Rare Earth Elements as Supporting Approaches for Early-stage Geothermal Exploration

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Integration of REEs analysis with isotopes of oxygen and deuterium as well as chemistry data can provide a supplemental assistance to determine the most important zone in a geothermal system: upflow zone. Eight hot springs samples as geothermal surface manifestations in Wayang Windu Geothermal Field in Bandung, Indonesia have been conducted for geochemistry analysis. Based on their genesis, those hot springs were divided into steam-heating water (SO_4) group and bicarbonate water (HCO_3) group. According to their geochemistry analysis, 4 distinctive areas came up as the signature agents of geothermal upflow zones: MBA, Citawa, Wayang, and Cibolang. Which one is the most representative geothermal reservoir?

Analyses have been deducted from their isotopes of oxygen and deuterium, mixing plots of Cl vs. Mg, Ca, and B, ratio of Ca/Sr, along with the normalized-to-chondrite REEs. The REE concentrations in both types of water showed large variations with 3σ of BGD: lowest concentrations (ΣREE≤0.1 µg/L) occurred in groundwater from andesitic volcanic aquifers; highest concentrations (ΣREE up to 10.000 µg/L) were observed in sedimentary aquifers.

The results indicate that there are 3 types of hot fluids from different host rocks: MBA - Wayang, Cibolang, and Citawa hot fluids. MBA and Wayang areas are the upflow zone of Wayang Windu Geothermal Field since they show the presence of steam-heated water from volcanic gases from the depth. In addition, they also reveal the high intensity of water-rock interaction of meteoric water with andesitic host rocks as shown from the ‘gull-wing’ of REE patterns with large fractionations on LREEs. Meanwhile Cibolang fluids are assumed derived from a contact of groundwater flow near the surface with andesitic volcanic rocks; and the genesis of Citawa hot fluid is assumed coming from meteoric water that corresponded with host rock with sedimentary layers.