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FLUID GEOCHEMISTRY CHARACTERISTICS OF TEMPURAN AND KALIPUTIH HOT SPRINGS, WANAYASA CENTRAL JAVA

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ABSTRACT

Wanayasa Geothermal manifestation (Tempuran and Kaliputih hot springs) indicating the existence of geothermal system around the manifestation area. Surface temperature of each springs ranged about $40,3^0$C-$43,7^0$C and pH near neutral about 6 -7. The area estimated as a part of different system from Dieng geothermal system, so, to prove the hipothesis it need the evaluation of some parameters such as geological condition and fluid chemistry characteristics. Those two hot springs has analyzed to figure out the type of fluids, concentration and configuration of geoindicator element, and to calculate fluid geothermometry if the fluid type eligible.

The results of fluid chemistry analysis are: principles anion Cl-SO4-HCO3, Tempuran springs: Cl: 612,8ppm, SO4: 0ppm, HCO3: 1016,7ppm; Kaliputih springs: Cl: 483,7ppm, SO4: 0,41ppm, HCO3: 1288,4ppm, and so both springs are bicarbonate waters with a significant chloride content. The ^{2}H and ^{18}O isotope analysis result are Tempuran spring -39,83/mil;-8,21/mil, and Kaliputih spring -40,02/mil;-7,47/mil, and the analysis of Cl-Li-B ternary diagram shows low ratio of Boron to Chloride.

Based on principles anion analysis, both springs interpreted as bicarbonate water, but the significant chloride content indicating the dilution of chloride water (reservoir source) by meteoric water. As the type of fluids are bicarbonate water and and the charge balance error calculation result in high difference of anion-cation content, both fluids are not eligible to use as parameters in geothermometry calculation. Isotope data indicating both fluids come from same source; near surface meteoric water mixed with reservoir water with lower influence of meteoric water. Based on Cl-Li-B ternary diagram, Tempuran and Kaliputih springs interpreted as lateral outflow or peripheral part of Dieng Geothermal System.

INTRODUCTION

Wanayasa area lies on steep hilly-mountains which strongly dissected with the elevation around 1200-2265 m above sea level. Mostly consist of volcanic rocks as a lava flow product, pyroclastic, or intrusion.The other lithology are sedimentary rock of Rambatan, Kalibiuk, and Tapak Formation. The steep mountainous landform are product of Rogojembangan and Dieng volcanic activity (fig 1)

There are some hot/warm springs occure around Wanayasa (named Kaliputih and Tempuran hot spring) with surface temperature ranged about 40^{o}C.

The occurence of those thermal manifestations indicating the existence of geothermal system around Wanayasa area, but the questions remains are which kind of geothermal system, and how are the relationship of the system with nearest geothermal system (Dieng geothermal system), is Wanayasa system connected or separated with Dieng geothermal system.

OBJECTIVES

The objectives of the study are to identify the type of fluids on the manifestation area based on principles anions concentration and distribution, to identify the chemical behavior of fluids, and determine the origin or source of each fluids by analyze the presence and distribution of the tracer or geoindicator dissolved in the thermal fluids such as Na, K, Mg, B, Li, and the deuterium (H^2) – O^{18} isotope ratio. The interpretation of fluid origin and chemical behavior expected to be guidance to determine the type of geothermal system and the relationship with nearest system.

GEOLOGI OF WANAYASA AREA

Lithology of Wanayasa area configured by several formation, from oldest to youngest are:

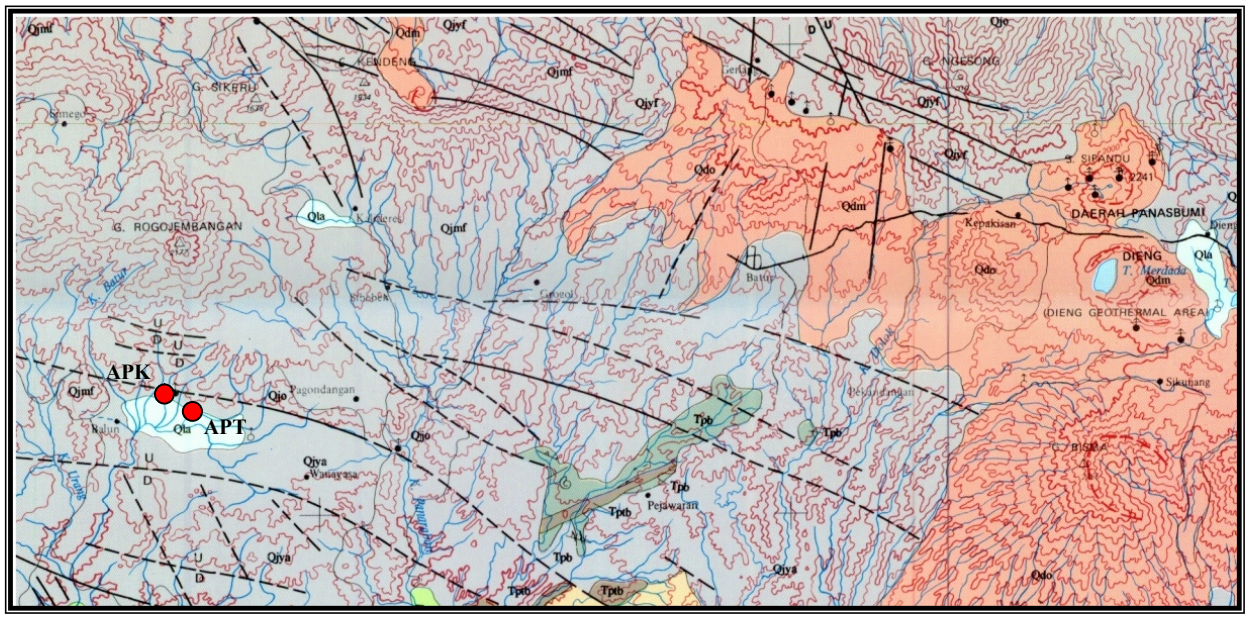

figure 1 Geological map of Wanayasa area and the location of APT AND APK warm springs

Rambatan Formation(Tmr)

Shale, marl, foraminifera rich calcareous sandstone, and Sigugur member is a reefal limestone containing large foram miogypsina and spiroclypeus.

Diorite intrusion (Tmd)

deep intrusion and hypabisal, andesitic composition, with coarse and porfiritic texture.

Tapak Formation (Tpt)

Calcareous sandstone and marl, greenish, containing molusks indicating Pliocene age.

Kalibiuk Formation (Tpb)

Marl and clay, intercalation with sandy tuff, grey colour, molusk rich indicating Pliocene age, sedimentary environment interpreted as tidal zone.

Ligung Formation (Qtlb)

Andesitic composition Volcanic breccia, agglomerate, andesitic lava, and tuff.

Jembangan Volcanic Product (Qj)

lava, pyroclastic flow and fall deposits, with pyroxene andesitic composition of lava, and also lahar deposit.

Lake deposit and alluvial (Qla)

young plateau-basin deposit consist of sand-silt-black clay, mostly volcanic composition and containing tuff.

Dieng Volcanic Product (Qd)

Lava, pyroclastic flow and fall deposit, tuff, quartz andesite composition, and lahar deposit. (Condon, et.al, 1996)

RESEARCH METHOD

The research methods are fluids sampling and chemical analysis of thermal fluids with main objects analyzed are the concentration distribution of principal anions (Cl, SO4, HCO3), principal chemical compound act as geoindicators and tracers such as Na, K, Mg, Li, B, SiO2, and the deuterium (^{2}H) and ^{18}O isotope ratio.

The anions ratio plotted on fluid type ternary diagram to determine the source or origin of fluids, so the characteristic of geothermal system could be predicted. The other compounds also analyzed and interpreted using ternary diagram to predict chemical behavior of thermal fluids related to subsurface fluid-rocks interaction.

RESULTS

The Tempuran warm spring (APT) and Kaliputih Warm spring (APK) occure on the toe of Rogojembangan Mountain sparated about 1 km distance.

both springs have similar chemical characteristic where APT have 483 ppm Cl, 0.4 ppm SO4, and 1288 ppm HCO3 where APK composed by 612 ppm Cl, 0 ppm SO4, and 1016 ppm HCO3. both have pH around 6,5, where surface temperature of APT 40,3^{o}C and APK 43,7^{o}C (table 1)

Table 1: Chemical Composition of Wanayasa area warm springs

Springs	Chemical Composition (mg/kg)					
APK	**pH**	**Ca**	**Mg**	**Na**	**K**	**Li**
	6,54	182,9	68,8	411	54	1,69
	B	**SiO2**	**NH3**	**Cl**	**SO4**	**HCO3**
	2,85	126,17	17,5	483	0,41	1288,4
APT	**pH**	**Ca**	**Mg**	**Na**	**K**	**Li**
	6,44	165,8	64,4	510	60	2,2
	B	**SiO2**	**NH3**	**Cl**	**SO4**	**HCO3**
	1,64	125,3	15,8	612	0	1016,7

The stable isotope analysis (deuterium (^{2}H) and ^{18}O) resulting a similar concentration of deuterium but quite different ^{18}O concentration (see table 2)

Table 2: Stable isotope analysis result

No	Sample	$\delta^{18}O$ /per mil	$\delta^{2}H$ /per mil
1	W1/APT	-8,21	-39,83
2	W2/APK	-7,47	-40,02

DISCUSSION

The chemical composition of APT and APK water indicating the dilute chloride-bicarbonate water type because of highest composition of HCO_3 about 60-70% and significant composition of chloride about 30-38%. (fig. 2)

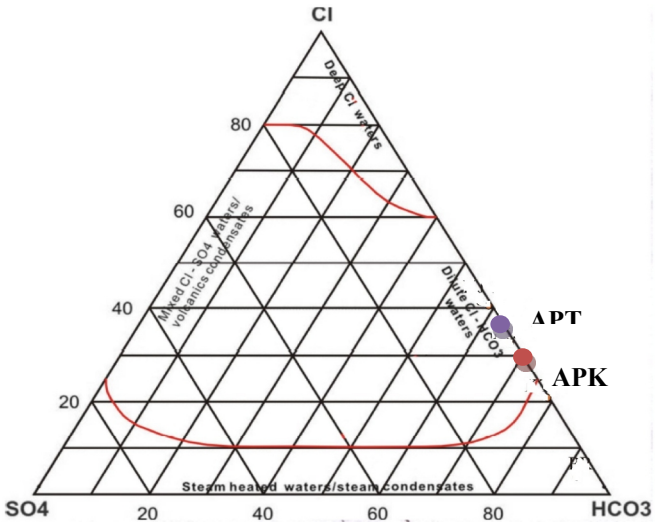

Figure 2: Water type ternary diagram with principal anions as end member

As the thermal fluids are dilute chloride-bicarbonate water, the thermal manifestation in Wanayasa area interpreted as lateral outflow zone of geothermal system. Significant chloride concentration indicating reservoir water flow outward centre of system which mixed by bicarbonate or meteoric water.

the stable isotope analysis conform with main anions distribution thus the thermal fluids interpreted as diluted/mixed reservoir water under meteoric water influence (fig.3)

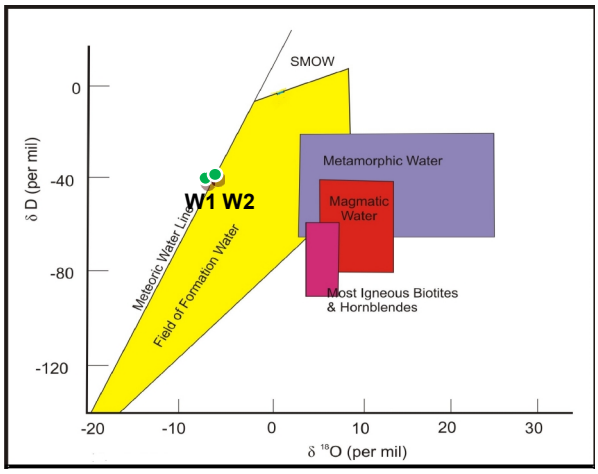

Figure 3: Plotting of stable isotope analysis of APT(W1) and APK(W2)

Based on Na-K-Mg ternary diagram plot (fig.4) both APT and APK placed on immature field, it confirm that both fluids are immature diluted/mixed water.

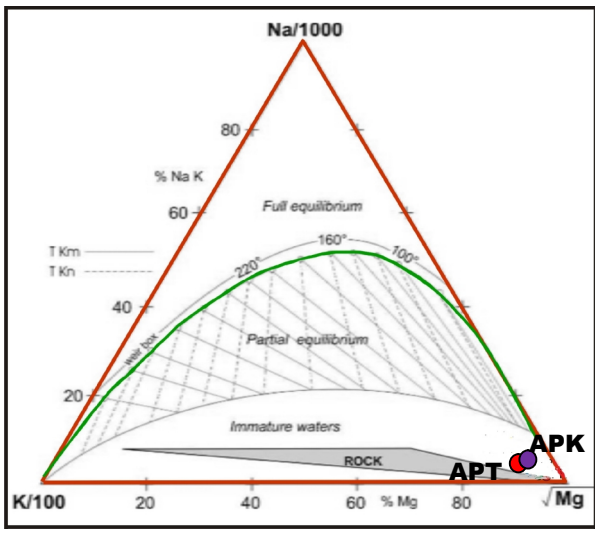

Figure 4: Plotting of APC1 and APC2 on Na-K-Mg ternary diagram

Cl-Li-B ternary diagram (fig.5) plotting APT and APK on Cl area confirm that the water have volcanic-macmatic origin, as a result of magmatic gas absorbtion with low B/Cl ratio. Low ratio of B/Cl indicating common fluid-rock process on outflow zone, resulting dissolution of minerals of the rocks passsed over by thermal fluids.

Based on all geochemical analysis, the Wanayasa geothermal manifestation area interpreted as outflow zone of a geothermal system, and might be related to nearest geothermal system as a peripheral part of Dieng geothermal system, but it need stable isotope investigation both in Dieng or Wanayasa manifestation to determine the relationship of those manifestation.

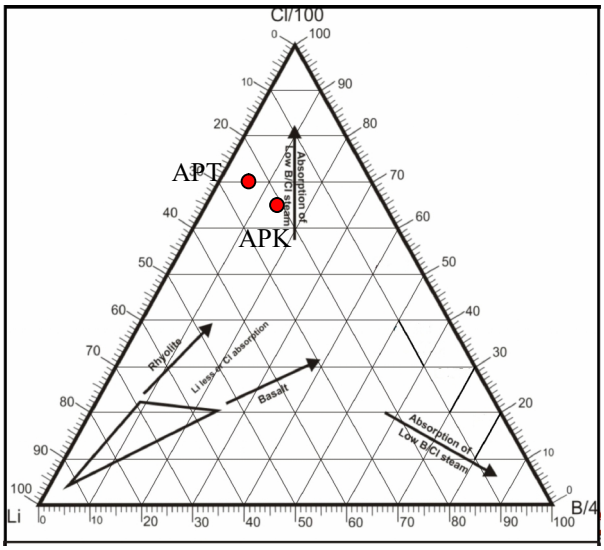

Figure 5: Plotting of APT and APK on Cl-Li-B ternary diagram

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