



Use of mechanical drill data and vertical electrical soundings for the identification of aquifer geometry of lower Maestrichian limestones M'Daourouch-Drea plain Wilaya of Souk-Ahras NE Algerian

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Abstract

This paper was made in the region of M'daourouch-Dréa which is part of the high plains of northeastern Algeria, located southwest of the Souk-ahras Wilaya in eastern Algeria. It is a plain with agricultural vocation which requires for its development more water. Knowing that the rainfall is low (465mm/year) and not enough to meet the needs of farmers, the use of groundwater then becomes the only alternative to fill this lack of resources. Among the aquifers identified in this region is that contained in fissured limestones of lower Maestrichian age. In order to satisfy farmers and citizens in water it is necessary to have a good characterization of this aquifer. The objective of this paper is to improve the knowledge on the morphology and the extension of this aquifer and to locate its roof in space to help operators choose areas favorable to exploitation, so direct them to the nearest areas of the surface thus minimizing the cost of the drilling operation. To achieve this goal, we have exploited by exploiting several tools (geological map, logs of boreholes and geophysics survey), whose combination gave an idea on the geometry of the aquifer as well as the depth of its roof in different regions of the plain and shows by the occasion, the affectation of these limestones by several tectonic accidents generating thus a structure in collapsed blocks from where the very variable depth of the roof of these limestones of a place of the plain to other.

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Introduction

The hydrogeology of the arid and semi-arid zones of Algeria, is a complex theme to apprehend it, it is necessary to make a good identification of the geological context to determine the geometry and the extension of the geological formations likely to be a potential aquifer.

The combination of tools: geological, data from mechanical surveys and geophysics gives interesting results, concerning the understanding of the extension of the Maestrichian age limestone aquifer. The region concerned by this study is the M'daourouch-Dréa plain which is located in the territories of the Souk-Ahras wilaya in the far north-east of Algeria (Fig. N° 1). It is 140km south-east of the city of Annaba and 200 km from Constantine. This plain is made up of a filling of the syncline of Montesquieu, it covers an area of 96Km² and is characterized by a semi-arid climate with an average annual temperature of about 14.3°C. This plain is largely oriented towards agriculture; rainfall is low and does not exceed 465 mm/year, so most of the water resource exploited for irrigation comes from groundwater. In addition, this plain has been the subject of several studies (Rezaiguia T. 1999, Mahamat SM, Sadick HA 2016) whose main objective was the hydrogeological potentialities of the detrital aquifer constituting the filling of the folded and collapsed zones in the region. This paper brings a plus by treating the extension of the maestrichian limestone aquifer constituting the bedrock of the aquifer indicated above as well as the depth of its roof whose knowledge remains the only alternative for a good exploitation and a better management of this resource.

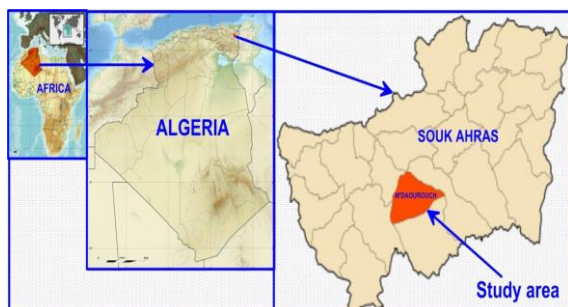


Fig. 1. Location of M'Daourouch-Drea plain

Materials and methods

The study of the geometry of the aquifer represents the first step in hydrogeological investigations. It requires the combination of several tools that complement each other and participate in the development of a synthetic image that schematizes the nature and lithological disposition of the formations studied. It also makes it possible to identify the accidents affecting these formations.

Geological context

The geological studies carried out on the region by different authors (Villa, 1981) helped us to identify the lithology of the Maestrichian aquifer in addition to the logs of several mechanical soundings that were made in the plain of M'Daourouch-Drea in the to meet the needs of the region for drinking water and irrigation. Data from these logs were used to develop a litho-stratigraphic correlation to show the geometry and extent of aquiferous limestones under the more recent detrital cover.

The Ahras souk sector is in a transition zone between the Tell Atlas and the Saharan Atlas. The M'Daourouch area belongs to the southern mountains of Souk Ahras. It lies between two large wadis: Oued Medjarda in the North and Oued Mellegue in the South and is part of the high plains of North-East Algeria, located southwest of the wilaya of Souk-Ahras. The orography consists of a mountainous system of the Saharan atlas.

The observation of the geological map extracted from the M'Daourouch N° 100 geological map at a scale of 1: 50,000 (Fig. N° 2) shows that the series of formations outcropping in the M'Daourouch region is more or less continuous, from the Triassic, being the oldest formation, in the Quaternary, the most recent terrains of the stratigraphic scale.

Extract from the geological map of M'Daourouch 1/50 000

The synthesis of litho-stratigraphic interpretation is illustrated from top to bottom in Table No. 1:

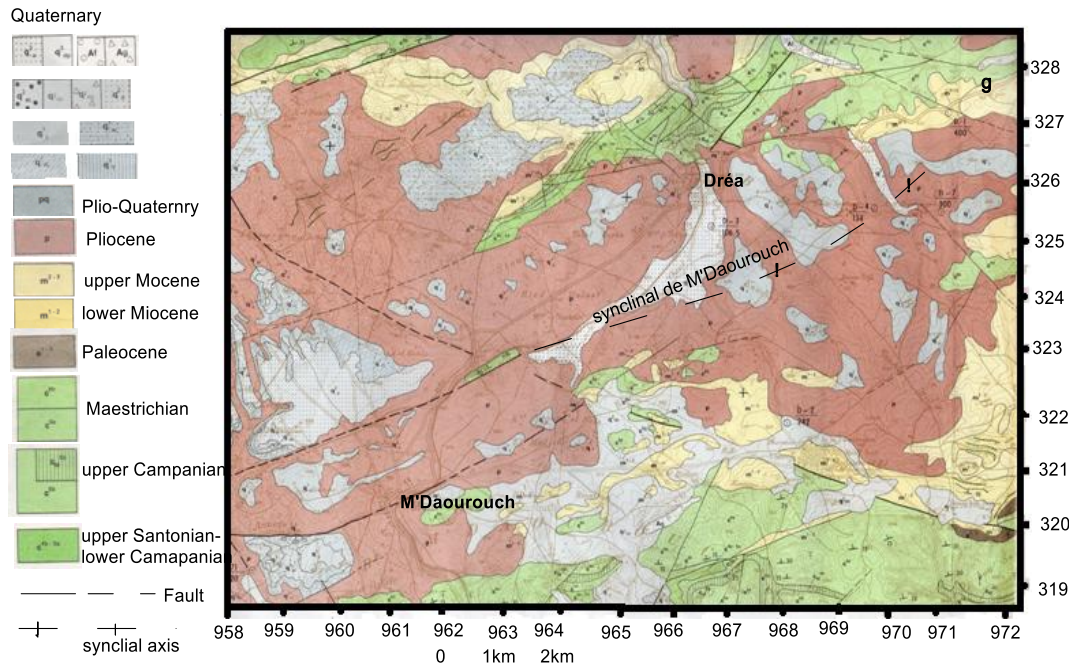


Fig. 2. Geological map of the studied area

Table 1. Synthesis of the lithostratigraphy of the M'Daourouche sector.

Age	Dominant lithology
Quaternary	Alluvium, terrace
Continental Mio-Pliocene	Red clay, sands and agglomerates
Upper Miocene	Clay and sandy clay
Lower Miocene	Sandy clay, clay and lake limestones
Oligocene	Red clay and sandy clay
Medium Eocene	Marl and limestone
Lower Eocene	Marl and limestone
Upper Cretaceous	Limestone and marl
Medium and lower Cretaceous	Marl and marly limestone
Trias	Marl, gypsum, limestone and dolomite

Géophysical context

In addition, the geophysical tool (ALGEO, 1982) was used to show the morphology of these aquiferous limestones of the Lower Maestrichian. To achieve this goal we have stripped the work of geophysical prospecting by vertical electrical sounding using the Schlumberger device and combined by other similar private studies in the area. Subsequently a correlation was made between geology and geophysics in order to establish a scale of electrical resistivities based on standard surveys carried out in the plain.

Results and discussion

The correlation test between boreholes D1, D4, D6 and MD2 (Fig. 3), is illustrated in Fig. N° 4, shows

that the limestones of the lower Maestrichian (aquifer) have been subjected to a very important brittle tectonic, generating a dense fault network, which explains the difference in the depth of these limestones, from one drill to another where they sometimes reach significant depths, which are probably accentuated by the subsidence of the faulted basin under the effect of the weight detrital sediments of the filling overcome them.

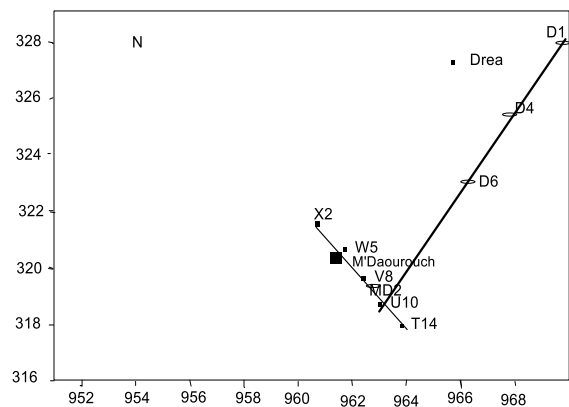


Fig. 3. Situation of the litho-stratigraphic correlation and the geo-electric section.

Moreover, the geophysical study exploited allowed us, first of all, to identify the averages of the resistivity values of the different geological formations of the region of study table N° 2.

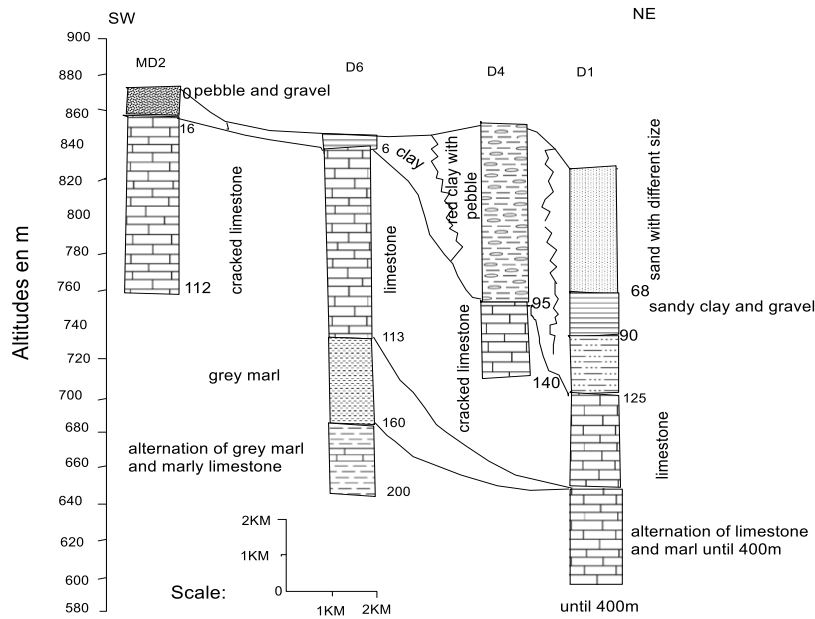


Fig. 4. Litho-stratigraphic correlation at the level of the plain from M'Daourouch-Drea

Table 2. lithology-resistivity correlation of the studied plain formations.

Formations	Âge	Adopted Résistivity en Ohm.m
Crust limestone and lacustrine limestones	Quaternary	170-610
Clays, marls, sand and sandstone	Mio-Pliocene	2-30
Sand and sandstone, Quartz and conglomerates		33-70
		79-140
Compact limestone	Lower Maestrichian	40-680

Then, it highlights the resistant zones corresponding to the Maestrichian limestones with inocera, gray-light, compact discharging into large platelets in which centimetric levels of marls, clay limestones and greenish clay marl are interspersed representing the interesting aquifer. The interpretation of the geo-electric section is N° 5, shows that the limestones are at varying depths due to a large fault network.

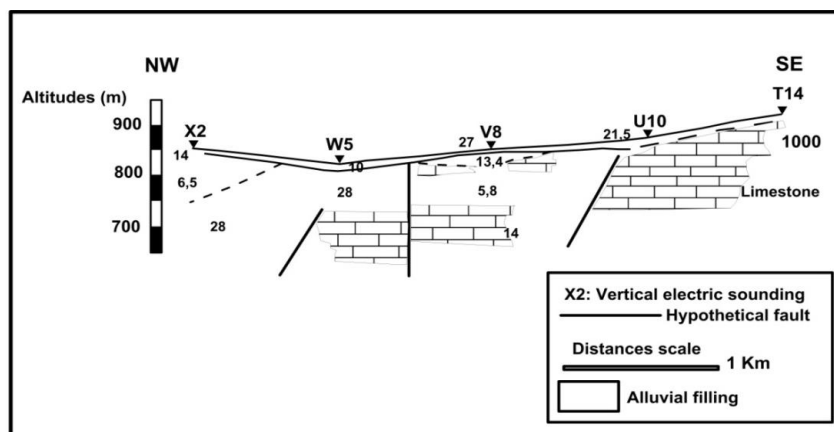


Fig. 5. Geo-electric section across the plain of M'daourouch-Drea

Based on the scale of resistivities, mechanical drilling data and electrical prospecting studies we have mapped the karstified and cracked limestones of the lower Maestrichian (Fig. 6), in the western part of the plain, the investigation has been extended beyond the limit of the geological map. The interpretation of this map shows:

- An area NW of the city of M'Daourouch in which these limestones reach a significant depth exceeding 200 m of a synformal morphology oriented slightly SW-NE following the orientation of the M'Daourouch syncline.

• East of the city of M'Daourouch and south of the town of Drea there is a collapse area of less importance than that described above but of a similar depth.

This limestone structure is interpreted by the differential collapse of the limestone blocks resulting from the brittle deformation represented by a large fault network that affected the area.

Hydrogeologically favorable areas for the implantation of water drilling exploiting the limestones are in white and light gray, located east of the city of M'Daourouch in the southern part of the study area and at the west of Drea in the northern part of the plain.

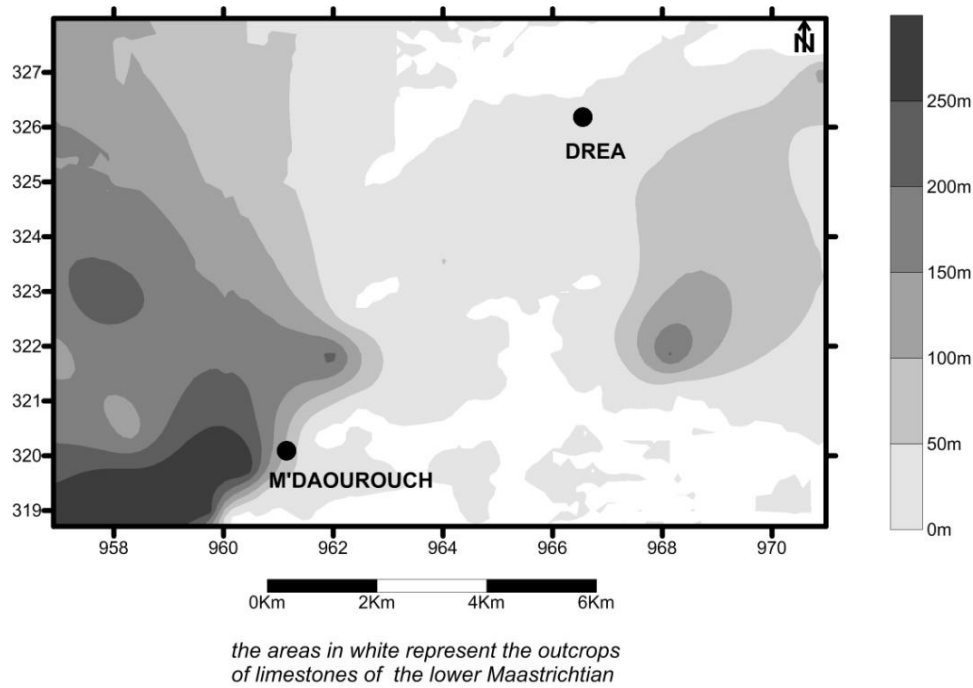


Fig. 6. Map of equal depth of limestones in the plain of M'Daourouch-Drea in black curves.

Conclusion

The combination of geology and geophysics applied to the Lower Maastrichtian limestone aquifer of the M'Daourouch-Drea plain has allowed the identification of the geometry of the formations studied, and highlights a faulted structure. The interpretation of the geo-electric sections as well as the map of equal depth of the limestones, from this study, shows a tiered limestone aquifer, which explains the depth of its roof which differs from a place in the plain to a other, the maximum depth reaches the value of about 200 m recorded in the South West sector of the study area. In addition, these limestones subsided under the influence of the detrital sediments of Tertiary age.

The combination of several tools allowed us to delineate the most favorable locations for the realization of water drilling reaching the fissured limestone aquifer at a lower cost.

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