



Water Geochemistry Evolution for a Sand Aquifer of the Terminal Complex in the Est-Northern Algerian Sahara

Idir Menad HOUARI⁽¹⁾, Imed Eddine NEZLI⁽²⁾, Boualem BOUSELSAL⁽³⁾, Mohamed Salah BELKSIER⁽⁴⁾ and Hamza LAOUINI⁽⁵⁾

⁽¹⁾ Laboratory of Geology of Sahara, Kasdi Merbah Ouargla University, univ-ouargla, Ouargla 30000, Algeria

⁽²⁾ Laboratory of Geology of Sahara, Kasdi Merbah Ouargla university, univ-ouargla, Ouargla 30000, Algeria

⁽³⁾ Laboratory of Underground Reservoirs; Oil, Gas and Aquifer, Kasdi Merbah Ouargla university, univ-ouargla, Ouargla 30000, Algeria

⁽⁴⁾ Laboratory of Underground Reservoirs; Oil, Gas and Aquifer, Kasdi Merbah Ouargla university, univ-ouargla, Ouargla 30000, Algeria

⁽⁵⁾ Laboratory of Geology of Sahara, Kasdi Merbah Ouargla University, univ-ouargla, Ouargla 30000, Algeria

⁽¹⁾ houarimenad22@gmail.com & houari.idir@ouargla-univ.dz

Abstract— The groundwater resources in the Northern Sahara are represented by two superimposed major aquifer systems: the Intercalary Continental (CI) and the Terminal Complex (CT). The waters of these aquifers pose serious physical and chemical quality problems; they are highly mineralized and very hard. The present work aims to describe the water's geochemical evolution of sand groundwater (Mio-Pliocene) of the Terminal Complex in the northeastern Sahara, by the research of the relationship between water's chemical composition and lithology of aquifer formations through. The results obtained show that the water's chemistry is essentially governed by the dissolution of evaporate formations, which gives to, waters an excessive mineralization expressed by high concentrations of sulfates, chlorides and sodium.

Key-Words— geochemistry, evolution, aquifer, terminal complex, Sahara

I. INTRODUCTION

The groundwater resources in the Algerian northern Sahara are represented by two superimposed major aquifers: the Intercalary Continental (CI) and the Terminal Complex (CT). The waters of these aquifers pose a serious physical and chemical quality problems; they

are highly mineralized and very hard, the understanding of the mechanisms by these waters acquire their chemical composition has become in recent years an important and vital stake for the protection and the management of our environment. Several previous studies have highlighted that the groundwater of this region has a very important salinity, especially the waters of the Complexe Terminal, these studies have focused on geological recognition [1]; [3]; [8], and hydrogeological [6]; [2]. [4] of the aquifer system of the Complexe Terminal and Continental Intercalaire of the Northern Sahara. While others have evaluated the water potential of the system, while proposing various scenarios of its exploitation in the medium and long term; [10]; [12]. The age and flow velocity of the waters, as well as the possible mixtures in a system, were determined using isotopic natural tracing (carbon-14, chlor-36, oxygen-18, Deuterium, tritium) applied to the aquifer system (CI and CT) of the northern Sahara; [7], [9]. [5], [13], have focused on the recharge and palaeorecharge modalities of this system. Other studies have been carried out by [11] and have focused on the geochemical evolution of the waters.

The objective of our work is to contribute to the study of aspects related to the geochemistry of the Complexe Terminal, from the South (Touggourt)

to the North (Still); From the upstream to the downstream (zones of the chotts), along the presumed axis of flow of the waters. We nevertheless limit our field of investigation to the Mio-Pliocene aquifer of the Terminal Complex.

II. MATERIALS AND METHODS

Twenty-two (22) water samples from the Mio-Pliocene aquifer were collected, the location of the sampled points covers an area of about 200 km (Fig. 1), from Blidet Amor (Touggourt) to (Chott Merouane and Melghigh) depending on the direction of flow (South / North). The following parameters: the hydrogen potential (pH), the temperature (T°) and the electrical conductivity (CE) were measured in situ, immediately after the sample was taken. The physico-chemical parameters of the water were carried out in the laboratory. Computer programs have been used to represent the above parameters and extract particular information (Surfer 12, Statistica 7, Diagramme...).

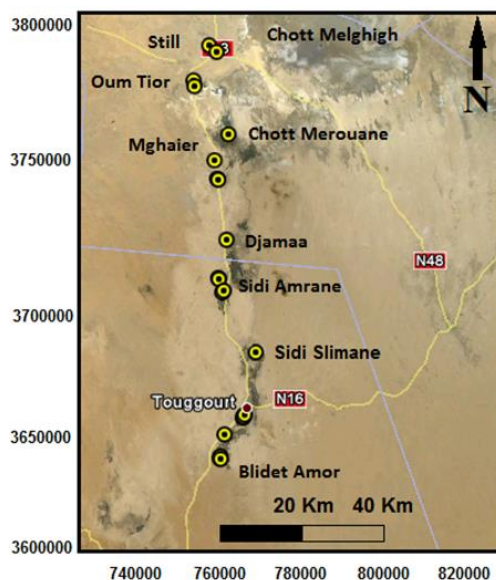


Fig. 1, Locations of water sampled points

III. RESULTS AND DISCUSSION

The values of electrical conductivity show a high amplitudes in the Touggourt region, the values exceed the standards (from 4650 to 7800 $\mu\text{S}\cdot\text{cm}^{-1}$), but extreme values have been recorded in Djamaa (8300 $\mu\text{S}\cdot\text{cm}^{-1}$). The pH and temperature values remain close to the norm and they do not present any anomalies (Table 1).

Table 1, Physical and chemical parameter values

	K ⁺	Na ⁺	Mg ²⁺	Ca ²⁺	NO ₂ ⁻	NO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ²⁻	CE ($\mu\text{S}/\text{cm}$)	T [°] C	pH
Max.	61	1440	496,64	687,37	0,423	69,5	186,05	2325	3075	8300	25,9	7,8
Min.	24,5	350	98,8	200,4	0	12,5	88,45	625	500	3030	23,4	6,9
Med.	36,70	734,22	255,91	460,17	0,03	34,11	131,76	1229,25	1910,55	5740,63	24,44	7,32

The major anions show an excess to the norms, for sulphates, the increase of the concentrations along the direction of water flow is clearly remarkable, with some extreme values for the points T5 (Temacin), and T6, T7 (Nezla), however, all the sampling points at the Djamaa, Mghaier, Oum Thior and Still localities present a high concentrations. For chlorides, high concentrations were observed throughout the study area, and then a clear relapse in the regions of Mghaier, Oum Tior, towards minimum values at Still. The concentrations of bicarbonates are also above standards, all recorded values remain almost constant with any remarkable variation (Fig. 2).

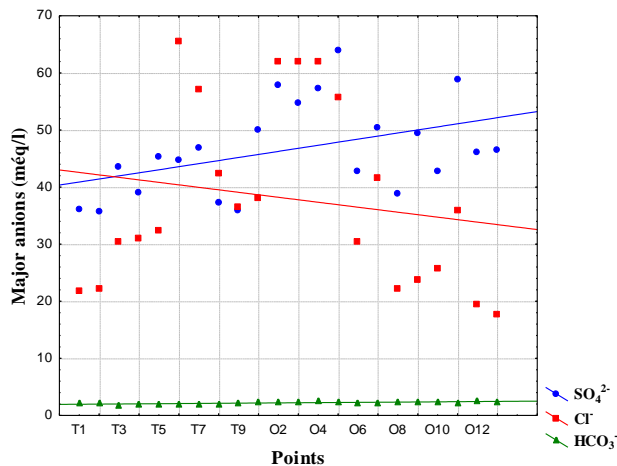


Fig. 2, Major anions evolution

For the major cations, the dominance of the sodium is clear, the values recorded show a high concentrations, sometimes very high at the points T6 (Nezla), O3 Tinedla) and O4 and O5 (Djamaa). This element also evolves along the direction of the flow of water, and simultaneously with the chlorides, the concentrations dropped at the points sampled at Mghaier, Oum Thior and Still. The calcium levels show remarkable evolution and high concentrations, exceeding potable standards, the same for magnesium, but to a lesser degree in terms of concentration or rate of evolution. Contrary to this, potassium levels appear to be

above standards but with no remarkable evolution (Fig. 3).

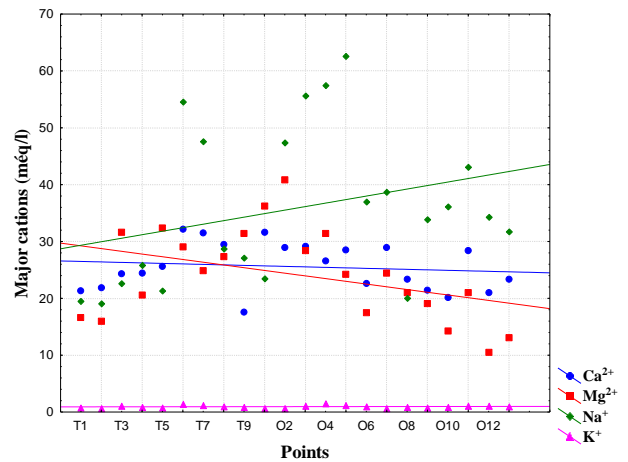


Fig. 3, Major cations evolution

IV. CONCLUSION

The waters of the Mio-Pliocene aquifer of our study area are in contact with a lithology rich in evaporites, reveal a strong mineralization expressed by very high electrical conductivity values ($8300 \mu\text{S}\cdot\text{cm}^{-1}$), which increase from upstream to downstream, these concentrations exceed the WHO standards and also increase along the direction of flow.

The use of chlorides as a concentration factor allowed us to follow the evolution of the chemical elements, it was observed that these elements evolve with a rhythm lower than that of the concentration factor, because of their precipitation (calcite, gypsum). We found in the downstream zones a falls in chloride concentrations suggest that the chemistry of the water evolves towards the precipitation of the halite and sylvite near the chotts.

REFERENCES

- [1] Bel F. & al (1966) : Etude géologique du



Séminaire International sur L'Hydrogéologie et l'Environnement

15 - 17 Octobre 2019, Ouargla (Algérie)



Continental Terminal, ANRH Alger, Algérie,
22p.

de Tunis El Manar, 261p.

- [2] Bel F. & al. (1969) : Mise au point des connaissances sur la nappe du Complexe Terminal, ERESS, Ouargla, Algérie, 20p.
- [3] Busson G. (1972) : Principes, méthodes et résultats d'une étude stratigraphique du Mésozoïque saharien. Thèse Paris, 464p.
- [4] Castany G. (1982) : Principes et méthodes de l'hydrogéologie. Edition: DUNOD, Paris. 233p.
- [5] Conrad G. (1970) : L'évolution continentale post-hercynienne du Sahara Algérien. Centre de recherche sur les zones arides. Série géologie n° 10, CNRS, Paris, 527p.
- [6] Cornet A. (1964) : Introduction à l'hydrogéologie Saharienne. SNED, Alger Algérie, 572p.
- [7] Edmunds W.M. et al (2003) : Groundwater evolution in the Continental Intercalaire aquifer of southern Algeria and Tunisia: trace element and isotopic indicators. Applied Geochemistry, Elsevier (2003).
- [8] Fabre J. (1976) : Introduction à la géologie du Sahara Algérien. SNED, Alger Algérie, 422p.
- [9] Guendouz A. et al (2003): Hydrogeochemical and isotopic evolution of water in the Complexe Terminal aquifer in the Algerian Sahara, Hydrogeology Journal (2003).
- [10] Nesson C. (1978) : L'évolution des ressources hydrauliques dans les oasis du Bas Sahara algérien. In : Recherche sur l'Algérie, (ed. CNRS), pp 7-100, Paris.
- [11] Nezli I. et al (2009) : Presence and Origin of Fluoride in the Complex Terminal Water of Ouargla Basin (Northern Sahara of Algeria), American Journal of Applied Sciences (2009).
- [12] OSS (2003 a et b) : Système Aquifère du Sahara Septentrional, Rapport interne. Annexes. Tunis, Tunisie, 229p.
- [13] Ould Baba Sy M. (2005) : Recharge et paléorecharge du Système Aquifère du Sahara Septentrional. Thèse de Doctorat, Université