

Hydrogeological and geochemical studies of the Efteni and Derdin geothermal areas, Turkey

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Abstract

The Efteni and Derdin geothermal areas are located in northwestern Turkey. Relatively low-temperature springs emerge from the Duzce Fault, a normal-component-dominated fault segment of the North Anatolian Fault System. The thermal waters of the Efteni and Derdin Springs show distinct geochemical and isotopic characteristics since they originate from different geothermal reservoirs and reflect the effects of different water–rock interaction processes. Geothermometry revealed higher reservoir temperatures for the Efteni system, however a strong $\delta^{18}\text{O}$ shift, interpreted as being the result of isotopic exchange at high temperatures, was observed in the Derdin system. Hydrogeological and geochemical techniques are applied to identify recharge mechanisms, water–rock interaction processes and to construct conceptual models of these geothermal systems.

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1. Introduction

The Efteni and Derdin low-temperature geothermal areas are located in the southwestern part of the Duzce Province, northwestern Turkey (Fig. 1). The region is characterized by its extreme tectonic activity. Large and frequent earthquakes are triggered by the influence of the westward motion of the Anatolian Plate along the North Anatolian Fault (NAF). The last activity ($M_w = 7.2$) on 12 November 1999 caused 845 fatalities in the Duzce Province and vicinity. After that earth-

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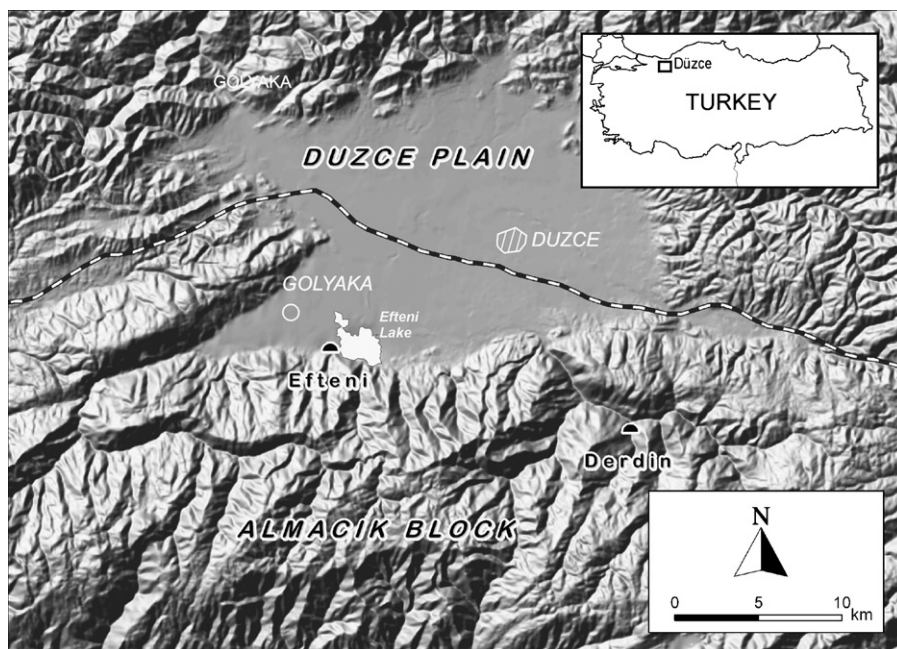


Fig. 1. Location of the Efteni and Derdin geothermal areas in northwestern Turkey.

quake several warm springs emerged along the surface fault rupture. One of them appeared on the shore of the Efteni Lake with simultaneous emission and combustion of methane.

The study area comprises two distinct morphological units that have been formed by the Duzce Fault, a normal-component-dominated fault segment of the NAF; in the southern part the Almacik Block presents peaks having elevations in the 1500–1800 m above sea level (m asl) range, while towards the north, the Duzce Plain is at 120–150 m asl. The mean annual temperature is 13.1 °C; and the precipitation is about 840 mm in the plain and exceeds 1100 mm in the Almacik Block. Relatively low-temperature thermal springs (22–43 °C) emerge from the active northern branch of the NAF.

The geothermal systems in this area have not been investigated in detail. No exploratory wells have been drilled; little is known about the subsurface geology and reservoir temperatures. We have carried out hydrogeological, geochemical and isotopic studies of the thermal springs to determine reservoir lithologies and the origin and recharge mechanisms of the geothermal systems.

2. Methodology

Isotopic and geochemical techniques together with geological and geophysical studies are widely used to define the hydrodynamic structures of geothermal systems. These techniques are of vital importance in geothermal investigations especially in unexplored areas.

Geologic and hydrogeologic investigations were performed first in the Efteni and Derdin geothermal areas in order to establish the local geological structure and the hydrogeologic properties of the various lithologic units and to identify possible reservoir and caprocks. Then, samples from hot and cold-water springs were collected and analyzed to determine the origin and chemical characteristics of the thermal waters.

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