



Hydro-geophysical and geochemical investigation of shallow and deep Neogene aquifer systems in Hajeb Layoun-Jilma-Ouled Asker area, Central Tunisia



Dalila Jellalia^{a,b,*}, Fethi Lachaal^a, Mouna Andoulsi^a, Taher Zouaghi^c, Monji Hamdi^b, Mourad Bedir^a

^a Georesources Laboratory, Water Research and Technology Center, Borj Cedria Ecopark, PO Box 273, Soliman 8020, Tunisia

^b General Direction of Water Resources, Ministry of Agriculture in Tunisia (DGRE), 43, rue Saïda El-Manoubia, Monfleury, 1008 Tunis, Tunisia

^c Faculty of Earth Sciences, King Abdulaziz University (KAU), P.O. Box 80206, Jeddah 21589, Saudi Arabia

ARTICLE INFO

Article history:

Received 8 January 2015
Received in revised form 22 June 2015
Accepted 24 June 2015
Available online 30 June 2015

Keywords:

Hydrogeology
Geophysics
Structuring
Geochemical
Aquifer
Central Tunisia

ABSTRACT

In the Hajeb Layoun-Jilma-Ouled Asker area (Central Tunisia), deep groundwater continues to be an increasingly important resource. In fact, the Neogene sandy, sandstone and clay deposits have important aquiferous potentialities, but their hydrogeologic properties are still unknown, due to their geological complexities and the lack of deep wells investigations. The aim of the following study is to integrate geological, geophysical and hydrogeological data in order to evaluate and characterize the complex Neogene aquifer system of the Hajeb Layoun-Jilma-Ouled Asker basin. Seismic-reflection and wireline logging of petroleum and water wells are used to understand the structuring and the characterization of the Neogene reservoirs. The study of isochron and isobath maps show folded structures and subsiding areas, delimited from West to East by major faults. The establishment of the piezometric maps and the correlation of hydraulic wells allowed us to recognize the hydrological processes in this aquifer system. Hydrodynamics of the shallow aquifer are controlled by geological structures; two independent compartments were identified: A general flow from West to East in the Hajeb Layoun region, a SW–NE flow direction exists in the southern part of the Hajeb Layoun basin. The recharge of the groundwater is in the piedmont of the Mghilla and the Labaeid outcrops as well as in the center of the plain. In the Ouled Asker sub-basin, flow direction is from West to East and becomes from NW to SE between the Sbeitla river and the Jebel Zaouia. In the southern part of the Sbeitla river, flow direction is from West to East. The geochemical analysis of well water samples highlights the distribution of hydrochemical facies of each aquifer. The shallow waters in this area can be identified by two main geochemical facies: Na–Ca–Mg–(SO₄), and Na–(Ca)–Mg–Cl–(SO₄)–HCO₃ mixed type. However, the deep waters are characterized by three main facies: Na–(Ca)–Mg–Cl–(SO₄)–HCO₃ mixed type, Na–Ca–Mg–Cl and Ca–SO₄.

© 2015 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	228
2. Geographical and geological setting	228
3. Materials and methods	228
4. Results and discussion	229
4.1. Structural context	229
4.2. Characterization of the Hajeb Layoun-Jilma-Ouled Asker aquifer systems	231
4.2.1. Langhian aquifer	231
4.2.2. Serravallian aquifer	234
4.3. Hydrodynamics of the shallow and the deep aquifers in the Hajeb Layoun-Jilma-Ouled Asker basins	235
4.4. Hydrochemistry	238
4.4.1. In situ measurements interpretation	238

* Corresponding author at: Georesources Laboratory, Water Research and Technology Center, Borj Cedria Ecopark, PO Box 273, Soliman 8020, Tunisia.

E-mail address: jellali.dalila.dgre@gmail.com (D. Jellalia).

4.4.2. Hydrochemical facies	238
4.4.3. Natural processes of mineralization	240
5. Conclusions and perspectives	243
References	243

1. Introduction

The hydrogeological investigations of aquifer systems and the characterization of groundwater resources are necessary to supply water demand in the arid and semi arid regions. In fact, the water resources are limited and formed essentially by groundwater resources. For the complex aquifer system and in the case of a lack of groundwater data, the hydrogeological investigation needs all available data and the use of different investigation techniques, especially, geological, geophysical, piezometric and hydrochemical methods (Larroque and Dupuy, 2004; Kamel et al., 2005; Moral et al., 2008; Ayenew et al., 2008; Mjemah et al., 2009; Lachaal et al., 2010, 2011, 2012a, 2012b; Khazri and Gabtni, 2014).

In Tunisia, water resources were evaluated in 2000 to 4825 Mm³, with 2700 Mm³ of surface water and 2125 Mm³ of groundwater. Throughout the country, the mean rainfall is approximately 230 mm/year. It varies in time and space from less than 100 mm in the extreme south to 1500 in the extreme north-west (DGRE, 2005).

In this study, we will endeavor to treat the case of the Neogene aquifer system located in the Hajeb Layoun-Jilma-Ouled Asker (HLJOA) basin (Central Tunisia). It forms a relatively narrow pan, elongated in a NE–SW direction and filled by Neogene and Quaternary deposits. This basin is characterized by an arid to a semi-arid climate with very low and irregular rainfall (annual average about 300 mm/year), a contrast in temperature between a hot and a dry summer and a cold winter with an average of 19 °C and high evaporation of about 2137 mm/year (INM, 2005). The Neogene aquifer system is a potential target for agriculture, irrigation and domestic drinking water supply. In this adverse weather, groundwater is subject to intensive exploitations in order to support the increase in irrigation and population's domestic use. An intensification of investigations throughout the basin, including indirect methods such as geophysical methods, becomes necessary to define the productive deep levels and the areas that are not yet identified.

The objective of this study is to identify and characterize the Neogene reservoirs in the HLJOA basin. In addition to the shallow aquifer that is logged in the Plio-Quaternary deposit, other deep reservoirs are target in this study. These aquifers are contained in the Miocene series; they can represent new groundwater resources which can be exploited through the water demand supply for the region. In this work, we will use an integrated approach that combines geophysical, hydraulic and hydrochemical investigations.

2. Geographical and geological setting

The study area is located in Central Tunisia between Kairouan and Sidi Bouzid regions. It covers the Hajeb Layoun, Jilma and Ouled Asker plains. It is bounded to the north by Jebel Labaaid, to the north-east by Jebels Zaouia-Roua, to the south and the south-east by Jebels Hamra, Lessouada and Koumine and to the west by Jebel Mghilla (Fig. 1). Geological outcrops in the study area are formed by Triassic to Quaternary deposits with the absence of Jurassic deposits (Koschell, 1980; Zouari, 1998; Ayadi, 2002; Zouaghi, 2008; Jellali, 2010).

According to the synthetic log in Jebel Labaaid (Fig. 2), Neogene series are formed of:

– Lower Burdigalian-Aquitainian (The Messioua Formation)

In Jebel Zaouia, the Messioua Formation contains red silts and sandy clays, with gypsum. It presents variable thickness from 50 m at the SSW to 10 m at NNE. The top of the deposit is represented by a ferruginous and hardened surface.

– Upper Burdigalian (The Grijima Formation)

The Grijima Formation is flushed in several locations in Central Tunisia. It is intercalated between the red facies of the Messioua Formation and the series formed by clays, limestones and sandstones of the Oued Hmam and the Ain Ghrab Formations. In Jebel Mghilla, the Grijima Formation is represented by an important fluvial series with coarse sandstones. In Jebel Labaaid, the thickness of the Formation ranges from 15 to 20 m. It presents a lenticular sandstone facies. The top of the Formation is materialized by a ferruginous and hardened surface (Ben Jemiaa, 1986).

– Lower Miocene which is materialized by the Ain Ghrab Formation (Upper Langhian) is composed of a sandstone bar along with the presence of a significant carbonate fraction, hence forming an excellent seismic marker in Central Tunisia (Bédir, 1989; Bédir et al., 1996; Ben Ismail-Latrache, 1981; Blondel, 1991; El Ghali and Rabhi, 1990). The Mahmoud Formation (Langhian) is a continuous strata represented by a fossiliferous green clay at the base, usually azoic and sandy at the top (Ben Jemiaa, 1986), showing a greater thickness (65 m) on the southern flank of Jebel Labaaid.

– Middle Miocene is represented by the Beglia Formation, composed by massive and white sandstones, with bedded dragees of quartz and oblique stratifications alternating with shale.

– Upper Miocene, represented by the Saouef Formation (Serravallian-Late Tortonian), is comprised of clay and sandy clay series with some intercalated sandstones.

The Segui Formation, attributed to the Mio-Plio-Quaternary stratigraphic series, is unconformably set on the deposits of the Saouef Formation. It is composed of conglomerates at the base, which is overlain by sandy clays, alternating with sandy layers and becoming sandy at the top (Mannaï-Tayech, 2009). In the Hajeb Layoun-Jilma region, groundwater is related to thick and continuous quaternary deposits. In the rest of the basin, we find perched and discontinuous aquifers related to the interbedded sandstones in the Saouef Formation clays. Groundwater is in hydraulic communication with the underlying aquifers of the Middle and Upper Miocene.

3. Materials and methods

The study of groundwater resources requires all available data. Numerous data from many sources and different types were collected in this study. These data were obtained both by leading field campaigns and by collecting archival data from several water and petroleum companies.

The geophysical data used in this study were provided by la Société Tunisienne des Activités Pétrolières (ETAP). The seismic acquisition was carried out by la Campagne Générale de Géophysique (CGG) for Union Texas Tunisia in the Kasserine region

Download English Version:

<https://daneshyari.com/en/article/4728600>

Download Persian Version:

<https://daneshyari.com/article/4728600>

[Daneshyari.com](https://daneshyari.com)