

# Origin of the salinity in the groundwater of the El Attaf alluvial aquifer

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## Abstract

The choice of this research theme was guided by the desire to better understand environmental issues, namely salinity and its origin, through the use of geophysical data from various surveys carried out between 1969 (CGG) and 2002 (IFES), to highlight the impact of the geological and structural upheavals that occurred during the earthquake of October 10, 1980, on the hydrodynamic processes. The interpretation of the resistivity data revealed that water salinity is highly variable and generally high near Jebel Temoulga. Chemical analyzes of all wells in the region confirm this. The hydrochemical study has shown the influence of local geology on the chemistry of the waters of the neighboring aquifer, and raises the question of the importance of gypso-saliferous facies in the region of El Attaf. The multifunctional statistical analysis revealed two chemical profiles within the same aquifer, but it should be noted that the highest concentrations were recorded on the Hay Bel Abbes - Bir Saf Saf axis.

**Keywords:** El attaf, geophysics, hydrochemistry, salinity, Triassic, Aquifer.

## 1. Introduction

In the Cheliff plain and particularly in the El Attaf sector which is the subject of this study, the salinity of the waters is a real concern, which adds to the aridity of the climate, with a drought persistent over the last three decades. The present work makes it possible to visualize the extent of this mineralization and to determine its origin, as well as its extension.

## 2. Methods

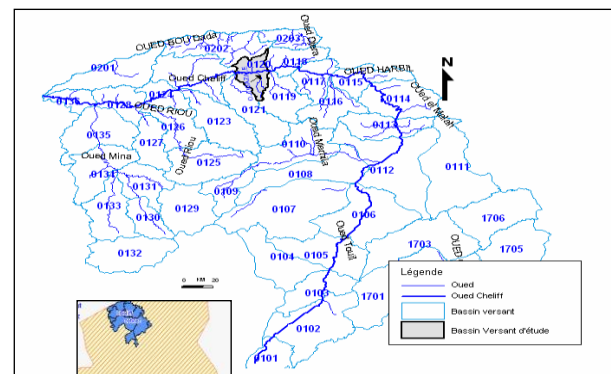
The study area, located in the middle Cheliff depression (Figure 1), in the wilaya of Ain Defla, 173km west of Algiers. Low rainfall, high evaporation, and temperature allow the study area to be assigned to the semi-arid area.

### 2.1 Geological, Geophysical and tectonic contexts

The significant seismic activity, known in the region, shows an unstable domain and active compatible with the present deformation and the recent tectonic relationship, "seismicity". To carry out our work, The

purpose of our study is to calibrate the data of the two electric prospecting campaigns; the analysis of logs concerning 08 boreholes was carried out.

**Figure 1.** Situation map of the study area.



We used the results from two successive electrical prospecting campaigns carried out successively by General Company of Geophysics just before the earthquake of 1969 and Icosium Forages Engineering Services (IFES) in 2002 after earthquake 1980. Based on the apparent resistivity maps made by CGG and IFES we note that there was a considerable increase in apparent resistivity values between 1969 and 2002 due to an invasion of alluvial water by mineralized limestone aquifers after replay during the 1980 Earthquake of the NW-SE faille affecting the Jebel Temoulga in its eastern part.

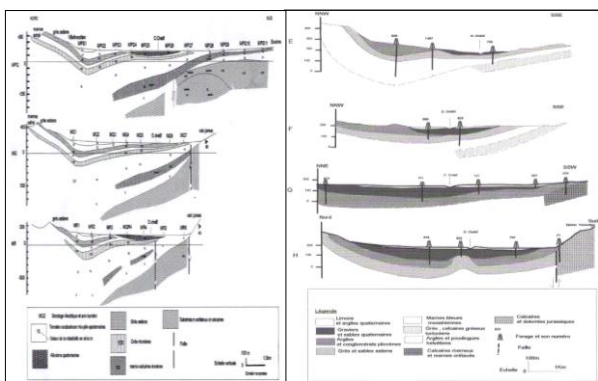
The geophysical study revealed the existence of two deep faults at the upstream foot of Jebel Temoulga, but there is only one that is responsible for the salinity of the waters of the El Attaf alluvial groundwater. An interpretive geological sections has been drawn up on occasion. Also, a geological model according to a NW-SE orientation profile was established; it allowed giving an order of magnitude, the depth, the extension and the volume of the lithological formations (Figure 2).

## 3. Results and Discussion

For the calibration of the geophysical survey data, we used the logs of the various boreholes (Figure 2). From the lithological point of view that the Eocene marl-limestones do not exist and the resistivity values obtained (100 Ohm.m) correspond to Pliocene clays and

conglomerates, which has not been demonstrated by geophysics. From the structural point of view, the orientation fault (NE-SW) affecting the northern slope of Jebel Temoulga is highlighted with the help of F1 drilling. The transverse orientation tectonic accident (NW-SE) is confirmed by drilling (E6 -636) which intersected under conglomerates and pliocene clays, marly limestones and Cretaceous marls. It shows that the eastern compartment has collapsed and Jurassic limestones have risen (the oldest formations have been raised and the most recent have collapsed)

Through the realization of hydrogeological interpretative sections, we have been able to remove more clarification on the structure, the lithology and the origin of the mineralization of groundwater occupying both the tectonic accident centers located at the foot of Jebel Temoulga and progressing north. The recharge of the El Attaf alluvial aquifer is done mainly by adjacent aquifers: in some cases (E, F, H sections), the alluvial aquifer can benefit from an ascending drainage from the Asti sandstones. Such a process can be done thanks to the folds of layers of sandstone (drilling 822). However, this aquifer remains characterized by significant mineralization leading to degradation of the hydrochemical quality of the El Attaf alluvial aquifer.



**Figure 2.** Comparison of the results of the geophysical study with drilling data

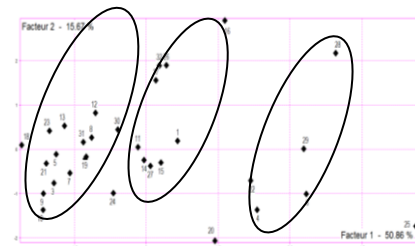
### 3.1 Hydrochemical context

Comparison of chloride levels with those of the other major elements and strontium shows that the groundwater salinity of the El Attaf alluvial aquifer has origin of the dissolution - precipitation of saliferous rock (triassic and permo-triassic formations), Strontium makes it possible to distinguish sulphates originating from the oxidation of sulphides found in low concentrations from those resulting from the dissolution of evaporites which are found in (high levels). The strontium of the wells near Jebel Temoulga, shows that the waters of the El Attaf aquifer have high levels of  $Sr^{2+}$  with concentrations up to 5.5 mg / l. The  $Sr^{2+} / Ca^{2+}$  ratio in the El Attaf zone is (3.8 ‰  $< Sr + 2 / Ca^{2+} < 7.1$  ‰) which is distinctly superior, characterizing the waters that passed through the Triassic.

The presence of strontium indicates an evaporitic origin of salinity. In fact, the waters from the depths (draining) pass through the Triassic formations and become rich in salt, as shown by the interpretative geological section H.

To determine the salinity-generating elements, we performed a PCA (Figure 3), (Principal Component Analysis). Supported elements come from a well-defined area (NW-SE fault zone affecting Jebel Témoulga). The positioning of individuals is essentially along the F1 axis, so we can see a regular distribution in three different groups in space. It thus clearly emerged that the variables that are most involved in degradation of water quality of the Chelif groundwater are all geological nature. Statistical analysis gave a strong correlation between these two-to-two variables.

**Figure 3.** Projection of individuals in the factorial plane F<sub>1</sub> F<sub>2</sub>



## 4. Conclusion

The NE-SW tectonic accident affecting Jebel Temoulga is the cause of the salinity of groundwater. It allows the ascent of deep waters, having stayed in the salt formations of the Permo-Triassic, towards the alluvial aquifer. At the level of the tectonic accident orientation NE-SW affect the Témoulga. The hydrochemical study has shown the influence of local geology on the chemistry of the waters.

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