

Surface Thermal Manifestation Monitoring of Kamojang Geothermal Field

West Java, Indonesia

Mulyanto, A. Nani, Agus A. Zuhro, Y. Ahmad

PT. Pertamina Geothermal Energy Kamojang Area

PO. BOX 120 Garut, West Java, Indonesia

mulyanto@pgeindonesia.com

Keywords: Surface thermal manifestation, Kamojang

ABSTRACT

The Kamojang Geothermal Field is located in high volcanic terrain beneath the upper slopes of the Gandapura Volcanic complex in West Java, Indonesia. The field has been producing electricity since 1978. Currently, the total installed capacity of this field is about 200 MWe. For monitoring the changes of reservoir conditions, surface thermal manifestation monitoring is a powerful tool, which has been carried out since 1976. The main objective of this study is to assess the changes of water and gas compositions and the changes of physical parameters and geometry related to the changes of reservoir conditions.

The surface area of active thermal manifestation in the Kamojang field covers a small area along the eastern side of the field and includes hot pools, fumaroles, mud pots and hot springs. Most of the surface discharged fluid from the features are acid and contain high concentrations of sulfate, but very low concentrations of chloride. These concentrations are typically associated with vapour dominated systems.

1. INTRODUCTION

The Kamojang geothermal field is located along the axis of the Sunda Volcanic Arc, which extends from Sumatra to Flores. This arc-trench system marks the convergent boundary between the Eurasian Plate to the north and the Indo-Australian Plate to the south. The orientation of plate convergence for Java is approximately N-S, making subduction nearly perpendicular to the arc front in central Java, but increasingly oblique towards Sumatra. The convergence rate for Java has been estimated to be 6–7 cm/year.

Physiographically, the Kamojang geothermal field is located on a large volcanic chain, 15 kilometers long and 5 kilometers wide, extending from Gunung Rakutak in the West-Southwest part to Gunung Guntur in East-Northeast part. The volcanoes in this chain erupted sequentially from the West-Southwest to East-Northeast, thus Gunung Rakutak is the oldest and Gunung Guntur is the youngest. A volcanic – sedimentary deposit, which consists of colluvial, alluvial deposits and volcanic debris, occupies the Danau Pangkalan area.

The surface manifestations in the Kamojang area consist of hot pools, fumaroles, mud pots and hot springs lying in the so called Kawah Kamojang thermal area. Neutral hot springs only appear in the Citepus area, which is located in the southern part of the Kamojang field. Most of the surface hot waters discharged from the features are very acidic (pH 2 - 4) and contain high concentrations of sulphate (1000-2000 ppm) but very low concentrations of chloride (< 5 ppm).

Temperatures of the surface manifestation waters are between 93°C – 95°C. A number of major fumaroles, discharging large volumes of superheated steam, occur in the area.

2. THERMAL SURFACE MANIFESTATIONS

All the major surface thermal manifestations in the Kamojang area occur in the upper end of Citepus Fault including mud pools, fumaroles, hot springs, mud pots, and steam vents.

2.1 Kawah Manuk

One of the area's surface thermal manifestations is Kawah Manuk, which consist of mud pools, a small mud volcano and a mud crack area. The maximum temperature of the surface is about 93°C -95°C. All thermal fluids in this area are acidic fluids with pH 3.5 to 4. The area spans 80 m in length and 40 m in width, northwest to southeast.



Figure 1: Surface thermal manifestation locations in Kamojang area.



Figure 2: Mud pool in Kawah Manuk area.

2.2 Kawah Berecek

Kawah Berecek is located 50 m southeast of Kawah Manuk. In this area has a mud pool manifestation. Kawah Berecek spans 80 m by 20 m. The maximum temperature in this area is about 93°C -94°C with very acidic fluids (pH 2, 87).



Figure 3: Mud pool in Kawah Berecek area.

2.3 Kawah Kamojang

Kawah Kamojang extends over 20 m by 30 m. Mud pools and hot springs are found in this area. The maximum temperature at the surface is about 90°C - 93°C. All hot springs are acid sulfate waters with pH 2.7.



Figure 4: Mud pool and small hot spring in Kawah Kamojang area.

2.4 Kawah Hujan

Kawah Hujan is located 250 m to east of the Kawah Berecek. This area spans 19 m by 15 m. Several thermal features occur such as fumaroles, hot springs and geysers. The maximum temperature at the surface is about 94°C. The water type in this area is also acidic sulfate water.



Figure 5: Fumarole occurred in Kawah Hujan.

2.5 Kawah Saar

Kawah Saar is located 220 m to north of Kawah Hujan. Kawah Saar spans 50 m by 25 m. Thermal surface manifestations in this area consist of dry mud pools and a small mud volcano with maximum temperature about 90°C.



Figure 6: Thermal manifestation in Kawah Saar.

2.6 Citepus Hotspring

The citepus hot spring is located 2 km south of the main thermal surface manifestations. This hot spring is situated on the southern flank of the Kamojang area. The water types of this hot spring are different from the other surface thermal fluid in the Kamojang area. The maximum temperature at the surface is about 55°C -60°C with bicarbonate water.

3. FLUID TYPES IN MANIFESTATIONS

The waters from the major thermal surface manifestations in the Kamojang area are dominated by acidic sulfate water except Citepus hot spring.

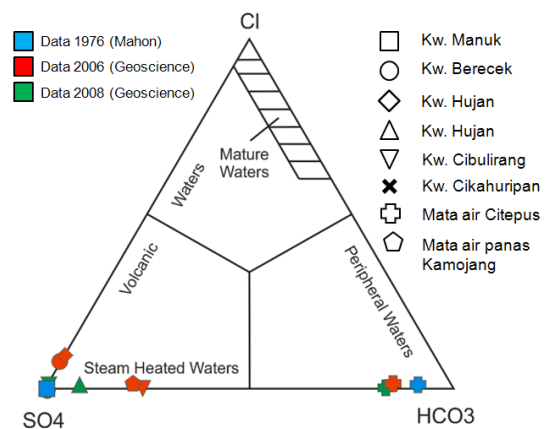


Figure 7: Thermal features Kamojang area water type based on SO4-Cl-HCO3 ternary diagram.

Tabel 1: Chemical of Kamojang area manifestation in 2008.

Water Sample		Location				
		Kw. Manuk	Kw. Berecek	Kw. Kamojang	Kw. Hujan	Citepus
pH		2.73	2.87	2.72	3.46	6.44
Fe	mg/l	7.92	7.28	6.25	3.57	0.48
SO4	mg/l	661	400	483	180	76
Cl	mg/l	< 1	< 1	< 1	2	< 1
HCO3	mg/l	nil	nil	nil	nil	394.1
SiO2	mg/l	232	154	154	147	160
S	mg/l	2.32	0.77	0.63	0.94	1.46
Gas Sample 2008		Location				
		Kw. Berecek		Kw. Kamojang	Kw. Hujan	
CO2	% wt	93.63		85.25	96.03	
H2S	% wt	3.08		2.94	2.95	
O2	% wt	0.04		0.75	0.008	
N2	% wt	2.88		10.71	0.91	
CO2/H2S		30.40		29.00	32.55	
Gas Sample 2006		Location				
		Kw. Berecek		Kw. Kamojang	Kw. Hujan	
CO2	% wt	35.62		49.72	47.2	
H2S	% wt	1.33		1.04	1.08	
O2	% wt	28.1		27.76	11.32	
N2	% wt	34.95		21.47	40.4	
CO2/H2S		26.78		47.81	43.70	

Non Condensable Gas samples show that the gas concentration of the thermal manifestations is increases with the time.

4. DISCUSSION

The geochemistry of thermal surface manifestations in the Kamojang area has been gradually changing during the steam production period in the Kamojang field. The gas concentration in the surface manifestations has increased from 2006 to 2008. The decrease of CO₂/H₂S ratio in Kawah Kamojang and Kawah Hujan shows that the Kamojang reservoir contains superheated steam.

REFERENCES

- Giggenbach, W.F.: Geochemical thecniques in geothermal exploration. UNDP publication, Rome-Italy (1991), pp. 119-142.
- Healy, J, Mahon W.A.J.: Kawah kamojang Geothermal Field, West Java (1976)
- Reyes A.G.: Petrology and mineral alteration in hydrothermal systems; From diagenesis to volcanic catastrophes, UNU GTP Report 118, Iceland (2.000).
- Utami, Pri.: Characteristic of The Kamojang Geothermal Reservoir (Jawa Barat) as Revealed by Its Geothermal Alteration Mineralogy Proceedings of WGC 2000, Kyushu-Japan, pp. 1921-1926.
- Yuan Y.: Geochemistry and isotope study of the thermal water from The Urban Geothermal Field, Beijing, china. Report in GTP United Nations Univ, Iceland (2005).
- Yunis: Evaluasi geokimia lapangan Panasbumi Kamojang setelah 13 tahun berproduksi . Subdin. Eks, Din. Eks Pabum EP, Pertamina (1997).