**Isotopic and hydrochemical investigation of the karstified carbonate aquifer of the Massif of Zaghouan (Northeastern Tunisia)**

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In spite of the fact that a large portion of the Tunisian landscape is composed of limestone or dolomite, there are only few karstified ranges. In most cases, the carbonates are relatively thin except in the northwestern part of the country as for Serdj or Bargou moutains that have been extensively explored and contains the country’s largest cave networks. The massif of Zaghouan, located northeastern Tunisia at the end of the Atlas range, is one of these specific geologic features, it lodges a large aquifer, known as the best quality water resources of the region. This aquifer is naturally discharging by several karst springs and galleries that supply drinking water for the local cities and for the capital since the Roman Times through an aqueduct. Nowadays, the Zaghouan groundwater is also exploited by means of wells which tap the carbonate aquifer. The natural quality of groundwater complies with the provisions of the Regulation on health and safety of drinking water. However, anthropogenic impacts in the form of nitrate pollution have been observed. Hydrogeological investigations have been conducted in order to identify the recharge areas of the groundwater source with the aim of ensuring additional quantities of drinking water and protection of the source from pollution.

Data from 36 water samples collected from springs, wells, galleries and dam lakes have been analyzed for various parameters such as pH, electrical conductivity, total dissolved salts, major ions, stable and radiogenic isotopes (18O, D and 3H) after standard procedures. Statistical and geochemical modeling were performed to understand the processes controlling groundwater geochemistry. The chemical quality of groundwater is related to the dissolution of minerals, ion exchange, and the residence time of the groundwater in contact with rock materials. Indeed, according to their dominance, major ions indicate that groundwater have mainly calcium-bicarbonate or bicarbonate facies in result of natural rainwater recharge and water-soil/rock interaction. The results of calculation saturation index by computer program DIAGRAM shows that nearly all of the water samples were saturated with respect to carbonate minerals (calcite, dolomite and aragonite) and undersaturated with respect to sulfate minerals (gypsum and anhydrite). On the other hand, some spring waters are contaminated by high nitrate contents exceeding drinking water standards (> 50 mg.l-1, WHO 2014).

The stable isotope signature of Zaghouan groundwaters and its close relationship with springs altitude indicates that groundwaters are mainly derived from local meteoric water that has undergone rapid infiltration through the aquifers fracturing network. This fact is also highlighted by the quick response of the springs discharge to rainfall events. Tritium contents of groundwater are of the same range of those measured for the dam lakes considered representative of local precipitation due to their short renewable rate. As proven by geochemical and isotopic tracers, the hydrodynamic of the aquifer is highly dependent from the geological and structural settings and characterized by very fast circulation which is an evidence of the vulnerability of the aquifers to climate changes as well as to anthropogenic activities.

**Keywords**: carbonate aquifer, karst springs, major ions, stable isotopes, tritium, nitrate