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Processes of mineralization in the Hauran Basin (Syria and Jordan) and in adjoining areas

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Volcanic rocks covering vast areas in central north Jordan and in central and southern Syria erupted during 6 different phases starting in Miocene and continuing - with major interruptions - into the Holocene. The petrological composition of the different flows of the Harrat ash Shaam Basalt complex is quite homogeneous with the major minerals: Plagioclase, K-feldspar, clinopyroxene, amphibole, biotite, olivine, magnetite, limonite, goethite, pyrite and chalcopyrite. The oldest basalts cover Cretaceous and Paleogene sediments, which at that time formed the land surface of drainage basins.

The basaltic aquifer contains groundwater with a wide range of salinities. They represent a continuous sequence of increasingly mineralized groundwater originating from precipitation over Jebel Druz flowing radially into all directions, in coincidence with the topographic slopes. Along the flow-paths halite and gypsum are dissolved. Ca^{2+} not only depends on gypsum dissolution but also increases proportionally to Mg. This may suggest that the combination of Ca^{2+}, Mg^{2+} and sulfate is a saline endmember fluid originating from the underlying carbonate formations of the basalt. Mixing with recharge water could explain the chemical composition of the various types of water. The signature of dissolved gypsum and halite indicates dissolution of evaporites that might have formed by evaporation either before the basalt covered the area or due to the hot basalts heating up the underlying carbonates and their enclosed fluids. Evaporation of water precipitated evaporites. Ca and Mg halides are hygroscopic, thus they are only present in solution. Such saline water, however, has not affected the low saline groundwater because their increase in Ca depends neither on the increase of Mg^{2+} nor of SO_4^{2-}. This leaves the formation of clay minerals as the probably sink for Na.

Inverse modelling applying PHREEQC with phreeq.dat database reveals that the mineralization of groundwater increases due to dissolution of increasing amounts of halite and gypsum which are mass-wise, the most important reactants. Concurrently, albite increasingly precipitates. Montmorillonite, gibbsite and calcite form, whereas kaolinite is consumed. Sulfides are oxidized. δD and δ^{18}O of well and springs fit an evaporation line rooted on the Ajloun MWL.

Hydrochemically, there are two sources of salts: Mixing with a saline endmember brine and/or dissolution of evaporites. Near Jebel Druz, dissolution of evaporites dominates, whereas mixing with a saline endmember and formation of clay minerals occur at greater distances.