THE HYDROGEOCHEMICAL CHARACTERIZATION OF AIN DJACER AQUIFER, NORTH-EASTERN ALGERIA.

Abderrahmane BOUDOUKHA[1], Dalila ZIANI[2]

[1]Laboratory of Applied Research in Hydraulics, Hadj Lakhdar University of Batna. 05000 Batna. Algeria. E-mail: boudoukha_abderrahmane@yahoo.fr Tel/Fax: +213 33 86 97 24
[2] Laboratory of Applied Research in Hydraulics, Hadj Lakhdar University of Batna. 05000 Batna. Algeria. E-mail: dalila_ziani@yahoo.fr Tel/Fax: +213 33 86 97 24

Abstract

Introduction

In north-east Algeria, the agricultural plain of Ain Djacer (35.9°N 6.3°E) is irrigated from the surficial aquifer, comprises fluvial sediments of the Miocene-Pliocene-Quaternary age. During the last decade or so, the region has known a rough drought and many surficial water sources dried out (Ziani 2009). The drought resulted an increasing dependence on groundwater sources, and over-exploitation of the aquifer (Bencer 2005); in turn, groundwater levels have dropped by 1 to 2 m.year^{-1} (Ziani 2009) and a progressive deterioration of the water quality in the irrigated area with the appearance of areas of high salinity (TDS> 2 g / l) which create problems of water use. (Ziani 2009). This phenomenon has been observed in various regions of the country. (Khedidja and Boudoukha 2014).

In light of these trends, there is an urgent need to better understand the inter-connectivity of the surficial aquifer with underlying (salty) formations and to constrain the exploitation of this water resource. This study provides a detailed geochemical characterization using chemical data from 21 groundwater samples, taken from the superficial aquifer. This typological analysis was done using various molar ratios of chemical elements and statistical tool to replenish hydrochemical process thereto.

Materials and method

The Ain Djacer basin, with a surface of 210 km², is part of the high plains of north-eastern Algeria (Fig. 1). It shows relatively flat surface with slight slope and an average altitude of 850 m and is surrounded by outcropping Cretaceous limestone reliefs that culminate at 1230 m. The region's climate is a semi-arid type, characterized by an average yearly rainfall is around 260 mm while the average yearly temperature is 13 °C. (Mebarki 2009). The Ain Djacer plain, consisting of Miocene-Pliocene-Quaternary fluvial sediments, is surrounded by Jurassic, Cretaceous limestone and Triassic evaporates formation (Vila 1980).

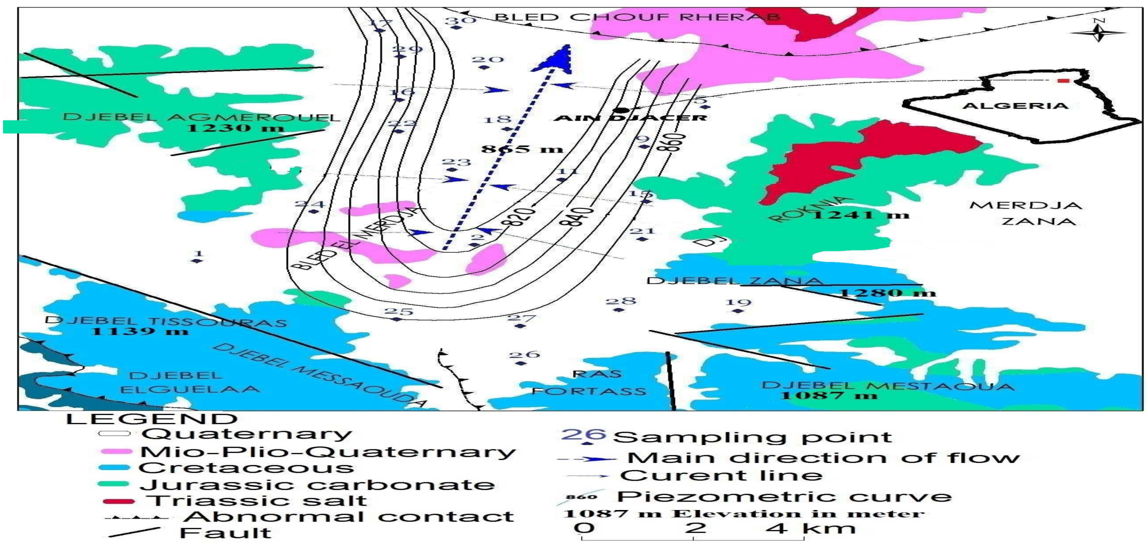

Figure 1 Situation and geology of the Ain Djacer region

The analysis of the stratigraphy of the region found that there is major a superficial aquifer located in the Miocene-Pliocene-Quaternary alluvial formations. The substratum of this aquifer is formed by clays and marls sometimes gypsum. This aquifer is exploited with an average drilling depth (100-150 m) and whose waters are used for irrigation. Since 1997, the water table is characterised by the presence of two parts: the western part characterized by west-east flow and the eastern part with an east-west flow. These two flows converge towards the center of the plain and are drained by Oued Boughezel in the north. Fig.1.

The chemical data (21 water samples) were subjected by statistical analyses using Ascendant Hierarchical Classification (A.H.C.). This technique is to classify the Ain Djacer water samples into distinct hydrochemical groups relative to the geological context. In addition, the correlation between salinity and the different chemical elements was analysed to help determine the salinity acquisition mechanism. The study was completed by examining the characteristic ratios and the saturation index (SI) of some evaporate and carbonates minerals.

Results and discussion

Examination of the average molar concentrations of different elements, shows that the salinity changes from a less salty group in the West (TDS <1000 mg / l), to a second group of average salinity (1000 <TDS <2000 mg / l) in the center, and a group of high salinity (TDS > 2000 mg / l) in the east. The cations evolve as follow: $Na^+ > Ca^{2+} > Mg^{2+} > K^+$ while the anions move to the following manner: $Cl^- > SO_4^{2-} > HCO_3^-$ which results in facies dominated by Na^+ and Cl^- in the majority of cases. The maximum concentration of NO_3^- is 125 mg/l in some places. This is in liaison with the use of fertilizers (chemical and/or organic) and the decomposition of organic matter, as has been reported in other recent studies. (Khedidja and Boudoukha 2014).

The result of such cluster analysis showed that the waters of the region are controlled by salinity and can be classified into three groups of increasing salinity: group 1 <group 2 <group 3. The use of chemical parameters has allowed refining the boundaries between the three groups, respecting the geographical distribution of these. The salinity of these three groups can have two origins, either carbonated or saliferous. To demonstrate this phenomenon we have established a diagram in which these elements are represented: $Ca^{2+} + Mg^{2+} / Na^+ + Cl^- + SO_4^{2-}$ vs TDS. The evolution of the groundwater chemistry depends on the water-rock interaction, depending largely on the chemistry of the water charging, of the matrix in which the water is stored, and the water residence time groundwater in the aquifer. The calculation of saturation indices of carbonate minerals shows that the solution is saturated which allows them to precipitate. Along the groundwater flow, exchange basic phenomena Ca/Na in clays, carbonate precipitation, the presence of gypsiferous Triassic terrigenous saline formations allow water to acquire a facies sulfated chlorinated sodium.

Conclusion

The application of hydrochemical and statistical tools in the groundwater study of the Ain Djacer shallow aquifer meant that its functioning could be clarified. The infiltration of rain water into the karstic aquifers on the edges where the waters acquire their original mineralisation (carbonate), mineralise further with chlorides, sodium and sulphates in contact with terrigenous saliferous formations and by basic exchange with the clays of the Miocene-Pliocene-Quaternary age. The chemical analyse shows that the groundwater samples are HCO_3-Ca type on the limits and shift to chlorinated sodium to sulphated sodium in the centre and Eastern. The salinization of the waters seems mainly due to dissolution of gypsum, halite, epsomite and weathering of silicate. This is in accordance with the under-saturation state for all groundwater samples.