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Assessment of geothermal energy potential by geophysical methods: Nevşehir Region, Central Anatolia

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ABSTRACT

In this study, geothermal potential of the Nevşehir region (Central Anatolia) was assessed by using vertical electrical sounding (VES), self-potential (SP), magnetotelluric (MT), gravity and gravity 3D Euler deconvolution structure analysis methods. Extensive volcanic activity occurred in this region from Upper Miocene to Holocene time. Due to the young volcanic activity Nevşehir region can be viewed as a potential geothermal area. We collected data from 54 VES points along 5 profiles, from 28 MT measurement points along 2 profiles (at frequency range between 320 and 0.0001 Hz), and from 4 SP profiles (total 19 km long). The obtained results based on different geophysical methods are consistent with each other. Joint interpretation of all geological and geophysical data suggests that this region has geothermal potential and an exploration well validated this assessment beyond doubt.

1. Introduction

Turkey is the seventh in the world ranking of geothermal energy potential (Jennejohn et al., 2012). Turkey has four main geothermal energy regions; the West, Central and East Anatolian regions, and the North Anatolian Fault Zone where there is young volcanic activity (Drahor and Berge, 2006). Among these especially the west Anatolia region has the highest geothermal potential. Some of the geothermal areas and their temperatures are: Kızıldere (242 °C), Germencik (232 °C), Simav (135 °C), Afyon (95 °C), Kozaklı (90 °C), Kızılcahamam (80 °C), Gönen (80 °C), and Kırşehir (57 °C) (Serpen et al., 2008).

The first time to generate electricity by using geothermal resources in Turkey was attempted by the General Directorate of Mineral and Research Institute (MTA) at Kızıldere-Denizli in 1968. A power plant which is generating 0.5 MWe electric energy from geothermal resources was put into service by MTA at Kızıldere-Denizli region in 1974.

In this study, we have presented the results of geothermal research around the town of Göre which is located at the Central Anatolian region of Turkey (Fig. 1).

Geophysical methods such as electric and electromagnetic are often used for geothermal exploration. Hydrothermal fluids modify the electrical resistivity based on the fluid content of surrounding geological formations. Generally, ionic conduction increases with temperature, salinity and porosity in the rocks (Özürlan and Şahin, 2006).

According to previous geological studies a caldera exists in the Nevşehir area and this area could be a potential geothermal resource (Le Pennec et al., 1994; Froger et al., 1998). The volcanism in the Central Anatolia is continental arc type (Pasquare et al., 1988). There is a low velocity upper mantle region beneath this area obtained by seismological studies (Gans et al., 2009). In a Curie point study of Turkey Ateş et al., 2005 suggested that the 580 °C isotherm contour around the Cappadocia Volcanic Province (CVP) could be a potential reservoir for a geothermal system. According to this study, Curie point depths near CVP are estimated to be around 8–12 km.

Based on the previous geological and geophysical studies, one can infer that the CVP may be a good place for geothermal conduits. Therefore, we applied several geophysical methods such as vertical electrical sounding (VES), self-potential (SP), gravity and magnetotelluric (MT) methods in order to delineate the geothermal area around the town of Göre.

2. Geological settings

The geological map of the study area is presented in Fig. 2. The geology of the Central Anatolia associated with the Nevşehir–Acıgöl Caldera

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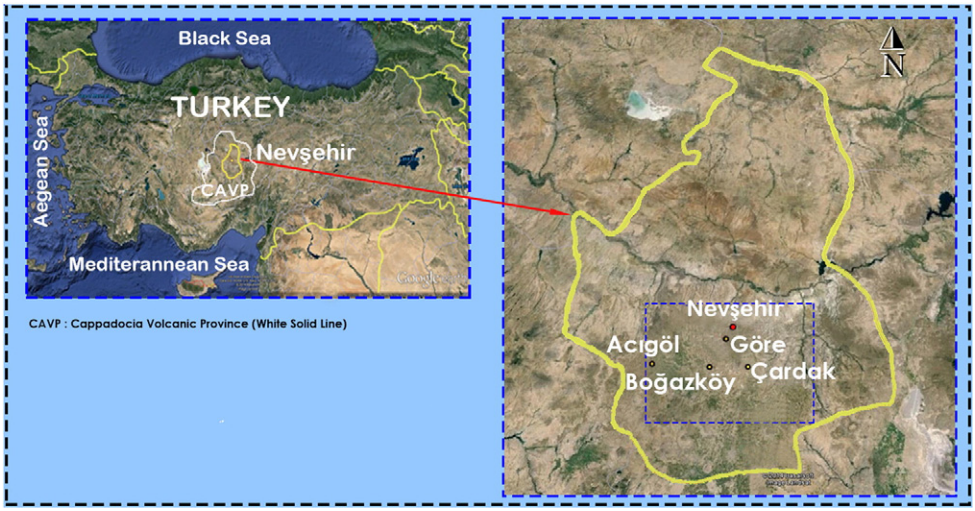

Fig. 1. Location map of the Nevşehir region, Central Anatolia, Turkey (Başarsoft/Google Earth, 2012).

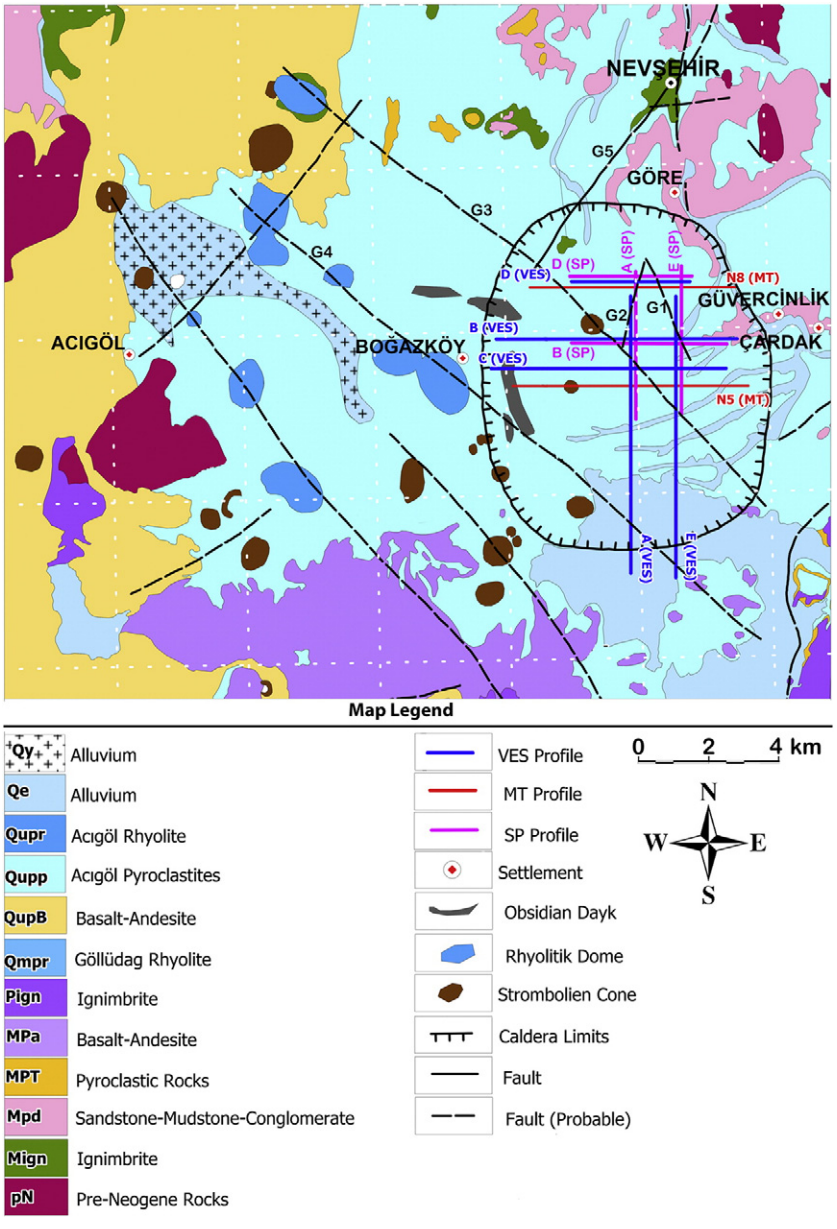

Fig. 2. The geology map of the Nevşehir region, Central Anatolia. The geophysical profiles are also shown.