Geophysical Research Abstracts
Vol. 14, EGU2012-8183-2, 2012
EGU General Assembly 2012

Characterization of a deep geothermal reservoir in an active volcanic area

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In this study an integrated methodological approach to characterize a complex deep geothermal reservoir located in an active volcanic setting in Indonesia is presented. The methods applied include hydraulic and hydrogeochemical (incl. isotope tracer) techniques to model groundwater flow, heat transport, and hydro-geochemical properties of the reservoir. 3D geological and hydraulic models of the area were constructed based on deep drill profiles, collected fluid and rock samples, and mapping of geological structures. First results show that the geothermal reservoir is composed of major geological units such as altered andesite, basalt, breccia, and tuff layers. Several tectonic faults crosscut the geological units into individual blocks and reservoirs and influence hydraulic pathways in multiple ways.

Hot water and steam are produced by nine wells. Fluids are reinjected into the reservoir through one injection well. Currently, a geothermal plant produces 60 MWe from steam withdrawn. Temperatures of the geothermal system range between 250 and 350 °C (Koestono et al. 2010). Based on the chemical composition of fluids from the production wells (concentration of major ions and physicochemical parameters) at least two different hydro-geochemical reservoirs could be identified. The deep reservoir with a moderate pH of 5 is marked by total silica concentrations up to 350 mg/L and high chloride concentrations of 430 mg/L. For the shallow reservoir, highly acidic conditions with pH values of 2.9 are analysed for water, while steam shows pH values around 4. Furthermore, high chloride (1550 mg/L), total silica (460 mg/L), and sulphate concentrations (1600 mg/L) are characteristic for the shallow reservoir. According to Giggenbach (1988) and Nicholson (1993) the water can be classified into sulphate-rich waters and neutral chloride-waters. Sulphate-rich water is expected to occur near to the heat source while chloride-rich waters discharge near the outflow zone. Surface reservoirs, e.g. an acid lake and several hot springs seem to be in close contact with the shallow reservoir.

References

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