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Hydrochemical and isotopic characterisation of deep groundwater reservoirs in the Sahara desert

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Large sedimentary basins are extended over hundreds of square kilometres cross the Libyan Sahara. These basins consist of several aquifer systems, which belong to various geological ages. Most common are Quaternary, Mesozoic and Palaeozoic aquifers. The Jabal Hasouna well fields are located about 700 km south of Tripoli and are part of the Great Man-Made River Project for water supply to the coastal areas. The well field area extends over 4000 km^2 with 440 production and 44 standby wells. In this region the main Cambro-Ordovician Sandstone aquifer is overlain by a shallow carbonate aquifer with a basal aquitard, predominantly composed of marly limestone, clay and shale.

Hydrochemical investigations involving collection and analysis of numerous deep groundwater samples from Hasouna well fields have been carried out to evaluate the regional groundwater quality and origin. Therefore, the groundwater samples were analyzed for major ions, trace elements, and environmental isotopes. Additionally, soil and rock samples were collected and characterized using XRD and XRF for mineralogical and chemical composition, respectively.

The groundwater can be classified in Na-Ca-Cl-SO_4, Na-Ca-Cl-SO_4-HCO_3, Ca-Na-Cl-SO_4-HCO_3 and Na-Ca-Mg-Cl-SO_4 types with moderate to high salinity. Most solutions indicate elevated ion concentrations of chloride, sodium, sulphate and nitrate. In some parts of the investigation area the respective ion concentrations in the groundwater exceed the WHO quality limits.

Stable hydrogen and oxygen isotopic composition of the H_2O show that the groundwater composition typically falls below the Global Meteoric Water Line and are far away from the Mediterranean Meteoric Water Line. Accordingly, the groundwaters were recharged in a climate different from that of the recent Mediterranean. The relationship between stable hydrogen and oxygen isotope ratios indicate that the ancient groundwater was recharged under cooler climate conditions. In order to verify the source of dissolved nitrate and sulphate, selected samples were analysed for nitrogen ($\delta^{15}N$) and oxygen isotopes ($\delta^{17}O$, $\delta^{18}O$) and sulphur ($\delta^{34}S$) and oxygen ($\delta^{18}O$) isotopes in NO_3^- and SO_4^{2-}, respectively.