Seminar Guidebook and Abstract

EARTH SCIENCE INTERNATIONAL SEMINAR 2012

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

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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,

Dr. Ir. Sudarmoyo, SE., M.S.

WATER GEOCHEMICAL ANALYSIS WITHIN AIR KLINSAR GEOTHERMAL AREA IN EMPAT LAWANG DISTRICT SOUTH SUMATRA

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Abstract

Geochemical analyses 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 geoindicator, 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 the geothermal systems. While the estimated reservoir temperature about 200°C

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

Abstrak

Telah dilakukan analisa geokimia pada beberapa sampel air manifestasi panasbumi yang terletak di desa Airklinsar, kabupaten Empat Lawang, Sumatera Selatan. Analisa geokimia air menggunakan metoda geoindikator, kesetimbangan ion dan geotermometer untuk menentukan temperatur dan karakteristik reservoar sistem panasbumi. 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 sekitar 200°C

Kata kunci : Geokimia, panas bumi, geotermometer, geoindikator, reservoar

WATER GEOCHEMICAL ANALYSIS WITHIN AIRKLINSAR GEOTHERMAL AREA IN EMPAT LAWANG DISTRICT OF SOUTH SUMATRA INDONESIA

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ABSTRACT

Geochemical analyzes have been conducted on several samples of water geothermal manifestations. They are located Airklinsar 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 Airklinsar 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. Airklinsar 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 Airklinsar 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. Airklinsar geothermal fields are located near the Bukit Nipis 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, linestone, shales, marls, tuffaceous claystone with sandstone intercolations (Gafoer, 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 fileds will be interested to study further. Among other related to the origin of the hot fluid, characteristic and geothermal temperature reservoir. Therfore, 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-SO_4-HCO_3, 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 molal 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-SO_4-HCO_3 triangular diagram (**Figure 3**), plotting of chemical compositions of Airklinsar hot springs lie in nuetral 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 HCO_3 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 CO_2 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 CO_2 during ascent to surface increases the pH of the natural discharge to neutral or slightly alkaline.

Tabel 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-SO_4-HCO_3 diagram.

Cl-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 Cl-Li-B ternary diagram were used to indicate the source of the fluid.

Based on the Cl-Li-B diagram (**Figure 4**), plotting of chemical compositions of the 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 reservoar temperature is more than 300°C), so the chemical geothermometers are used by Na-K (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 geotermometer 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

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REFERENCES

Armannsson, H., (2007) Application of Geochemical Methods in Geothermal Exploration. United Nations University-Kenya Electricity Generating Co., Ltd., Presented at short course II on surface exploration for geothermal resources, 1-9.

Fournier, R., and Truesdell A., (1973) An Empirical Na-K-Ca Geoindicators. Geochim. Cosmochim. Acta, 37, 1255-1275.

Fournier, R. O., (1979) Chemical Geothermometers and Mixing Models for Geothermal System. Geothermics, 5, 41-50.

Gafoer, S., T.C. Amin and R. Pardede (2007) Geological Map Of Bengkulu Quadrangle Sumatra, Geological Survey Institute, Bandung.

Giggenbach, W. (1988) Geothermal Solute Equilibria. Derivation of Na-K-Mg-Ca Geoindicators, Geochim. Cosmochim. Acta, 52, 2749-2765.

Mnjokava, T.T., (2007) Interpretation of Exploration Geochemical Data for Geothermal Fluid from The Geothermal Field of The Rungwe Volcanic Area, SW-Tanzania. United Nations University, Geothermal Training Programme, Report 2007 No. 14, 303-332.

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

Table 1. Geochemical Data

No	SAMPLE	HCO3	SO4	Cl	Li	B	Na	K	Mg	Ca	SiO2
1	Airklinsar-Hot Springs 1	60,9	290	636,4	0,231	17,23	32,25	7,89	0,52	133,25	48,5
2	Airklinsar-Hot Springs 2	83,74	340	639,8	0,223	16,78	32,25	9,1	1,5	132,7	62,5
3	Airklinsar-Hot Springs 3	83,74	340	627,55	0,219	16,46	31,03	9,74	1,47	126,96	72,5
4	Airklinsar-Cool Water	45,68	20,7	12,25	0,021	0,07	1,12	1,64	7,2	34,65	31

Table 2. Ion Balance

No	SAMPLE	ΣKation	Σ Anion	Δ Charge%	TNa-K (F)	TNa-K (G)	TNa-K-Ca
1	Airklinsar-Hot Springs 1	8,309	-24,967	16,658	308,059	315,621	41,722
2	Airklinsar-Hot Springs 2	8,393	-26,479	18,085	325,773	331,482	45,567
3	Airklinsar-Hot Springs 3	8,067	-26,134	18,066	339,721	343,894	47,847
4	Airklinsar-Cool Water	2,416	-1,525	0,891	650,807	604,318	0,957

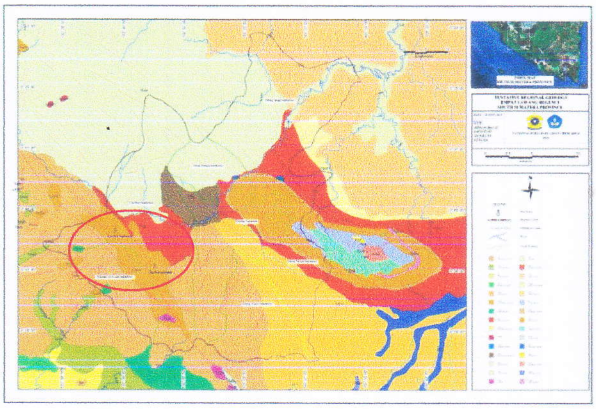

Fig. 1. Modification of Geological Map of Bengkulu Sheet (Gafoer, 2007). The red circle indicates the location of the manifestation.

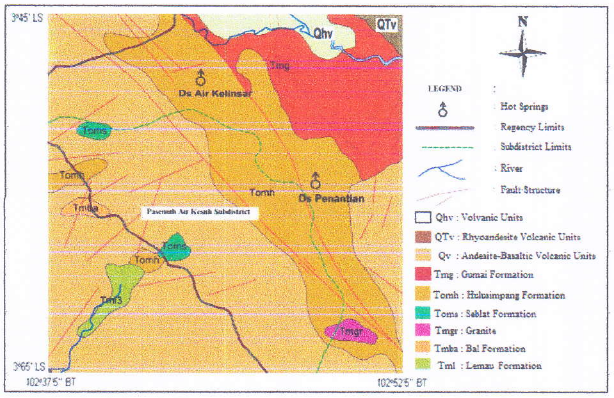

Fig. 2. Map location of hot springs manifestations (take from Modification of Geological Map of Bengkulu Sheet; Gafoer, 2007).

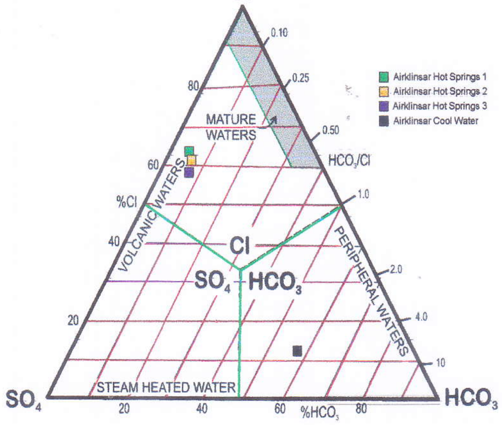

Fig. 3. Cl-SO_4-HCO_3 Diagram

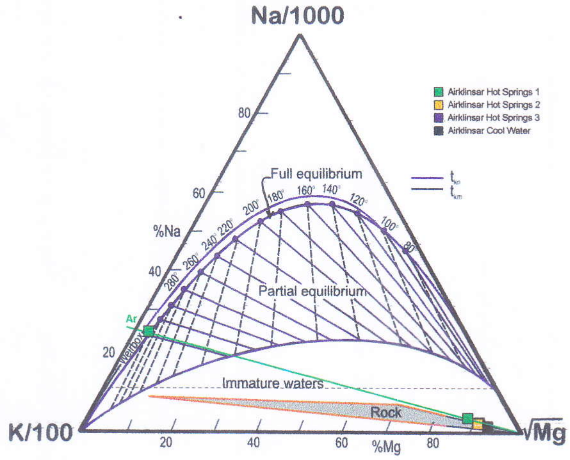

Fig. 4. Na-K-Mg Diagram

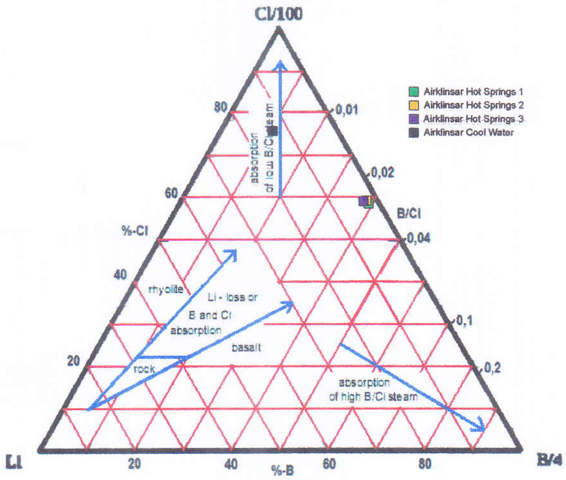

Fig. 5. Cl-Li-B Diagram