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FACULTY OF MATHEMATICS AND NATURAL SCIENCE
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Foreword

Welcome to the International Conference on Physics 2012, this conference is the continuation of the previous Jogja International Physics Conference 2007 and the Jogja Regional Physics Conference 2005. This conference is organized by the Physics Department Universitas Gadjah Mada to enhance networking, cooperation, the development of research, and education in physics. We are very happy for the enthusiastic participations on this conference. We welcome you also to Jogjakarta, the most beautiful cultural based city in Indonesia.

The Department of Physics would like to appreciate and recognize all of the keynote speakers in this conference, Prof. Dr. Shoichi Kai (Kyushu University), Prof. Dr. Makoto Notomi (Waseda University), Dr Isao Watanabe (RIKEN, Japan), Prof. Frans. J.M.Harren (Radboud Nijmegen University), Dr. Hirotaka Sato (Nanyang Technological University), Dr. Nurul Taufiqurrahman (Chairman Indonesian Nanotechnology Society), and Prof. Dr. Kamsul Abraha (Universitas Gadjah Mada University).

On behalf of the Physics Department I would like to express sincere gratitude to the Organizing Committee members of the conference, all Laboratories, and Study Programs for their hospitalities and supports. Last but not least I would to give my thanks to the Faculty of Mathematics and Natural Sciences Universitas Gadjah Mada for their continuous supports. I hope this conference will give significant contributions to physics development in Indonesia.

With sincere gratitude
Head of Physics Department
Gadjah Mada University, Yogyakarta Indonesia

Dr.-Ing. Ari Setiawan

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Foreword

International Conference on Physics 2012 is the third physics conference organized by department of Physics, Gadjah Mada University. The conference is intended for physicist-research sharing forum all over the world to increase their interaction toward enhancing the progress in the field of physics.

This year there are six papers in the plenary session, which are presented by sex invited speakers. The committee also received 92 papers. The papers consist of Condensed Matter (34 papers), Geophysics, Atomic and Molecular Physics, and Interdisciplinary Physics (18 papers), Computational and Theoretical Physics (18 papers), Instrumentation and Applied Physics (15 papers), and posters (7 papers). There will be five different concurrent sessions can be attended at any time during the conference.

The committee has done an admirable job of arranging the program for thr benefit of participants. The committee hopes that this conference can enrich, enhance the physics knowledge, and serves as a forum for individual to meet and discuss physics current issue.

Dr. Edi Suharyadi
Chair person

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ANALISIS TIPE RESERVOIR DAN SUHU LAPANGAN PANASBUMI TIRIS PROBOLINGGO JAWA TIMUR

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ABSTRAK

Lapangan panasbumi tiris terletak di wilayah Kabupaten Purbolinggo tepatnya di bagian timur Gunung Lamongan. Data geokimia diambil dari 15 lokasi. Dua lokasi Sungai Tancak dan Air Sumur Tiris dianalisis geokimia berdasarkan metode, geotermometer, geoindikator, dalam rangka menentukan karakteristik reservoir dan keadaan suhu sistem panasbumi Tiris Kabupaten Probolinggo Jawa Timur. Hasil sementara menunjukkan bahwa karakteristik reservoir bersifat basa dengan suhu reservoir lebih dari 280° C.

THE ANALISYS OF THE RESERVOIR TYPE AND TEMPERATURE OF THE TIRIS GEOTHERMAL PROSPECT PROBOLINGGO JAWA TIMUR

A. Suprianto[1, 2], Wahyudi[2], W. Utama.[3], Suharno[4] dan W. Suryanto[2]

1. University of Jember,
2. Gadjah Mada University,
3. Sepuluh Nopember Institute of Technology,
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ABSTRACT

The Tiris geothermal prospect situated within the Purbolinggo District, Jawa Timur Province, eastern the Gunung Lamongan. Geochemical data collected from fiveteen location. Two location were analised using geochemical methods of the geothermometer and geoindikator, doe to determine the reservoir characteristic and temperature conditions of the Tiris geothermal system, Probolinggo District, Jawa Timur Province. The tentaive result indicated that the the characteristic of the reservoir sould be sodium with temperature more than 280° C.

1. INTRODUCTION

The Tiris geothermal field is located on one of the major volcanic areas spread throughout the country. Therefore, the country has many hot springs with a variety of temperatures ranging between 38 °C and 50°C. The hot springs are located mainly on major active fractures and old crater lake volcanic areas one of which is air panas Tancak di Desa Segaran Kecamatan Tiris and Danau vulkanik Ranu Bedali, Ranu Klakah, Ranu Segaran.

The air panas Tancak is one of the prospective areas in Probolinggo District Jawa Timur Province. The map location is shown in Figure 1.

The Tiris geothermal field is located near the Pandak, Argopuro and Old Tengger volcanic rocks, which is Quarter in age. The Leprak Formation composed sedimentary unit, intrusive of the granite. The geothermal area covered by Tertiary sedimentary units assumed to be cap rock. The rocks of the Tiris geothermal field are divided into ten zones that are characterized in Figure 2.

The geothermal manifestation spreads throughout an area including travertine and swampy areas formed by hot water emergence and leakage, boiling hot springs, lake of carbonate water. The results of chemical analysis of hot and cold water samples have been evaluated for fluid using Giggenbach diagrams.

2. CHEMICAL COMPOSITIONS OF THE WATERS

The geochemical study is based on discharge water samples collected from the discharge of two hot water springs. These samples were collected in June 2010. Samples were untreated and included acidified water. Chemical analyses of Na, K, Mg, SO4, SiO2 pH, Cl, HCO3.

The average chemical compositions of the geothermal water from the Sungai Tancak and Sumur Desa Tiris are presented in Table 1. The discharge water from Tancak hot water are of the chlorate type with alkaline pH (6-7) and with total dissolved solids in range the of 400-700 mg/kg. The samples form Sungai Tancak, a HCO3 are predominate cations with concentration more than 1500 mg/l, SiO2 and Cl respectively 116 and 458 mg/kg, SO4 is less, about 1 mg/kg. The anion Na, K and Mg respectively 306, 306 and 238. In contrast, waters discharged from Sumur Tiris are neutral (pH-6-7) composite of the Na, K, Mg, SO4, HCO3, SiO2 and Cl respectively 8, 11, 18, 1, 186, 53, 27in mg/kg.

The chemical compositions of the waters were classified on the basis of major ions using the Cl-SO4-HCO3 triangular diagram of Giggenbach (Figure 3). All samples plot to area of mature waters and can be classified as Cl-rich geothermal water which formed by the interaction of geothermal fluids with the host rock and dilution with low salinity water at depth (White and Muffler, 1971).

The Tiris possesses great potentiality for the utilization of geothermal energy. The region has been centre of attraction to a number of visiting national scientists, encouraging them

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to collect and analyze geothermal water samples at different localities on a sporadic basis. One of such studies has determined the temperature and reservoir characteristic.

3. ESTIMATION OF THE RESERVOIR

Even though the above table suggests that none of the springs have a huge mass flow rate, a number of springs emerging in the vicinity could have lowered the flow rate. Water containing chloride concentration more than 450 mg/kg. No high concentration of silica is observed relative to discharge temperature in all spring waters. The waters at sumur Tiris lying in this region have relatively high chloride, suggesting that the waters are fairly mature as indicated by the Giggenbach's diagram of concentrations of the major anions, Cl, SO4 and HCO3. This is illustrated in Figure 3. Figure 3 suggest that the reservoir is carbonat with high consentration of HCO3.

Table 1. Geochemical data from the Sungai Tancak and Air Sumur Tiris geothermal field.

Sampel	Na	K	Mg	SO4	HCO3	SiO2	Cl
Sungai Tancak	306	63	238	1	1585	116	458
Sumur Desa Tiris	8	11	18	1	186	53	27

4. SUBSURFACE TEMPERATURE ESTIMATION

Chemical geothermometers are used in order to estimate the reservoir temperature. The important criteria for chemical geothermometer application to thermal spring are the pH, temperature and discharge rate of the spring. Some of them give unreliable results such as either lower than spring temperature or extremely high temperature. These equations are based on geothermometers for chalcedony and quartz, which assume hat these minerals used in geothermometers, are not in equilibrium with rock – water interaction in reservoir.

The silica and cation geothermometers were used for the evaluation of subsurface temperature for discharges (Table 1). The Source of temperature equations: T–measured temperature, T: Na-K– Fournier and Truesdell (1973), T: Na-K – Giggenbach (1988), T-Fournier (1977) were used. The sample form Sungai Tancak suggest that the reservoir temperatures is about 287°C. The Na-K geothermometer of Giggenbach (1988) suggested reservoir temperature temperatures is about 297°C.

The Na-K-Mg triangular diagram shows the equilibrium between the geothermal fluids and rock and reservoir temperature (Figure 4). By considering the diagram presented in Figure 4, the Kozakli hot springs plot in the immature water part, so using the chemical geothermometers is not reliable according to the theory used to establish the diagram. In

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this Na-K-Mg diagram all the samples have not gained equilibrium with rock, presumably due to fast circulation of luid through the rock fractures. This causes the water to be mature, considering the ion exchange processes that, equilibrium has not been reached yet with rock minerals because of circulation flow. Figure 4 shows that samples from studied geothermal fall on the full equilibrium line, suggested attainment of the (Sungai Tancak) has temperature between 287 - 297°C.

3. CONCLUSION

The geothermal waters discharged from Sungai Tancak geothermal field and Sumur Tiris within the Sub-Disrict of Tiris, Probolinggo District, jawa Timur Province are of carbonate type with a high concentration of HCO3 and moderately Cl. The chemical compositions of reservoir waters indicate that the reservoir is located in the liquid dominant zone and geothermal waters come from an old geothermal system. The water composition from Sumur Tiris is carbonate and chloride water. Thermal fluid is in equilibrium with reservoir rocks, which can be the product of water-rock interaction at high temperature. Common geothermometers have been used for estimating the subsurface temperature. The results from Na-K geothermometers and Na-K-Mg geoindikcator, indicate that the reservoir temperature. The calculated temperatures using Na-K geothermometers and Na-K-Mg geoindikcator is more than 280°C. However, the fact or temperature may confirm with the measurement well temperature arter drilling.

Figure 1. The topography map location of the Sungai Tancak and Air Sumur Tiris geothermal field.

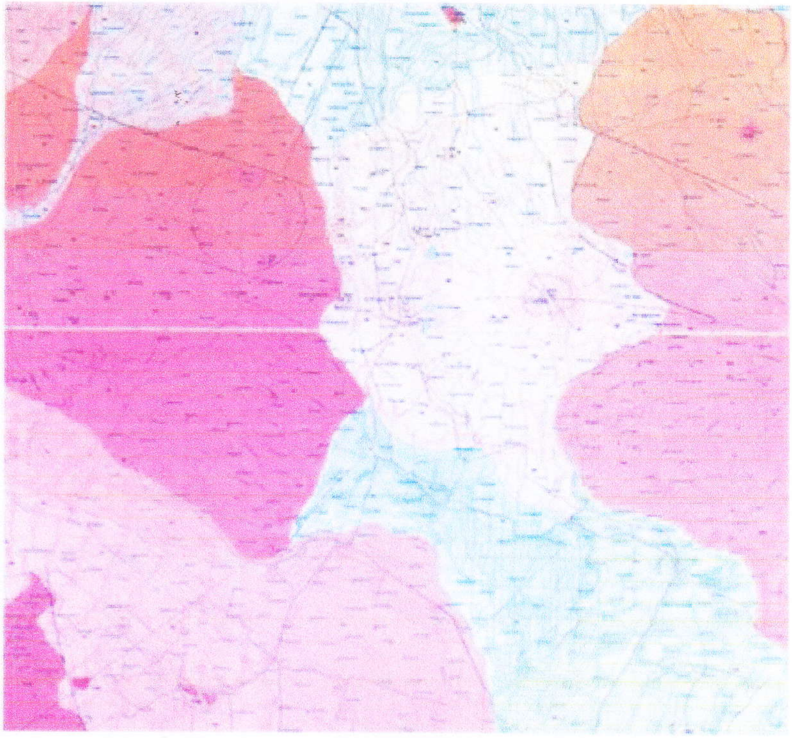
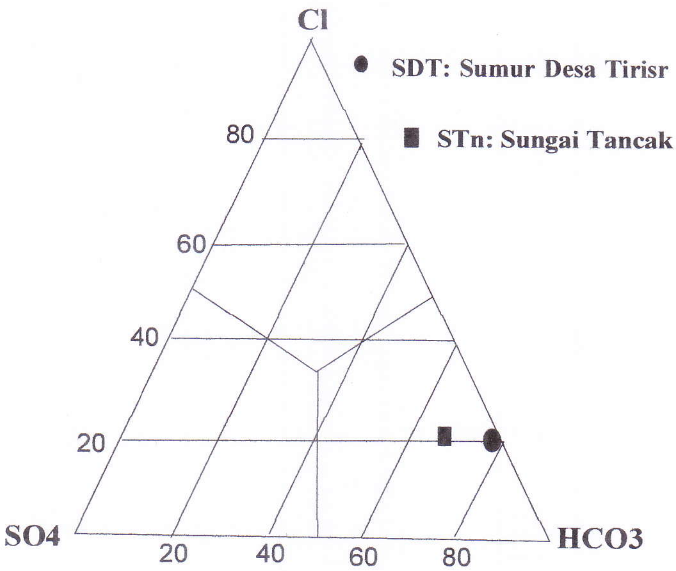


Figure 2. The geological map of the Sungai Tancak and Air Sumur Tiris geothermal field.



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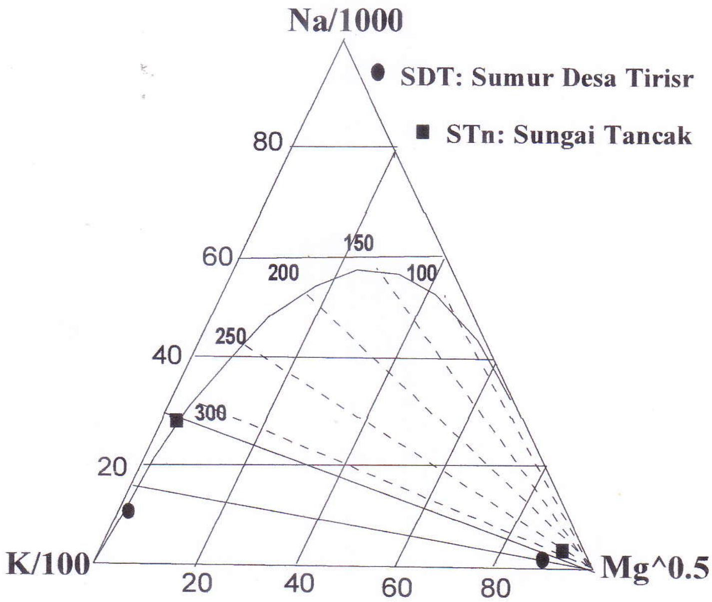
Figur 3. The diagram of the Sungai Tancak and Air Sumur Tiris reservoir characteristic.



Figur 4. The diagram of the temperatures of the Sungai Tancak and Air Sumur Tiris geothermal reservoir.

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GEOCHEMICAL RESERVOIR ANALYSIS OF THE GUNUNG UNGARAN GEOTHERMAL PROSPECT, SEMARANG DISTRICT, CENTRAL JAVA PROVINCE

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ABSTRACT

The Gunung Ungaran geothermal prospect situated within the Semarang District, Central Java Province. Geochemical data collected from sixteen location. The geochemical analysis using the ions balance, geothermometer and geoindikator analysis, doe to determine the reservoir characteristic and temperature conditions of the Gunung Ungaran geothermal prospect, Semarang District, Jawa Tengah Province. The tentative result, although the ions balance indicate that not good balance, but the geoindictor and geothermometer indicated that the characteristic of the reservoir should be acid with temperature more than 200° C.

The discharge test measurements show that chemical composition of the reservoir water was analyzed by standard methods and subsequently classified using Cl-SO4, HCO3 and Cl-Li-B triangular diagram. A Na-K-Mg triangular diagram was used to classify waters according to the state of equilibrium at given temperatures. The geothermal waters are of sodium-acid type and from a relatively old hydrothermal system. Thermal fluid is in equilibrium with reservoir rocks. The calculated temperatures using Na-K geothermometers suggested the subsurface temperature is more than 325°C and Na-K-Mg geoindicator suggested the subsurface temperature is more than 300°C.

Key word: geochemical, geothermometer, geoindicator, geothermal Ungaran

1. INTRODUCTION

The Ungaran geothermal field is located on one of the major tectonic belts of the central Java. In addition to this, there are volcanic areas spread throughout northward from Mt.Merapai, Mt. Merbabu, Mt. Ungaran and Mt. Gunungpati. Therefore, the Ungaran has many hot springs with a variety of temperatures ranging up to 95°C. The hot springs are located mainly on major active fractures and volcanic areas one of which is called Gedongsongo and others.

The Ungaran geothermal field is located near the Gunung Ungaran Massive, which is Paleozoic in age. This Massive is mainly composed of metamorphic schists, marble and granite, and forms the basement of the geothermal area covered by Tertiary volcanic-sedimentary units assumed to be cap rock. The geothermal manifestation spreads throughout an area including boiling hot springs, travertine and swampy areas formed by hot water emergence and leakage. The results of chemical analysis of hot and cold water samples have been evaluated for fluid using Giggenbach diagrams.

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2. CHEMICAL COMPOSITIONS OF THE WATERS

The geochemical study is based on discharge water samples collected from the discharge of six hot water springs. Samples were untreated and included acidified water. Chemical analyses of Na, K, Ca, Mg, B, Li, and SO4, and the SiO2 pH, Cl, HCO3.

Table 1. Geochemical data from Ungaran geothermal feild

No	LOKASI	SiO2	Ca	HCO3	SO4	Cl	Li	B	Na	K
1	**Gedongsongo 1**	78	18	61	96	35	7	11	4	8
2	**Gedongsongo 2**	106	6	0	372	164	0	0	5	9
3	**Gedongsongo 3**	74	16	36	146	59	0	1	3	8
4	**Gedongsongo 4**	129	22	0	1681	176	0	0	5	14
5	**Gedangan**	38	10	73	5	6	0	0	1	2
6	**Diwak 1**	67	182	1416	7	112	3	3	105	29

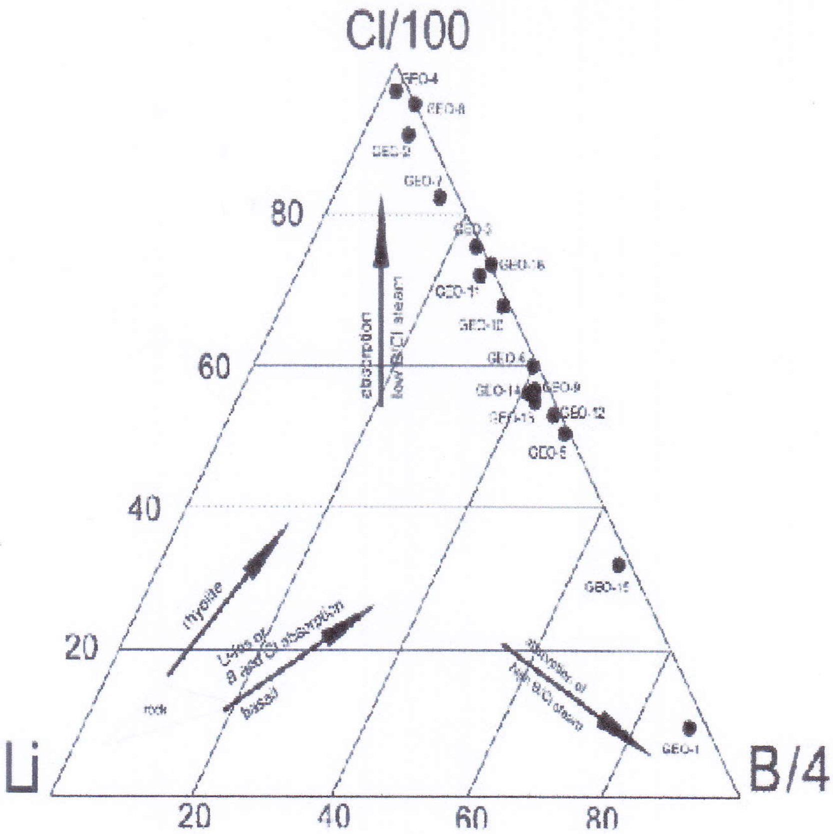

Figure 1. The diagram Cl-B-Li triangle Ungaran geothermal field.

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Li, Cl and B are conservative elements in the geothermal system. They are fixed in fluid phase and have not equilibrated. The conservative elements are the best geoindicators of the origin of the geothermal system. B/Cl ratio and Cl-Li-B ternary diagram were used to indicate the source of the fluid. A plot of the relative concentrations of Cl, Li and B is shown in Figure 1. All geothermal waters have high Cl content relative to Li and B, indicating that they are from an old hydrothermal system and that fluid migrated from the old basement rock.

2.1 Classification of the thermal fluids

The average chemical compositions of the geothermal water from the Ungaran are presented in Table 1. The discharge water from Ungaran hot water are of the sodium and acid. A Cl are predominate cations in gedongsongo 2 and Gedongsongo 4 with concentration more than 164 and 176 mg/l respectively. In contrast, hot waters discharged from Diwak 1 hot spring are acid and concentration of carbonate ions are very high (1416 mg/l). The chemical compositions of the waters were classified on the basis of major ions using the Cl-SO4-HCO3 triangular diagram of Giggenbach (Figure 1). All samples plot to area of mature waters and can be classified as sodium-rich geothermal water which formed by the interaction of geothermal fluids with the host rock and dilution with low salinity water at depth (White and Muffler, 1971).

The Ungaran possesses great potentiality for the utilization of geothermal energy. The region has been centre of attraction to a number of visiting national scientists, encouraging them to collect and analyze geothermal water samples at different localities on a sporadic basis. One of such studies has determined the temperature and reservoir characteristic.

2.2 Estimation of Reservoir

Even though the above table suggests that none of the springs have a huge mass flow rate, a number of springs emerging in the vicinity could have lowered the flow rate. Average the water containing chloride concentration lower than 100 mg/l. No high concentration of silica is observed relative to discharge temperature in all spring waters. The waters at Ungaran lying in this region have relatively high sulphate, suggesting that the waters are fairly mature as indicated by the Giggenbach's diagram of concentrations of the major anions, Cl, SO4 and HCO3. This is illustrated in Figure 2. The Ungaran geothermal reservoir characterized by sodium rich and acid sulphat.

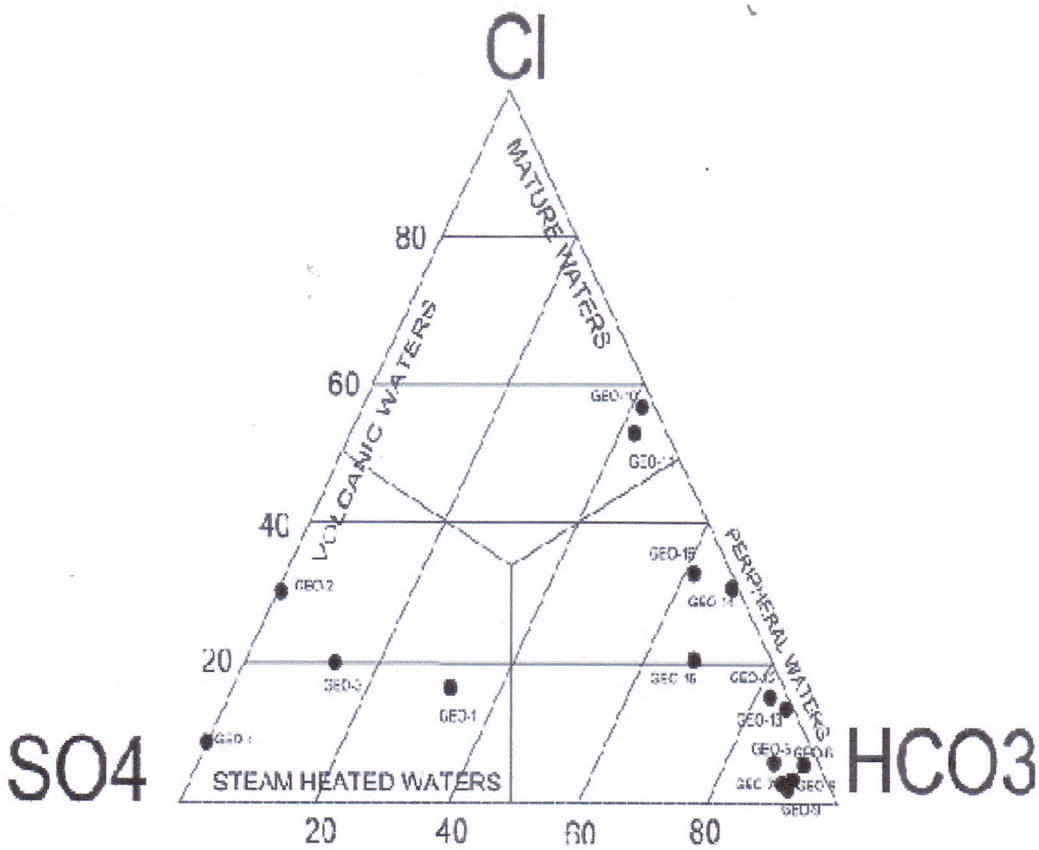

Figure 2. The diagram Cl-HCO3-SO4 triangle Ungaran geothermal field.

2.3. Subsurface Temperature Estimation

Chemical geothermometers are used in order to estimate the reservoir temperature. The important criteria for chemical geothermometer application to thermal spring are the pH, temperature and discharge rate of the spring. Some of them give unreliable results such as either lower than spring temperature or extremely high temperature. These equations are based on geothermometers for chalcedony and quartz, which assume that these minerals used in geothermometers, are not in equilibrium with rock – water interaction in reservoir.

The silica and cation geothermometers were used for the evaluation of subsurface temperature for discharges (Table 2). The Source of temperature equations: T–measured temperature, T: Na-K–Fournier and Truesdell (1973), T: Na-K – Giggenbach (1988), T- Fournier (1977) were used. These give reservoir temperatures ranging 325 - 700°C. The Na-K geothermometer of Giggenbach (1988) suggested reservoir temperature more than 330°C and Fournier (1977) suggested reservoir temperature more than 325°C.

The Na-K-Mg triangular diagram shows the equilibrium between the geothermal fluids and rock and reservoir temperature (Figure 3).

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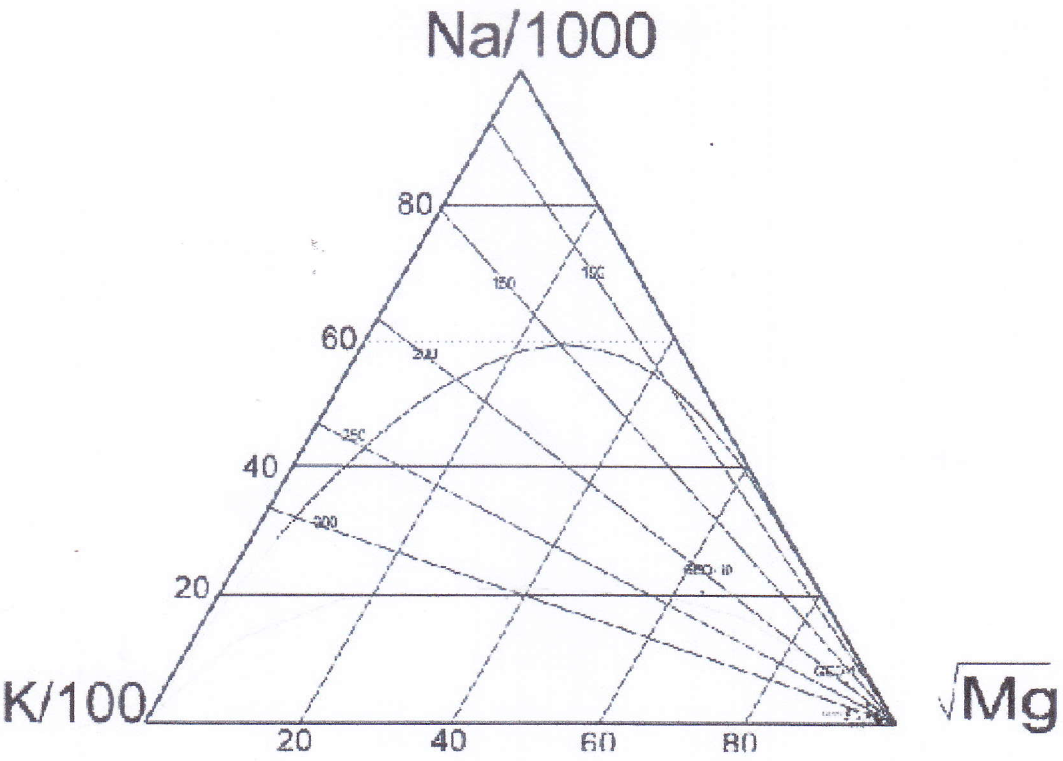

Figur 3. The diagram Na-K-Mg triangle of the temperatures of the Ungaran geothermal reservoir.

Table 2. Na-K Fourier and Giggencbach) from Ungaran geothermal feild

No	LOKASI	Na-K (Fournier)	Na-K (Giggencbach)	Quartz	Chalce dony	Cristo balite	Opal CT
1	Gedongsongo 1	795°C	715 °C	124 °C	96 °C	73 °C	25 °C
2	Gedongsongo 2	689 °C	634 °C	140 °C	114 °C	90 °C	41 °C
3	Gedongsongo 3	834 °C	744 °C	121 °C	93 °C	71 °C	23 °C
4	Gedongsongo 4	872 °C	772 °C	152 °C	127 °C	102 °C	52 °C
5	Gedangan	772 °C	698 °C	90 °C	59 °C	39 °C	6 °C
6	Diwak 1	324 °C	330 °C	116 °C	88 °C	66 °C	18 °C

By considering the diagram presented in Figure 2, the Ungaran hot springs plot in the immature water part, so using the chemical geothermometers is not reliable according to the theory used to establish the diagram. In this Na-K-Mg diagram all the samples have not gained equilibrium with rock, presumably due to fast circulation of fluid through the rock fractures. This causes the water to be immature, considering the ion exchange processes that, equilibrium has not been reached yet with rock minerals because of circulation flow. Figure 3 shows that samples from studied geothermal wells fall on the full equilibrium line, suggested attainment of the Ungaran 300°C.

3. CONCLUSION

The geothermal waters discharged from Ungaran geothermal field are of sodium-acid type with a high concentration of HCO3 and SO4. Chemical compositions of reservoir waters indicate that the reservoir is located in the liquid dominant zone and geothermal waters come from an old geothermal system. The water composition from Gedongsongo and Diwak is carbonate and sulphate. Thermal fluid is in equilibrium with reservoir rocks, which can be the product of water-rock interaction at high temperature. Common geothermometers have been used for estimating the subsurface temperature. The results from Na-K geothermometers and Na-K-Mg geoindikcator, indicate that the reservoir temperature. The calculated temperatures using Na-K geothermometers and Na-K-Mg geoindikcator is more than 300°C. However, compare with measured temperature further.

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MAGNETC, GRADIENT TEMPERATURE AND GEOCHEMISTRY SURVIE S WITHIN PASEMA AIR KERUH GEOTHERMAL AREA EMPAT LAWANG DISTRICT, SOUTH SUMATERA PROVINCE iNDONESIA

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ABSTRACT

The Pasema Air Keruh geothermal area situated within the Empat Lawang District, Sumatera Selatan Province. Magnetic, gradient temperature and geochemistry survies conducted within that area, in 9 June 2012. The magnetic and the gradient temperature were not analysed zet. The geochemical analysis using the geothermometer and geoindikator, doe to determine the reservoir characteristic and temperature. The first geothermal exploration activities in Empat Lawang District Sumatera Selatan Province were carried out in the Penantian hot spring field Air Keruh Sub District and Airklinsar hot spring field Ulu Musi Sub District. The discharge test measurements show that chemical composition of the reservoir water was analyzed by standard methods and subsequently classified using Cl-SO4, HCO3 triangular diagram. A Na-K-Mg triangular diagram was used to classify waters according to the state of equilibrium at given temperatures. The geothermal waters are of chloride water type and from a relatively old hydrothermal system. Thermal fluid is in equilibrium with reservoir rocks. The chemical geothermometers were used to predict subsurface temperature. The calculated temperatures using Na-K geothermometers and Na-K-Mg geoindikcator is more than 300°C. However, compare with measured temperature furthere.

Key word: geochemical, geothermometer, geoindicator, geothermal Empat Lawang

1. INTRODUCTION

The Empat Lawang geothermal field is located on one of the major tectonic belts of the Fault Sumatera System. In addition to this, there are volcanic areas spread throughout the country. Therefore, the country has many hot springs with a variety of temperatures ranging up to 98°C. The hot springs are located mainly on major active fractures and volcanic areas one of which is Penantian and Airklinsar.

The Penantian and Airklinsar is one of the prospective areas in Empat Lawang District Sumatera Selatan Province for geothermal exploration which was initiated by Virgo Team are the first in June 2012. The map location is shown in Figure 1.

The Empat Lawang geological extends elongated the Fault Sumatera System between the Bengkulu and Sumatera Selatan.

The Penantian and Airklinsar geothermal field is located near the Gunung Kasih Massif, which is Paleozoic in age. This Massif is mainly composed of metamorphic schists, marble and granite, and forms the basement of the geothermal area covered by Tertiary volcanic-sedimentary units assumed to be cap rock. The rocks of the Empat Lawang are divided into ten zones that are characterized in Figure 2.

The geothermal manifestation spreads throughout an area including boiling hot springs, travertine and swampy areas formed by hot water emergence and leakage. The results of chemical analysis of hot and cold water samples have been evaluated for fluid using Giggenbach diagrams.

2. CHEMICAL COMPOSITIONS OF THE WATERS

The geochemical study is based on discharge water samples collected from the discharge of two hot water springs. These samples were collected in M June 2012. Samples were untreated and included acidified water. Chemical analyses of Na, K, Ca, Mg, B, Li, and SO4 were carried out in the site laboratory of Lampung University (Bandar Lampung), and the SiO2 pH, Cl, HCO3, in laboratory of Sriwijaya University (Palembang).

Li, Cl and B are conservative elements in the geothermal system. They are fixed in fluid phase and have not equilibrated. The conservative elements are the best geoindicators of the origin of the geothermal system. B/Cl ratio and Cl-Li-B ternary diagram were used to indicate the source of the fluid. A plot of the relative concentrations of Cl, Li and B is shown in Figure 3. All geothermal waters have high Cl content relative to Li and B, indicating that they are from an old hydrothermal system and that fluid migrated from the old basement rock.

3. CLASIFICATION OF THE THERMAL FLUIDS

The average chemical compositions of the geothermal water from the Penantian and Airklinsar are presented in Table 1. The discharge water from Airklinsar hot water are of the chlorate type with alkaline pH (6-7) and with total dissolved solids in range the of 400-700 mg/kg. A Cl are predominate cations with concentration more than 600 mg/l respectively, whereas Mg is present only in trace (0.4-2 mg/l). In contrast, hot waters discharged from Penantian hot spring are neutral (pH-6-7) and concentration of sulfate and carbonate ions are lower. The chemical compositions of the waters were classified on the basis of major ions using the Cl-SO4-HCO3 triangular diagram of Giggenbach (Figure 3). All samples plot to area of mature waters and can be classified as Cl-rich geothermal water which formed by the interaction of geothermal fluids with the host rock and dilution with low salinity water at depth (White and Muffler, 1971).

The Empat Lawang possesses great potentiality for the utilization of geothermal energy. The region has been centre of attraction to a number of visiting national scientists, encouraging them to collect and analyze geothermal water samples at different localities on a sporadic basis. One of such studies has determined the temperature and reservoir characteristic.

4. ESTIMATION OF THE RESERVOIR

Even though the above table suggests that none of the springs have a huge mass flow rate, a number of springs emerging in the vicinity could have lowered the flow rate. Water containing chloride concentration more than 100 ppm. No high concentration of silica is observed relative to discharge temperature in all spring waters. The waters at Airklingsar lying in this region have relatively high chloride, suggesting that the waters are fairly mature as indicated by the Giggenbach's diagram of concentrations of the major anions, Cl, SO4 and HCO3. This is illustrated in Figure 3.

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Table 1. Geochemical data from Penantian and Airklingsar hot spring

Sampel	Na	K	Ca	Mg	B	Li	SO4	HCO3	SiO2	Cl
Penantian	15	9	31	0,4	6	0,3	228	190	64	119
Airklingsar	32	9	133	2	17	0,2	340	61	50	664

5. SUBSURFACE TEMPERATURE ESTIMATION

Chemical geothermometers are used in order to estimate the reservoir temperature. The important criteria for chemical geothermometer application to thermal spring are the pH, temperature and discharge rate of the spring. Some of them give unreliable results such as either lower than spring temperature or extremely high temperature. These equations are based on geothermometers for chalcedony and quartz, which assume hat these minerals used in geothermometers, are not in equilibrium with rock – water interaction in reservoir.

The silica and cation geothermometers were used for the evaluation of subsurface temperature for discharges (Table 1). The Source of temperature equations: T–measured temperature, T: Na-K– Fournier and Truesdell (1973), T: Na-K – Giggenbach (1988), T-Fournier (1977) were used. These give reservoir temperatures ranging from 211° to 251C. The Na-K geothermometer of Giggenbach (1988) suggested reservoir temperature in the range of 331°C – 429 °C and Fournier (1977) suggested reservoir temperature in the range of 271-289oC which is higher than measured temperature. The Na-K-Ca geothermometers (Fournier and Truesdell (1973)) predict anomalously high reservoir temperature (326°C – 438 °C).

The Na-K-Mg triangular diagram shows the equilibrium between the geothermal fluids and rock and reservoir temperature (Figure 4).

By considering the diagram presented in Figure 5, the Kozakli hot springs plot in the immature water part, so using the chemical geothermometers is not reliable according to the theory used to establish the diagram. In this Na-K-Mg diagram all the samples have not gained equilibrium with rock, presumably due to fast circulation of luid through the rock fractures. This causes the water to be mmature, considering the ion exchange processes that, equilibrium has not been reached yet with rock minerals because of circulation flow. Figure 4 shows that samples from studied geothermal wells fall on the full equilibrium line, suggested attainment of the (Airklinsar) and 350°C (Penantian)

3. CONCLUSION

The geothermal waters discharged from Airklinsar of the Empat Lawang geothermal field are of chlorate type with a high concentration of Cl. Chemical compositions of reservoir waters indicate that the reservoir is located in the liquid dominant zone and geothermal waters come from an old geothermal system. The water composition from Penatian Empat Lawang is carbonate and sulphate. Thermal fluid is in equilibrium with reservoir rocks, which can be the product of water-rock interaction at high temperature. Common geothermometers have been used for estimating the subsurface temperature. The results from Na-K geothermometers and Na-K-Mg geoindikcator, indicate that the reservoir

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temperature. The calculated temperatures using Na-K geothermometers and Na-K-Mg geoindikcator is more than 300°C. However, compare with measured temperature furthere.

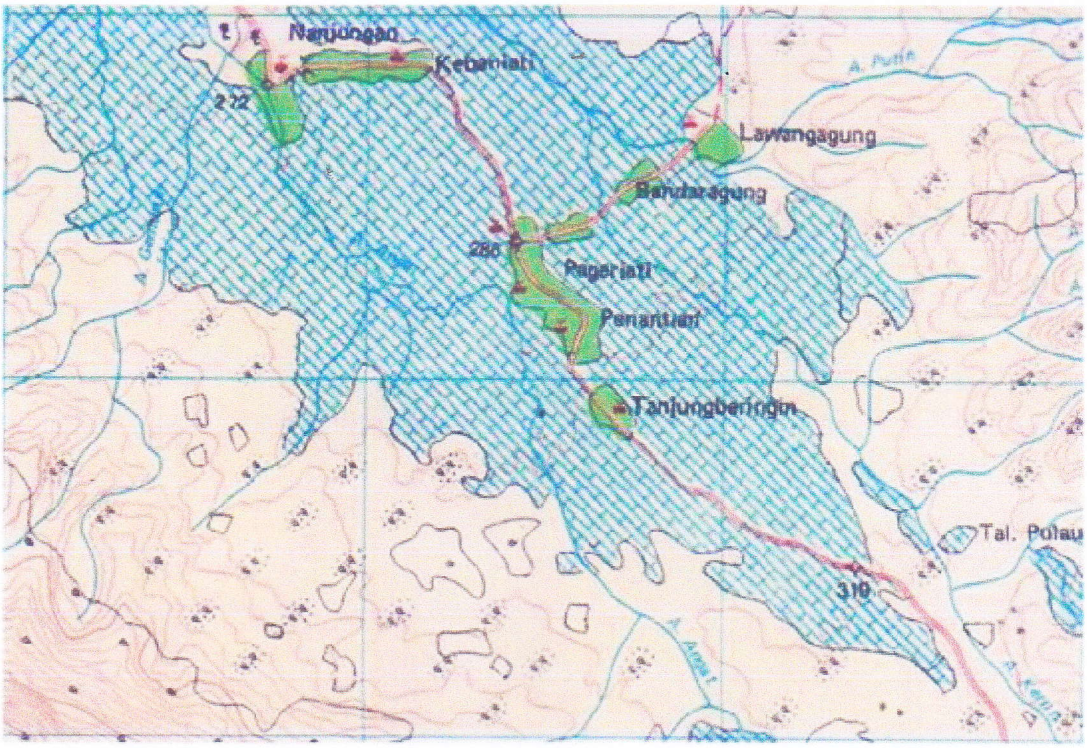

Figure 1. The map location of the Penantian and Airklinsar geothermal field.

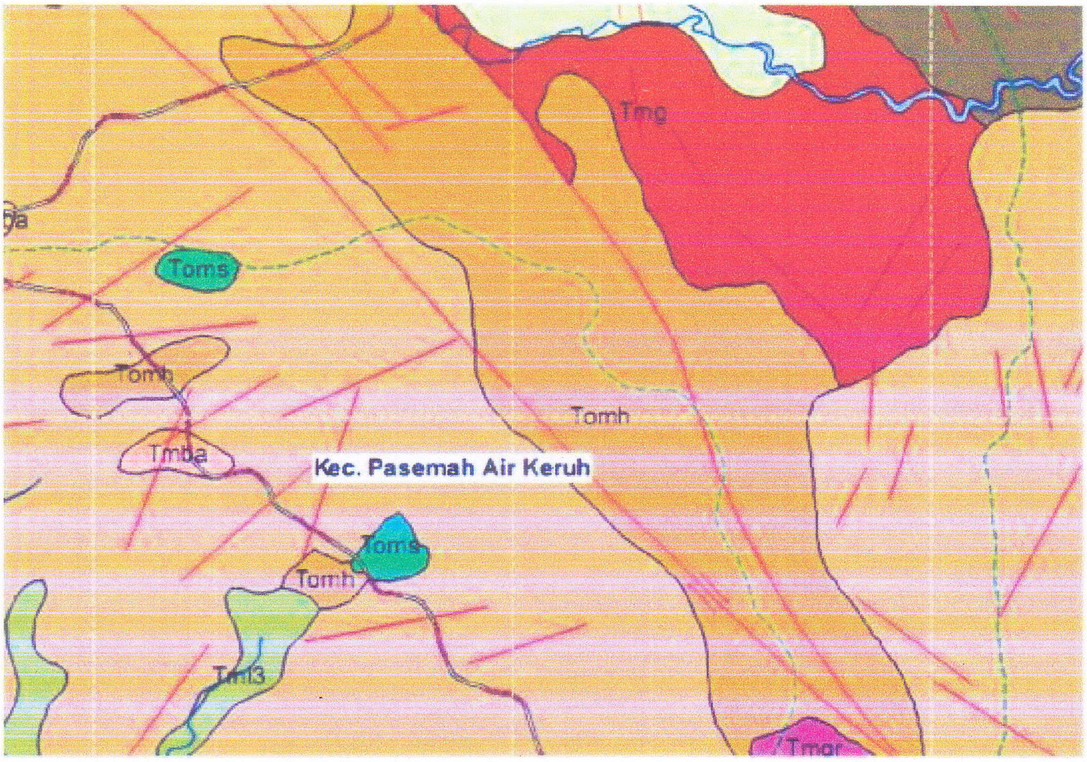

Figure 2. The geological map of the Penantian and Airklinsar geothermal field.

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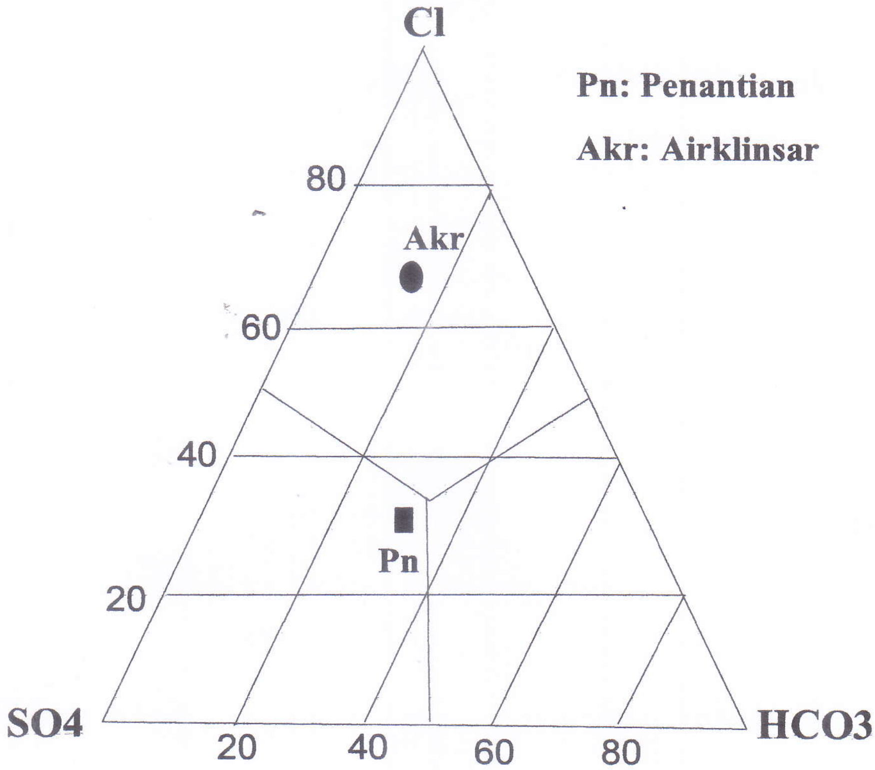
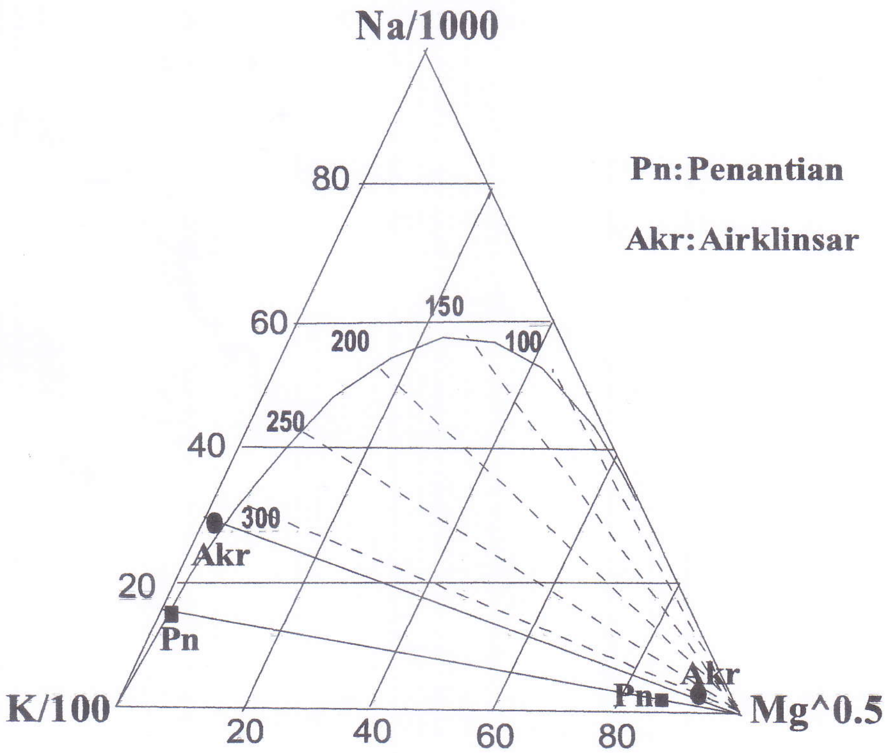


Figur 3. The diagram of the Penantian and Aklinsar reservoir characteristic.



Figur 4. The diagram of the temperatures of the Penantian and Aklinsar geothermal reservoir.

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