



## The chemistry of water bodies flowing to and in the Lower Yarmouk Gorge

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Considering their chemical composition, the groundwater flowing to and in the LYG can be subdivided in the following manner:

(1) Groundwater of relatively low  $\text{Cl}^-$  and  $\text{SO}_4^{2-}$  concentrations ( $< 200$  and  $< 55$  mg/l respectively), and high ( $> 1.0$ ) Na/Cl ratio values. The temperature of this water is of the order of 29-46°C. This group includes water flowing through basaltic lithology from Jebel Druze, Hauran Plateau, Mukheibeh wells (including JRV1), Sahina spring (in Hammat Gader Group) Meizar 1 and Meizar 3 (before 2008).

(2) Thermal groundwater (41-73 °C) of higher  $\text{Cl}^-$  and  $\text{SO}_4^{2-}$  concentrations ( $> 200$  mg/l and 100-341 mg/l, respectively with Na/Cl ratio values  $< 1.0$ ). The water included in this group are: Maqla, Balsam and Reah springs (Hammat Gader Group), Meizar 2 and 3 (after 2008) and the springs of Amarat, Himma, Hamamat Mukheibeh, Bisharat and Khalid.

By mapping the distribution of the two main (basaltic and non-basaltic groundwater bodies in the LYG against the structural background, it occurs that the strike-slip fault delineating the eastern margins of the Hammat Gader block acts as a distinct boundary between the basaltic water (Mukheibeh 1-13 and Meizar 3 before 2008) and the non-basaltic groundwater body including the Mukheibeh and Hammat Gader springs and the water of Meizar 1, 2, 3(2008). The deep-rooted faults act as preferential flow paths facilitating upsurge of thermal and pressurized groundwater thus creating a hydraulic barrier for the basaltic waters of Mukheibeh preventing their further westward flow. High average concentrations of sulfate and of the sulfate/anion fraction are recorded in groundwater of certain Meizar wells, Hammat Gader springs, well JRV1 and the springs on the Ajlun side there the Late Triassic (Carnian) Abu Ruweis Formation seems to be the most plausible and (geographically) closest source of high sulfate concentrations in upflowing groundwater. Such beds occur at about 2000 m below surface (Abu-Saad and Andrews, 1993). Maximal water temperatures measured in the area (77°C) coincide with the local temperature gradient. The Yarmouk river water (258-270 mg/l and 0.51 sulfate fraction, respectively) is also enriched in sulfate which cannot be explained by mixing with Hammat Gader or Meizar groundwater.

**Abu-Saad L, Andrews IJ (1993)** A database of stratigraphic information from deep boreholes in Jordan Natural Resources Authority (NRA), Amman