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Water-rock interaction in the Granada Basin (southern Spain): A regional study to understand groundwater flow in sedimentary basins

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Understanding groundwater flow at sedimentary basin scale plays a crucial role into the prevention of environmental issues (e.g., groundwater contamination, land aridification). However assessing and constraining groundwater circulation in sedimentary basins remain a challenge in geosciences because of, among other factors, the different water origins and the multi-scale heterogeneity of the system. The Granada Basin (southern Spain), which is a Neogene intra mountainous basin within the Betic Cordillera, has been selected as a regional study case for characterizing present-day water circulations and their interactions with the sedimentary system using water geochemistry. The basin is currently a semi-arid area with low precipitations, where the groundwater recharge is mainly localized in the mountains surrounding the basin.

In the present study, the physicochemical characterization (temperature, pH, conductivity, alkalinity) and chemical composition (major and minor elements) of thirty water samples from springs and wells of the Granada Basin have been investigated to apprehend the water composition evolution. Water samples have been selected in order to get relatively large ranges of conductivity and temperature, both from freshwaters to brines and from cold to thermal. Assuming cogenetic waters, the composition of water samples evolves from carbonate-dominated waters at the basin border to sulfate- and chlorine- dominated waters in the basin center.

A direct thermodynamic modeling approach of this multi-component system has been performed in order to deepen the description of the water geochemistry and identify potential reaction paths. The preliminary results point out that (1) waters are mainly saturated with respect to calcite and dolomite buffering the pH of waters; (2) there is a reaction path from the border to the center of the basin with progressive water saturation with respect to sulfate minerals (barite first, then celestite and finally gypsum); (3) saturation with respect to halite is not reached; and (4) there are reaction paths involving clays, feldspar and quartz. The study of reactivity, especially with sulfate minerals, enables us to trace circulation within the Granada Basin that is in good agreement with current hydrological information (e.g., piezometric maps). Therefore, our study shows that reaction paths defined from thermodynamic modeling approach could be a powerful low-cost tool to enhance the understanding of groundwater flow at the sedimentary basin scale.