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Thermal impacts of magmatic intrusions on dolomitization processes in the Tiberias Basin, Jordan-Dead Sea Transform

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The Tiberias Basin (TB) is located within the Jordan–Dead Sea Transform and is bordered to the west by the Lower Galilee (Israel), where Pliocene basalts cover an area of 35 km2. Hydrochemical analyses highlight that two types of brines exist around Lake Tiberias (LT) (Mandel 1965; Möller et al. 2009): (1) Along the eastern side of LT, brine is characterized by Mg/Ca>1, which resulted from evaporation of seawater during the Late Miocene, whereas (2) along the western side of the lake, brine is characterized by Mg/Ca<1, possibly formed out of the Mg-rich brine by dolomitization of limestones (Möller et al. 2012). Dolomitization of limestones occurs at temperatures of at least 100 °C. We suppose that basalts which erupted through numerous fissures, forming nowadays sills within the Cretaceous and Eocene limestones, sufficiently heated the formations, which build up the Lower Galilee, west of LT. As a result, the Cenomanian Formations, where the original brine is mostly buried, were only sufficiently heated in the eastern Galilee.

In this study, we try to estimate to which extent and through which mechanisms fissure eruptions have induced heated brine to flow within the limestone aquifers. 2D simulations of coupled heat transport and fluid flow show that different aspects control the heat transport in the limestone aquifer. Preliminary results indicate that conductive heat transport generates sharp temperature fronts that extent 30 meters after 5 years of continuous magmatic intrusion from the fissures, ruling out heat conduction as a major mechanism for dolomitization. By contrast, convective cells in the Turonian and Cenomanian aquiferous formations have the potential to develop at different scales that depend on (a) hydraulic conductivity and porosity of the aquifer, (b) the orientation of the regional flow and (c) the topography of the aquifer. As a result of convective flow, brines surrounding a single fissure intrusion are heated more than 100 °C up to a width of 2 km in both directions. The thermally induced flow velocities are in the range of 2 m/year. In simulations with multiple intrusions, the thermal plume can stretch over 5.5 km. The simulations indicate that magmatic induced advective/convective heating may have generated temperature conditions favorable for dolomitization, which in turn may explain the existence of two different brines that are found around the LT.

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