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Tracing the origin of nitrate accumulation in a deep groundwater reservoir in the Sahara desert using mass dependent and non-mass-dependent isotopic signatures

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Accumulation of nitrate in groundwater is a well known problem and mostly due to anthropogenic activities. However, in desert regions far from any anthropogenic pollution the accumulation of nitrate in groundwaters has to be related to other processes. In the present study an integrative hydrogeochemical and isotopic approach is used to identify the origin of nitrate in the Hasouna basin. The Jabal Hasouna wellfields are located in Libyan desert about 700 kilometers south of Tripoli. In the groundwater samples aqueous major and trace elements as well as traditional and non-traditional environmental isotopes were analyzed.

Stable hydrogen and oxygen isotopic composition of the groundwater indicate that the ancient groundwater was recharged under cooler and more humid climate conditions. Nitrogen (δ^{15}N) and oxygen isotopes (δ^{17}O, δ^{18}O) of dissolved nitrate as well as sulphur (δ^{34}S) and oxygen (δ^{18}O) isotopes in sulphate were measured to identify nitrate and sulphate sources and accumulation mechanisms. Our results indicate that nitrate in groundwater of the study area is of natural origin**.** Moreover, all investigated samples yield positive Δ^{17}O values of nitrate, which clearly indicate that every groundwater contains an individual degree of atmospheric nitrate within dissolved nitrate. Δ^{17}O values are strongly correlated with nitrate concentration, whereas the trend for δ^{18}O is less diagnostic. A similar but more ambiguous trend can be also found for δ^{18}O of sulphate.

Our investigations indicate that Δ^{17}O signatures of nitrate can be applied as a powerful tool to trace the origin and fate of nitrate in deep groundwater reservoirs. Involving Δ^{17}O signatures in groundwater studies may provide enhanced understanding of ancient and recent recharge conditions in arid areas.