EARTH SCIENCE INTERNATIONAL SEMINAR 2012

The Increasing Role of Earth Science and Technology to Support the Acceleration of Mineral and Energy Resources Conservation

Yogyakarta, November 29th, 2012
at Arie Frederik Lasut Building

Faculty of Mineral Technology
UPN "Veteran" Yogyakarta
PREFACE

Role of science and technology in geo-sector for mineral and energy resources exploration and exploitation is sufficient, but not enough to give maximum result. It makes international seminar committee faculty of mineral technology, UPN "Veteran" Yogyakarta initiated this seminar to bring together academics, practitioners and policy makers for improve role of earth science and technology to supporting acceleration of mineral and energy resources conservation. Other sector that want to be appointed in this seminar is geological and mining heritage in the broadest sense. It aims to preserving and developing all types of geological and mining heritage to be the geological and mining tourism areas and world heritage that can provide benefits to the peoples.

Thus Seminar Committee would like to say thank you to the donator and supporter from all of side in this successful seminar.

Yogyakarta, 27th of November 2012
Committee Head,

[Signature]

Dr. Ir. Sudarmoyo, SE., M.S.
THE GEA-1 WELL OF THE “X” AREA, BARITO BASIN
Sari Wulandari Hafsari & Salatun Said

GEOWARISAN TAPAK IMPAK METEORIT BUKIT BUNUH, LENGGONG, PERAK, MALAYSIA: BUKTI LAPISAN SUB-PERMUKAAN
Shyeh Sahibul Karamah & Mokhtar Saidin

THE CONTINUITY OF QUARTZ VEINS BASED ON FRACTURE SYSTEM OCCURRED IN THE LEVEL OF 500 – 600 m IN PONGKOR AREA, BOGOR REGENCY, WEST JAVA
Heru Sigit Purwanto & Harry Riswandi

INFLUENCE OF METAL MINERALS CONTENT ON THE TIME DOMAIN INDUCED POLARIZATION (TDIP) RESPONSE: PRELIMINARY RESULT
Yatni, Santoso, D & Laesanpura, A.

WATER GEOCHEMICAL ANALYSIS WITHIN AIR KLINSAR GEOTHERMAL AREA IN EMPAT LAWANG DISTRICT SOUTH SUMATRA
F. Virgo, Karyanto, Ady Mara, Agus S, Wahyudi, Suharno, W. Suryanto

PRESENTATION AT SEMINAR ROOM OF GEOLOGICAL DEPARTMENT

GEOHERITAGE RESOURCES WITHIN PAHANG RIVER BASIN: PRELIMINARY STUDY ON THEIR SUSTAINABLE DEVELOPMENT POTENTIAL
Mohd. Shafcea Leman, Kamal Roslan Mohamed, Juhari Mat Akhir, Mohd. Rozi Umor, Che Aziz Ali & Tanot Unjah

STUDI ATRIBUT SEISMIK FORMASI UPPER RED BED CEKUNGAN SUMATERA TENGAH UNTUK PENENTUAN DISTRIBUSI DAN KUALITAS RESERVOAR
Ratna Putri Sari Dewi, Sugeng Widada, Bambang Triwibowo

THE MODEL OF EARLY WARNING SYSTEM ACTIVITIES SEMERU VOLCANO WITH INTEGRATED WIRELESS SENSOR NETWORK: IN STUDY
Yudianto, D., Istiyanto, J.E., Broto K.S., & Sismano

THE EVOLUTION PATTERN OF TURRITELLINE SHELL MORPHOLOGY IN JAVA; RELATION WITH GEOCHRONOLOGICAL ASPECTS
Hita Pandita, Yahdi Zaim, Aswan & Yan Rizal

EXPLORING JOGJA GEOHERITAGE: THE LIFETIME OF AN ANCIENT VOLCANIC ARC OF JAVA
C.Prasetyadi
WATER GEOCHEMICAL ANALYSIS WITHIN AIR KLINSAR GEOTHERMAL AREA IN EMPAT LAWANG DISTRICT SOUTH SUMATRA

F. Virgo1,2, Karyanto1, Ady Mara1, Agus S1, Wahyudi2, Suharno3, W. Suryanto3
1. Physics Dept of Sriwijaya University
2. Physics Dept. Of Gadjah Mada University
3. Physics Dept of Lampung University
4. FTM of Yogyakarta UPN Veteran University
fvirgo@mailcity.com

Abstract

Geochemical analyzes have been conducted on several samples of water geothermal manifestations are located in the Airklinsar village, Ulu Musi- Empat Lawang district, South Sumatra. Geochemical analysis of water use geindicator, ion balance and geothermometer methods to determine the temperature and the characteristics of the reservoir. From the data processing obtained that the composition of Airklinsar geothermal water is the chloride types. This indicates that the hot water coming from origin of old geothermal systems. While the estimated reservoir temperatures above 280°C.

Keywords: Geochemical, geothermal, geothermometer, geindicator, reservoir

Abstrak

Telah dilakukan analisis geokimia pada beberapa sampel air manifestasi panasbumi yang berada di desa Airklinsar, kabupaten Empat Lawang, Sumatera Selatan. Analisis geokimia air menggunakan metoda geindikator, kesetimbangan ion dan geothermometer untuk menentukan temperatur dan karakteristik reservoar bawah permukaan. Dari pengolahan data diperoleh bahwa komposisi air panasbumi Airklinsar adalah tipe klorida. Hal ini mengindikasikan bahwa air panas berasal dari sistem panasbumi yang lebih tua. Sedangkan temperatur reservoar diperkirakan di atas 280°C.

Kata kunci : Geokimia, panas bumi, geothermometer, geindikator, reservoar
WATER GEOCHEMICAL ANALYSIS WITHIN AIRKLINSAR GEOTHERMAL AREA IN EMPAT LAWANG DISTRICT OF SOUTH SUMATRA INDONESIA

F. Virgo, Karyanto, Ady Mara, Agus S, Wahyudi, Suharno, W. Suryanto

1. Physics Dept. of Science Faculty, Sriwijaya University
2. Physics Dept. Of Science Faculty, Gadjah Mada University
3. Geophysical Dept. Of Engineering Faculty, Lampung University
4. Chemistry Dept. Of Science Faculty, Sriwijaya University
5. Geophysics Dept of FTM, Yogyakarta UPN Veteran University

fvirgo@mailcity.com
MP. 081532650502

ABSTRACT
Geochemical analyzes have been conducted on several samples of water geothermal manifestations. They are located Airklinasr village Ulu Musi subdistrict, Empat Lawang district, South Sumatra. Water Geochemical analysis is used by geoindicator, ion balance, and geothermometer methods to determine the chemical characterization, hot water type, and temperature of the reservoir. The result of data processing shown that the composition of Airklinasr geothermal water was chloride type. It reflects that the origin of hot water from an old hydrothermal system and fluid migrated from the old basement rock. Airklinasr reservoir temperatures obtained more than 320°C.

Keywords: Geochemical, geothermal, geothermometer, geoindicator, reservoir.

INTRODUCTION
The Empat Lawang District is located in 3°25′-4°15′ SL and 102°37′-103°45′ EL, Figure 1. There are many hot springs with a variety of temperatures. They are located in Airklinasr village with temperature ranging up to 65°C (pH=7). The country is in the main tectonic belt of Sumatra Fault System and Musi-Keruh Fault, precisely located in the area of active faults and volcanoes.

In regional geology, Empat Lawang district extends along Sumatra Fault system between Bengkulu and South Sumatra provinces. Airklinasr geothermal fields are located near the Bukit Nipsis from the Middle Oligocene to early Holocene. Geothermal area rock types can be seen in Figure 2. The country rocks mostly composed of sedimentary rocks of Tertiary age volcanic, including Gumai Formation (Tmg) that composed of calcareous shale, marls, claystones with tuffaceous sandstone and calcareous sandstones intercalations. Then, Seblat Formation (Toms), composed of sandstone containing silicified wood, claystone, conglomeratic sandstone, limestone, shales, marls, tuffaceous claystone with sandstone intercalations (Gafaer, 2007). Based on the geology analysis, it can be presumed that the Gumai Formation is a cap rock and Seblat Formation is a reservoir of geothermal systems.

Based on geological information and the facts of surface temperature is relatively high. The geothermal fields will be interested to study further. Among other related to the origin of the hot fluid, characteristic and geothermal temperature reservoir. Therefore, water geochemical surveys have been conducted in the vicinity of manifestation.

METHODS
The geochemical study is based on discharge water samples collected from the several hot springs. These samples were collected in June 2012. Chemical analyses of Na, K, Ca, Mg, B, Li, and SO4 were carried out in the laboratory of Lampung University, and the SiO2, Cl, HCO3, in laboratory of Sriwijaya University (Palembang). The results can be seen in Table 1.

The data processing was carried out by several methods. First, geoindicator method, it is used by using Cl-SO4-HCO3, Cl-Li-B, and Na-K-Mg triangular diagrams. They are being used to determine chemical characterization, hot water types, and temperatures within reservoir. Then, ion balance method is being used to check the equilibrium of moal concentration within the hot water types. The result may indicate the origin formation of hot water type. Further, the geothermometer method, it being used to determine temperature of reservoir and
equilibration temperature with basement rock (Simmons, 1998).

RESULTS AND DISCUSSION

CHEMICAL CHARACTERIZATION AND TYPE OF HOT WATER

Based on the Cl-SO₄-HCO₃ triangular diagram (Figure 3), plotting of chemical compositions of Airklinsar hot springs lie in neutral chloride water (in the Cl area). It reflects that the geothermal waters are chloride type. As is typical of deep water. Chemical compositions of waters indicate that the reservoir is located in the liquid dominant zone and geothermal waters come from an old geothermal system.

While, Airklinsar cool waters fall in the HCO₃ area. It shows that the water contains low chloride with carbonate as the major anion plus variable sulfate. In systems dominated by volcanic country rocks, carbonate waters typically form in the marginal and shallow subsurface region where CO₂ gas is absorbed and steam is condensed into cool ground water. The carbonate waters form beneath the water table where they are weakly acidic, but loss of dissolved CO₂ during ascent to surface increases the pH of the natural discharge to neutral or slightly alkaline.

Table 2 shows the values of ion balance of each sample. Ion balance is good to within 5% (Simmons, 1988). Airklinsar hot springs have a value of ion balance more than 15%. It indicates that the molal concentration does not balance due to volcanic acid water. It is consistent with Cl-SO₄-HCO₃ diagram.

CI-Li-B triangular diagram are the most powerful tracer of the origin of the geothermal systems (Armannsson, 2007). They are conservative elements in the geothermal system. They are fixed in fluid phase and have not equilibrated. The conservative elements are the best geoindicators for the origin of the geothermal system. B/Cl ratio and CI-Li-B ternary diagram were used to indicate the source of the fluid.

Based on the CI-Li-B diagram (Figure 4), plotting of chemical compositions of Airklinsar hot waters are located in near the Li-Cl line, the area of low absorption of B/Cl steam. It may reflects the origin of geothermal water is old hydrothermal systems and the water migrated from the old basement rock (Mnjokava, 2007).

The Na-K-Mg triangular diagram shows the equilibrium between the geothermal fluids and rock and reservoir temperature (Figure 5). In this diagram all the samples have not gained equilibrium with rock, presumably due to fast circulation of fluid through the rock fractures. It 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 5 shows that the Airklinsar estimated reservoir temperature above 320°C.

SUBSURFACE TEMPERATURE ESTIMATION

Chemical geothermometers are used to estimate the subsurface temperature. Based on the result of Na-K-Mg diagram (the reservoir temperature is more than 300°C), so the chemical geothermometers are used by NaK (Fournier, 1979 and Giggenbach, 1988) and Na-K-Ca (Fournier and Truesdell, 1973) geothermometers. The result can be seen in Table 2.

For the Airklinsar geothermal water, Na-K Fournier geothermometer suggested subsurface temperature in the range 308°C to 340°C, Na-K Giggenbach geothermometer estimated subsurface ranging from 316°C to 344°C. Meanwhile, Airklinsar Na-K-Ca geothermometers give subsurface temperature between 42°C to 48°C, it is too low. They indicate that the geothermal water is much more saline than the diluting water.

If we compare, the value obtained from the reservoir temperature diagram with values obtained from geothermometer temperature. They appear that Airklinsar had the same reservoir temperatures above 300°C. This proves that there are a good correlation between the two methods which used above.

CONCLUSION

The results of water geochemical analysis shown the compositions of Airklinsar geothermal water is chloride type. It reflects that the hot water coming from old hydrothermal systems and the water migrated from old basement rock. Airklinsar reservoir temperature are estimated more than 320°C.

ACKNOWLEDGEMENTS

I extend many thanks to the Directorate General of Higher Education Ministry of National Education through the National Strategic Research Grant for Fiscal Year 2012, which has funded this research. And also, I am grateful to the Government of the Empat Lawang District for the opportunity and cooperation provided, so that the study can be completed.

REFERENCES


Simmons, F. S., 1998. Geochemistry Lectures Notes, Geothermal Institute, University of Auckland, 6-10.

Table 1. Geochemical Data

<table>
<thead>
<tr>
<th>No</th>
<th>SAMPLE</th>
<th>Na</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>F</th>
<th>SiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Airkliness-Hot Springs 1</td>
<td>6.7</td>
<td>0.8</td>
<td>6.4</td>
<td>0.2</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>Airkliness-Hot Springs 2</td>
<td>6.3</td>
<td>0.6</td>
<td>6.1</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>Airkliness-Hot Springs 3</td>
<td>6.4</td>
<td>0.5</td>
<td>6.3</td>
<td>0.2</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>Airkliness-Cool Water</td>
<td>10.5</td>
<td>1.1</td>
<td>10.0</td>
<td>2.0</td>
<td>1.1</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 2. Ion Balance

<table>
<thead>
<tr>
<th>No</th>
<th>SAMPLE</th>
<th>△Na</th>
<th>△K</th>
<th>△Mg</th>
<th>△Ca</th>
<th>△Na-K</th>
<th>△K-Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Airkliness-Hot Springs 1</td>
<td>6.7</td>
<td>0.8</td>
<td>6.4</td>
<td>0.2</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>2</td>
<td>Airkliness-Hot Springs 2</td>
<td>6.3</td>
<td>0.6</td>
<td>6.1</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>Airkliness-Hot Springs 3</td>
<td>6.4</td>
<td>0.5</td>
<td>6.3</td>
<td>0.2</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>Airkliness-Cool Water</td>
<td>10.5</td>
<td>1.1</td>
<td>10.0</td>
<td>2.0</td>
<td>1.1</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Fig. 1. Modification of Geological Map of Bengkulu Sheet (Gafoor, 2007). The red circle indicates the location of the manifestation.

Fig. 2. Map location of hot springs manifestations (take from Modification of Geological Map of Bengkulu Sheet; Gafoor, 2007).
Fig. 3. Cl-SO₄-HCO₃ Diagram

Fig. 4. Na-K-Mg Diagram

Fig. 5. Cl-Li-B Diagram