

## **Geochemical processes controlling the fluoride concentrations in the groundwater of the Lake Acıgöl Basin (Denizli, Turkey)**

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The lacustrine Acıgöl basin formed as an extensional half-graben host to various bodies of water, such as cold-hot springs, lakes, streams, and wells. This study examines the fluoride evolution of the groundwater in the semi-arid, closed Acıgöl Basin (using 165 samples). The economically important saline/hyper-saline lake that borders the NE-trending Acıgöl fault zone is located in the southern part of the basin. The brackish springs and deep waters that discharge along the NE-trending Acıgöl fault zone feed the hyper-saline lake. The groundwater chemistry of springs that discharge near or around the lake is affected by carbonate- and sulphate-rich lacustrine sediments.

The fluoride concentrations varied from 0 to 2.9 mg/L (mean value 0.8 mg/L, n=165) in groundwater samples of the Lake Acıgöl Basin. The mean fluoride concentration values were 0.5 mg/L (n=42) in dry seasons and 0.9 mg/L (n=123) in wet seasons. According to the water type, the mean value of fluoride concentrations in deep wells, shallow wells, springs, and streams were 0.8 mg/L, 0.3 mg/L, 0.9 mg/L, and 0.2 mg/L, respectively. Over 12.7 % of the groundwater in basin had fluoride concentrations above 1.5 mg/L (the WHO drinking guideline), and 38% of the groundwater in the basin had fluoride concentrations above 1.0 mg/L (Turkish Standards-TS266). The highest fluoride concentrations were measured in brackish deep groundwater (2.9 mg/L) that bordered the hyper-saline lake and Beylerli Thermal springs (2.7 mg/L) located south west of the hyper-saline lake. The Hayriye Başpınar Spring had the lowest fluoride concentration. The high-fluoride groundwater zones were mainly located along the NE-trending Acıgöl fault zone at the south part of the basin. The mean fluoride concentration value was 1 mg/L at these zones.

The fluoride enrichment in springs discharged from the Acıgöl fault zone is higher than in springs discharged from lithological units. According to the spatial variation map of fluoride, the main fluoride source in the basin is the thermal waters around Beylerli. The groundwater flow direction of the west part of the basin is from Beylerli to the hyper-saline lake. The fluoride concentration decreases from Beylerli to the hyper-saline lake in the direction of groundwater flow.

The fluoride concentration in the springs and deep waters discharged along the Acıgöl fault zone was positively correlated with that of Ec, Na, Cl<sup>-</sup>, and SO<sub>4</sub><sup>2-</sup>. These correlations indicate that groundwater with high Cl<sup>-</sup> and SO<sub>4</sub><sup>2-</sup> contents help dissolve some fluoride-rich minerals and evaporates, such as gypsum and mirabilite. Dissolving evaporates in lacustrine sediments bound to the Acıgöl fault by springs increases fluoride concentrations. The water type of groundwater containing high fluoride is Na-SO<sub>4</sub>, Na-Cl, Ca-SO<sub>4</sub> ve Mg-SO<sub>4</sub>. The interactions between groundwater and fluoride-rich minerals may be responsible for the increased fluoride concentration in groundwater discharged from lithological units. The Karaböğürtlen Formation in the southern part of the Acıgöl Basin contains fluoride-rich minerals, such as fluorapatite and hornblende.