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# Hydrogeochemical modeling (KIRMAT) of spring and deep borehole water compositions in the small granitic Ringelbach catchment (Vosges Mountains, France)

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## Abstract

This study presents the results of the coupled hydrogeochemical modeling of the geochemical compositions of spring and borehole waters from the Ringelbach catchment, which is located in the Vosges Mountains (France). This site has been equipped with 150-m-deep boreholes, facilitating the sampling of both rock and groundwater in the granitic bedrock. The data point to very contrasting chemical compositions between spring and borehole waters, which are discussed and explained in this study by the application of the coupled hydrogeochemical code KIRMAT. Using hydrological and geochemical data, simulations were performed through two different water pathways, which crossed different types of rocks within the Ringelbach massif: a subsurface and fast (>2.5 $m_{H2O}.yr^{-1}$) water flow, which is more or less parallel to the slope, for waters supplying the springs, and a rather vertical and slower flow (0.5 to 0.1 $m_{H2O}.yr^{-1}$) for the borehole waters. The KIRMAT simulations make it possible to account for not only the geochemical differences between the spring and borehole waters but also the geochemical variations observed in waters in both contexts. For borehole waters, the model confirms the importance of the dissolution of minor mineralogical phases that are present in the granite (here, carbonates/dolomites) on the chemical budget of waters. It also shows that the chemical