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THE USE OF MULTIVARIAT STATISTICAL METHODE TO STUDY THE AQUIFER SYSTEM OF TERMINAL COMPLEX WATER IN THE WADI RIGH VALLEY AREA (SOUTHERN ALGERIA)

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ABSTRACT

Groundwater resources in the wadi Righ valley are presented by two major aquifers: Intercalary Continental and Terminal Complex. From a qualitative point of view, various studies have highlighted that the waters of this region showed excessive mineralization, including the waters of the Terminal Complex (EC = 5854.61µS / cm) .The present article is a statistical approach by two multi methods various complementary (ACP, CAH), applied to the analytical data of multilayered aquifer waters Terminal Complex of the Wadi Righ valley. The approach is to establish a correlation between the chemical composition of water and the lithological nature of different aquifer levels formations, and predict possible connection between groundwater's layers. The results show that the mineralization of water is from geological origin. It concerns the composition of the layers that make up the Terminal Complex.

Keywords: Terminal Complex (CT); Mineralization; Statistical Approaches; wadi Righ; Algeria.

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1. INTRODUCTION

The Algerian Sahara is until now the subject of numerous several academic studies, scientific papers and technical reports. Among other theses studies were have focused mainly on geological and hydrogeological issues of their aquifers reconnaissance aquifer system of the Northern Sahara[4,9,11,13,14]. We denote that some investigations were various studies have also focused on the quality physicochemical and bacteriological sometimes, the waters of this aquifer system. They were able to estimate their potability and the ability for to irrigation, and therefore their impact influence on human health and the environment were identified. Thus studies suggest some treatments for proposals, suited to the quality parameters to be corrected, were performed [1,2,8,16].

The valley of Wadi Righ is located on a fossil bed (Wadi-Igharghar) which is a wide ditch subsidence in South-North direction with a longitudinal slope of 1 ‰ south El Goug to Chott Merouane north (Fig. 1). The geological formations are mainly of aged of Quaternary they are age and resulting from erosion of preexistent formation aged of continental Mio-Pliocene deposits.

The climate of the region of Wadi Righ is of the hyper arid like the Saharan type, mild winters with a permanent drought therefore; where rainfall is low and erratic and hardly exceeding 60 mm / year over during 39 years. The average maximum temperatures is around 40 ° C, while the cumulative annual evaporation is (2400 mm / year) exceeds almost 40 times that of rainfall; (ONM, 2016).

Three aquifers are distinguished: two layers of Mio-Pliocene age with a sandy lithology and a layer of Lower Eocene age represented by limestone. The Mio-Pliocene is heterogeneous and it shows a variation of the thickness. It consists of sand and sandstone and sometimes limestone and clay, and evaporates with the dominance of clay formation in notably M'ghaier and Umm Thior. The hydrogeological cross-section of Terminal Complex (Fig. 2), show that the general flow direction follows the topographic model, i.e. from south to north.

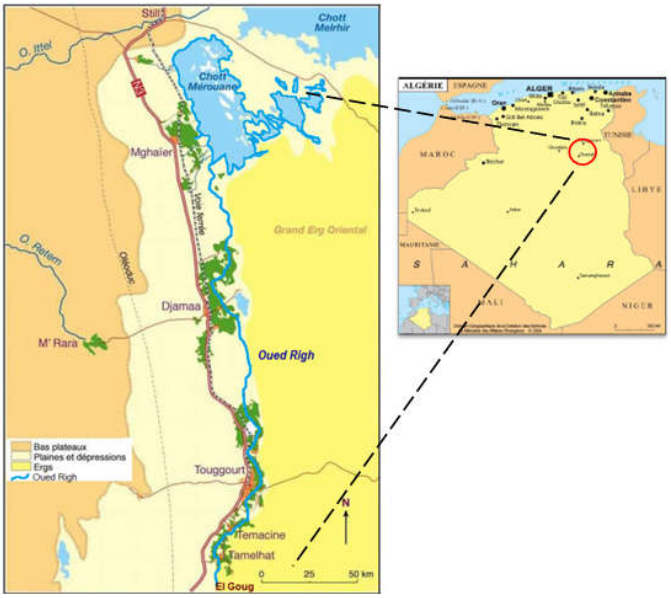

Fig.1. Physical framework (geographic division of the directorate of the archives of the ministry of foreign, 2004)

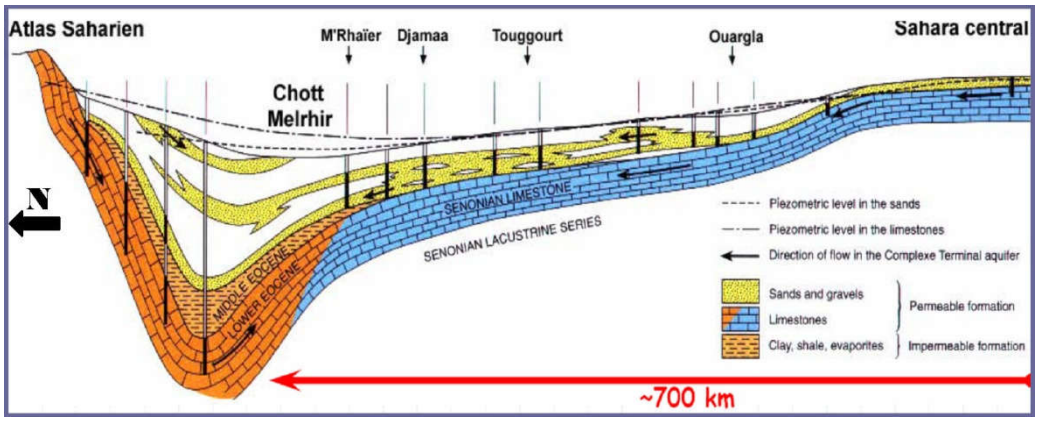

Fig.2. Cross-section the hydrogeology framework in the regionical cup in the web of highlighting the terminal complex in Algeria (UNESCO, 1972)

2. MATERIALS AND METHODS

Fifty two samples (52) of water were collected from the system of superimposed layers of Terminal Complex (Fig. 3) Bottom-up occurs (one layers of Eocene carbonate and two layers of Mio-Pliocene sands). The analytical data were tested and validated by the computer program AqQA, version Demo 1.1 (RockWare, Inc.Golden, Colorado, USA). Statistical analysis of data was performed using ascending hierarchical classification (HCA) and main component analysis (ACP) was conducted by Statistica v6.1 (Stat Soft France, 2003) in a

demo version (Saporta, 1990).

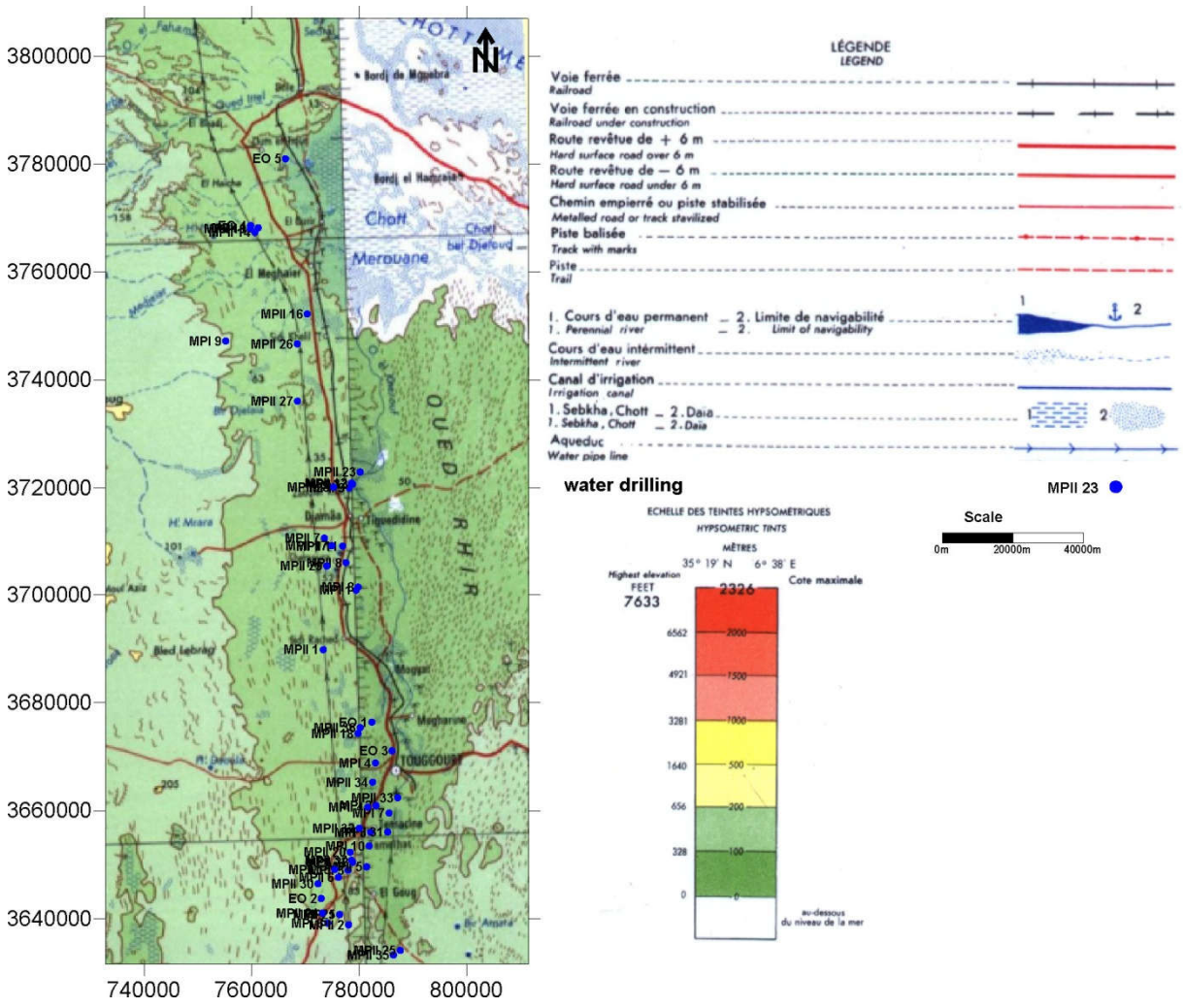

Fig.3. Inventory of water samples (map of Sfax published by the National Institute of Cartography 1974, 1/1000000)

3. RESULTS AND DISCUSSION

3-1. CORRELATION MATRIX

The examinations of the correlation matrix were performed on carried on 52 samples (Table1). It shows that the most a significant correlations could be found between the electric conductivity and Mg^{2+} (r = 0.9), Na^{+} (r = 0.89), Cl^{-} (r = 0.91) and SO_4^{2-} (r = 0.81).

Other significant correlations have been recorded as, between: Mg^{2+} and Na^{+} (r = 0.83), Mg^{2+} and Cl^{-} (r = 0.88), Mg^{2+} and SO_4^{2-} (r = 0.76), Na^{+} and K^{+} (r = 0.36), Na^{+} and Cl^{-} (r =

0.94), Na^+ and SO_4^{2-} (r = 0.64) and between Cl^- and SO_4^{2-}(r = 0.58).

Tableau 1 Correlation matrix of chemical elements from the web Complex Terminal aquifers (0.90 *: significant correlation).

	PH	CE	Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	SO_4^{2-}	HCO_3^-	NO_3^-
PH	1.00									
CE	0.05	1.00								
Ca^{2+}	-0.06	0.07	1.00							
Mg^{2+}	0.09	0.90*	-0.24	1.00						
Na^+	-0.01	0.89*	-0.20	0.83*	1.00					
K^+	-0.09	0.43	0.32	0.24	0.36	1.00				
Cl^-	0.01	0.91*	-0.23	0.88*	0.94*	0.37	1.00			
SO_4^{2-}	0.09	0.81*	0.28	0.76*	0.64*	0.23	0.58*	1.00		
HCO_3^-	-0.09	-0.16	0.14	-0.22	-0.11	0.33	-0.20	-0.18	1.00	
NO_3^-	0.27	0.06	0.10	0.08	-0.07	-0.05	-0.11	0.20	-0.13	1.00

3.2. PRINCIPAL COMPONENT ANALYSIS (PCA)

The distribution of the variance of factors axis shows that the first factor (F1) axis distinctly predominant over others. It alone accounts for represent 44.68% of total variance, according to the projection of variables in terms of on the F1F2 axes (Fig.4). This last which represents a cumulative variance of 60.95%. It show: electrical conductivity with an association of , reflecting the mineralization, is in a considerable correlation with the most soluble and evaporate elements (Sulfate, magnesium and sodium chloride), this association is correlated positively well with the factor F1, and therefore, this axis it is regarded as exhibit the water mineralization factor. In addition, whereas the less soluble components, namely such as: potassium, nitrates, calcium and bicarbonate have low do not seem in good correlation with the factor F1.

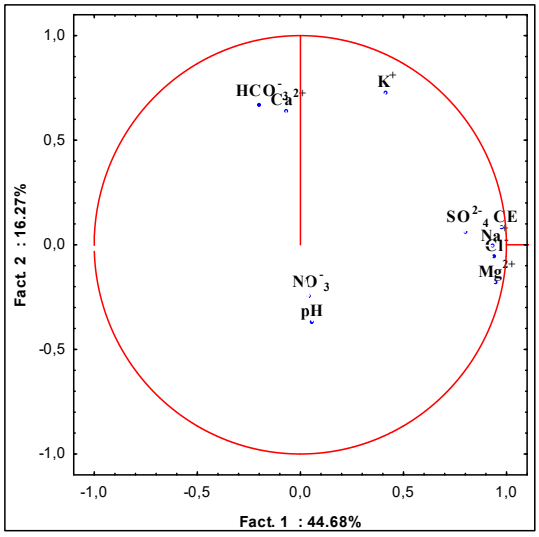

Fig.4. Results of the principal components analysis: varying projection of variables on the f1 versus f2 (complex terminal water) plan

3.3. HIERARCHICAL ASCENDING CLASSIFICATION (CAH)

Dendrograms of variables and observations (Figs. 5, a, b) show four classes:

The first class: with indicates the mineralization pole that gathers the drillings wells (MPII6, MPII30, MPII13, MPII12, MPII22, EO3) characterized by high electrical conductivities (6200µs / cm - 9030µs / cm).

The second class: indicates the evaporite pole (Na^{+}, Cl^{-} and SO_4^{-2}) that gathers the drillings (MPII4, MPII19, MPI8, MPI4) and the drilling of the third layer Eocene (OE1) characterized by high salinity (EC varies between 5500 and 6000µs / cm), the sodium chloride facies, or sulfated sodium caused by the dissolution of evaporate rocks and gypsum that characterizes the study area.

The third class: indicates the pole carbonate (Ca^{+2} Mg^{+2}, HCO_3^{-}), which gathers (EO2, EO5) and the drillings of the second layer Mio-pleocene (MPII18, MPII11, MPII13) characterized by the sulphated magnesium and sodium chloride facies. A communication between these superimposed layers is apparent in position of drilling of second layer Mio-pliocene in the class pole carbonated and drilling of the Eocene in the class of evaporate pole.

The fourth class: This class shows the pole pollution (NO_3^{-}, pH, K^{+}), regrouping the drilling of two plies of Miop-liocene, most water points are located in areas characterized by

agricultural activities with depths closest to the surface (60 to 170m).

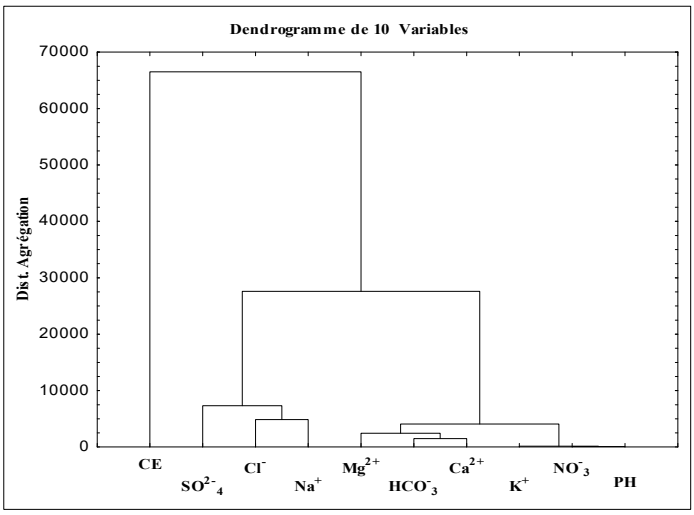

Fig.5(a) Ascending hierarchical classification of variables

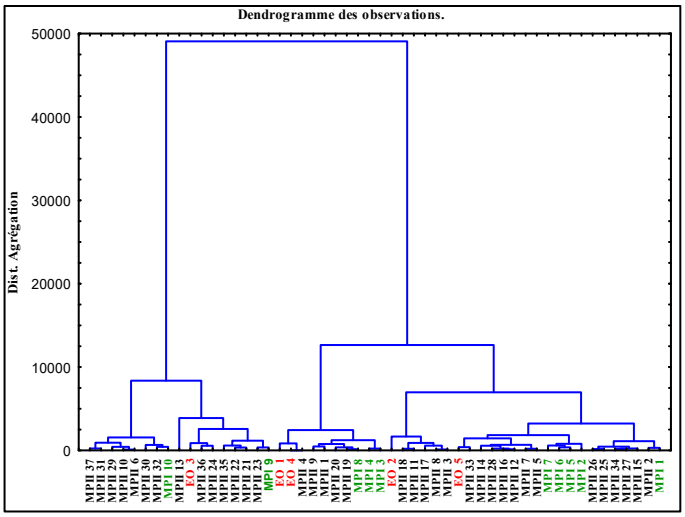

Fig.5(b) Ascending hierarchical classification of observations

4. CONCLUSION

Our work is part of a study on the geochemical origin of the mineralization of the waters of the Terminal Complex in the region of the Wadi Righ in an arid area. The application statistical methods such us the principal component analysis with hierarchical clustering (two complementary methods) allowed us to demonstrate that the three aquifers groundwater levels making of the Terminal Complex according to their lithology are characterized by two (2)

distinct poles, (1) namely; the carbonated pole (Ca^{2+}, Mg^{2+} and HCO^{-}_{3}) on the sheet represent Eocene formation and the evaporatice pole (Na^{+}, Cl^{-}, and SO_4^{2-}) which has a correlative with the proxy to the two sheets of Mio-pliocene.

All in all according this study, we could conclude by stating that the mineralization and water salinity are of geological origin. It concerns the litholigical composition of the layers that form the web from the Terminal Complex. This study approuved a communication between these superimposed layers is very apparent in the situation of drilling the second layer Mio-pliocene (MPII18, MPII11, MPII13) in the class pole carbonated and drilling of the Eocene (OE 1) in the class of evaporate pole.

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