinois.edu Internet Source	1 %
14	mafiadoc.com Internet Source	1 %
15	rafhladan.is Internet Source	1 %
16	journal.ipb.ac.id Internet Source	<1 %
17	lib.unnes.ac.id Internet Source	<1 %

18	teensofgkc.blogspot.com Internet Source	<1 %
19	F. B. Elehinafe, O. B. Okedere, A. O. Mamudu, M. E. Emetere. "Energy Status, Energy Mix and Renewable Energy Potentials of Nigeria", Energy and Environment Research, 2021 Publication	<1 %
20	vdocuments.mx Internet Source	<1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		