

Hydrogeological modeling of the geothermal waters of Alaşehir in the continental rift zone of the Gediz within the Menderes Massif, Western Anatolia, Turkey

Nevzat Özgür

Suleyman Demirel University, Faculty of Engineering, Department of Geological Engineering, Isparta, Turkey

In western Anatolia, Turkey, the continental rift zones of the Büyük Menderes, Küçük Menderes and Gediz were formed by extensional tectonic features striking E-W generally and representing a great number of active geothermal systems, epithermal mineralizations and volcanic rocks from Middle Miocene to recent. The geothermal waters are associated with the faults which strike preferentially NW-SE and NE-SW and locate diagonal to general strike of the rift zones of the Menderes Massif. These NW-SE and NE-SW striking faults were probably generated by compressional tectonic regimes which leads to the deformation of uplift between two extensional rift zones in the Menderes Massif. The one of these rift zones is Gediz which is distinguished by a great number of geothermal waters such as Alaşehir, Kurşunlu, Çamurlu, Pamukkale and Urganlı. The geothermal waters of Alaşehir form the biggest potential in the rift zone of Gediz with a capacity of about 100 to 200 MWe.

Geologically, the gneisses from the basement rocks in the study area which are overlain by an Paleozoic to Mesozoic intercalation of mica schists, quartzites and marbles, an Miocene intercalation of conglomerates, sandstones and clay stones and Plio-Quaternary intercalation of conglomerates, sandstones and clay stones discordantly. In the study area, Paleozoic to Mesozoic quartzites and marbles form the reservoir rocks hydrogeologically. The geothermal waters anions with $\text{Na}+\text{K}>\text{Ca}>\text{Mg}$ dominant cations and $\text{HCO}_3>\text{Cl}$ dominant anions are of Na-HCO₃ type and can be considered as partial equilibrated waters. According to the results of geochemical thermometers, the reservoir temperatures area of about 185 °C in accordance with measured reservoir temperatures. Stable isotopes of $\delta^{18}\text{O}$ versus $\delta^2\text{H}$ of geothermal waters of Alaşehir deviate from the meteoric water line showing a intensive water-rock interaction under high temperature conditions. These data are well correlated with the results of the hydrogeochemical analyses which also indicate intensive water-rock interaction and reactions with silicates.

In the study area, the geothermal waters of meteoric origin. The infiltration takes place along the Menderes Massif. Due to the deep circulation which is made possible by the deep reaching fault system of the rift zone of Gediz, the meteoric waters are heated by recent subvolcanic activity such as Kula volcano with human foot prints. In the area of Alaşehir, the meteoric waters percolate at fault zones and permeable clastic sediments into the reaction zone of the roof area of a magma chamber (of Kula volcano) situated at a probable depth of 2-4 km where meteoric waters are heated by the cooling magmatic melt and ascend to the surface due to their lower density caused by convection cells. The volatile components of CO₂, SO₂, HCl, H₂S, HB, HF and He out of magma reach the geothermal water reservoir where an equilibrium between altered rocks, gas components and geothermal waters performs. Thus, the geothermal waters ascend in tectonic zones of weakness at the rift zone of the Gediz in terms of hot springs, gases and steams. Finally, the geothermal waters of Alaşehir are distinguished by a 2,0 percent CO₂ of productions in geothermal power plants especially.