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Geothermal Energy: Case Study Identification Based on Analysis of Ion Balance and Reservoir Characteristic Abstract – Some samples of data from the world's geothermal system consisting of: (1) geothermal systems Padang Cermin (a. Padang Cermin 1, b. Padang Cermin 2, c. Margodadi, d. Wadok, (2) Kawah Ijen (East Java) , (3) Wairakei (New Zealand), (4) Sea water, and (5) Te Aroha (New Zealand). Analysis of ion balance is performed on the fifth geothermal system data stretcher. Analysis triangle ternary diagram (Cl-HCO3-SO4) performed on all the data from the five samples. Ion balance analysis results showed that: (1) showed good hydrothermal system (ion balance value between 0.1 up to 2.19%), (2) shows that the hydrothermal system is not good (the value of the ion balance 47%), (3) showed good hydrothermal system (ion balance value of 1.2%), (4) shows the hydrothermal system that is not good (the value of the ion balance 64%), and (5) indicate that the hydrothermal system is not so good (the value of the ion balance between 8.5%), (Cl-HCO3-SO4) triangle ternary diagram analysis results showed that: (1) produce a type of chloride water reservoir, (2) produces chloride water reservoir types, (3) produces chloride water reservoir types, (4) produce a type of chloride water reservoir, and (5) to produce the type of carbonate reservoir water. Keyword: geothermal system, Ion balance analysis, (Cl-HCO3-SO4) triangle ternary diagram analysis.

INTRODUCTION The unifying scheme for classifying geothermal system was very simplified classification on hydrologic style [1]. Geothermal fluids have diverse chemical compositions. Many of these chemical differences depend on the sources of recharge waters and the contribution of volatiles from metamorphic or magmatic sources[2]. Fluid composition change caused by the effect the degree of boiling of mixing. Large-scale fluid hydraulic factors, further determine whether a system undergoes fluid convection in the stagnant reservoir. While general trends in fluid chemistry exist for various geothermal environments.

It is our task as geochemists to learn the processes which govern fluid compositions and thereby use this information to understand the individual geothermal system. METHODS The method in this research using: (1) analysis of ion balance, (2) Cl-SO4-HCO3 and (3) Na-K-Mg chart analysis. Ion balance is the method of checking how good the chemical composition of the geothermal system. In most solutions are the dominant ions Na+, K+, Ca+2, Mg+, Cl-, HCO3 , and SO4 .

To calculate the value of the formula used Ion Balance: Change% = {(cations+ anions)/| cations+ anions|}x100 Calculation Cl-SO4-HCO3 using the formula: S = cCl + cSO4 + cHCO3; % Cl = (100 cCl)/S and % HO3 = (100 cHCO3)/S. Calculation Na-K-Mg using the formula: S = cNa/1000 + cK/100 + cMg1/2 % Na = (cNa)/ 10S and % Mg = (100 c cMg1/2)/S. [3]; [4]. RESULT The results of this study are calculation of ion balance and calculation of Cl, HCO3, SO4, Na, K, and Mg concentration in Table 1.

While the results of ternary diagrams analysis (Cl-HCO3-SO4) and (Na-K-Mg) are illustrated in Between Figures 1 and 6b. DISCUSSIONS From Figure 1a. Cl-SO4-HCO3 and NA-K-Mg chart analysis of the geothermal system from spring Padang Cermin 1 (Pc1), indicated that the Padang Cermin 1 geothermal system (Pc1) is chloride water within partial equilibrium. Figure 1b. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Padang Cermin 2 (Pc2), indicated chloride-water system within the immature liquid condition. Figure 1c.

Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Margodadi Padang Cermin (Mg), indicated carbonated water reservoir condition within partial equilibrium condition. Figure 1d. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Wadok Padang Cermin (Wadok), indicated chloride water reservoir condition situated between partial equilibrium and immature liquid condition. The Padang Cermin geothermal reservoir should be a hight temperature geothermal system if we compare to Wairakei geothermal system New Zealand). The Wairakei Na-K-Mg analysis shows in Figure 1. Figure 2.

Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring of Kawah Ijin East Java (IjenS), indicated chloride-water system within the immature liquid condition. Figure 3a. Cl-SO4-HCO3 chart analysis of Wairakei geothermal system well (WrkW), and Na-K-Mg chart analysis of Wairakei geothermal system well of (WrkW) and Wairakei geothermal system spring (WrkS), and Figure 3b. Cl-SO4-HCO3 chart analysis of Wairakei system spring (WrkS). indicated the reservoir of Wairakei is chloride water.

The liquid condition is a partial equilibrium in the spring, and full equilibrium in the well and the measures temperatures were 99o C in spring and 240oC in well. The temperature determination using Na-K-Mg chart analysis was consistent with well-measured temperature. Figure 4. Cl-SO4-HCO3 chart analysis of Sea Water (SW), indicated that sea water is rich of chloride altho has much SO4 and HCO3. So that chloride mineral still dominant in sea water. Figure 5. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from Salton Sea well USA (SsUsW), indicated the chloride water and liquid condition of full equilibrium.

The liquid condition in full equilibrium so consistent temperature analysis chart of Na-K-Mg with well-measured temperature. For example, the temperature measured the Salton Sea well USA was 330oC and the Na-K-Mg chart analysis more than 300o C (see Figure 5 and Tabel 1). The other example, the temperature measured the Mirabilis was 245o C and the Na-K-Mg chart analysis closed to well temperature measured (see Figure 6a and Table 1). Figure 6b.

Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system Mirabilis spring Cero Pro Mexico (MvCrS), indicated the chloride water reservoir and liquid condition in partial equilibrium. Table 1. Data and results of geochemical analysis of sea water and geothermal system of Padang Cermin, Ijen Crater, Wairakei, Salton Sea and Miraviles. No _Station _C _Na _K _Ca _Mg _Li _B _Cl _SO4 _HCO3 _%Cl _%Hco _%Na _%Mg _HCO/Cl _Ion Balance _ _1a _Pc1 _ _1243 _93 _117 _7 _15 _3 _1972 _113 _306 _82,5 _49,1 _25,8 _54,9 _0,155 _-0,1 _ _1b _Pc2 _ _326 _72 _51 _13 _8 _13 _510 _15 _250 _65,8 _56,8 _7,0 _77,5 _0,490 _2,2 _ _1c _Mgd _ _1545 _100 _142 _13 _13 _2 _2588 _52 _104 _94,3 _26,6 _25,1 _58,6 _0,040 _1,4 _ _1d _Wadok _ _1166 _170 _124 _7 _15 _1 _2037 _68 _100 _92,4 _31,7 _21,2 _48,0 _0,049 _1,1 _2 _IjenS _60 _1030 _1020 _3150 _680 _ _ _1675 _30 _4 _98,0 _11,8 _2,8 _69,9 _0,002 _71,1 _ _3a _WrkW _240 _1170 _167 _20 _0,01 _10,7 _26 _1970 _35 _5 _98,0 _0,8 _39,8 _3,4 _0,003 _-0,2 _ _3b _WrkS _99 _1220 _140 _30 _4,5 _14,5 _43 _2100 _30 _30 _97,2 _7,9 _25,7 _44,7 _0,014 _-1,5 _ _4 _SW _4 _10760 _390 _410 _1290 _ _ _19340 _2710 _140 _87,2 _4,9 _21,3 _71,0 _0,007 _0,03 _ _5 _SsUsW _330 _38400 _13400 _22010 _10 _ _ _118400 _4 _140 _99,9 _97,2 _21,9 _1,8 _0,001 _-3,6 _ _6a _MvCrW _245 _1970 _238 _73 _0,02 _5,7 _54 _3300 _36 _40 _84,0 _6,0 _43,9 _3,1 _0,012 _-5,3 _ _6b _MvCrS _73 _1970 _79 _22 _6,5 _3,4 _48 _2600 _120 _910 _71,8 _79,7 _37,1 _48,0 _0,350 _-0,7 _ _ CONCLUSION The fluid compositions should be informed to understand the individual geothermal system, is it chloride water, or acid water or carbonated water reservoirs. We concluded that Na-K-Mg chart analysis with full equilibrium fluid illustrated the consistent temperature with rail temperature well measure.

The Padang Cermin geothermal field Pesawaran Lampung Indonesia should be the hight temperature geothermal system refer to Wairakei geothermal system New Zealand. AKNOLEDGMENT I would like to thanks to Simmons that have product the lecturer book for aNalysis reference and some data that using to be analyzed

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Figure 1. Interpretation from Na-K-Mg chart analysis does determine the temperature of the reservoir. Comparison between the Wairakei spring data analysis (WrkS), and Wairakei well data analysis (WrkW) compare to the good temperature. _Figure 1a. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Padang Cermin 1 (Pc1)

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Figure 1b. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Padang Cermin 2 (Pc2) _Figure 1c.

Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Margodadi Padang Cermin (Mgd)

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Figure 1d. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring Wadok Padang Cermin (Wadok) _Figure 2. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from spring of Kawah Ijin East Java (IjenS)

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Figure 3a. Cl-SO4-HCO3 chart analysis of Wairakei geothermal system well (WrkW), and Na-K-Mg chart analysis of Wairakei geothermal system well of (WrkW) and Wairakei geothermal system spring (WrkS), _ Figure 3b.

Cl-SO4-HCO3 chart analysis of Wairakei geothermal

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Figure 4. Cl-SO4-HCO3 chart analysis of Sea Water (SW),Waairkei system spring (WrkS). _Figure 5. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system from Salton Sea well USA (SsUsW)

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Figure 6a. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system Miraviles well (SsUsW) _Figure 6b. Cl-SO4-HCO3 and Na-K-Mg chart analysis of the geothermal system Miraviles spring (SsUsS)

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