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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Salinization origin of Souf Terminal Complex: Application of statistical modelling and WQI for groundwater management" *by* Hafidha Khebizi et al.

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Dear referee (RC1), For your decision, I am completely against even for the remarks and I see that they are made technically after a superficial reading without making the relation between the various parameters introduced (in particular, the geographical, geological and the hydrogeological context and the new concept introduced). From your comments, I am not sure that you are hydrogeologist or hydrologist. That is why I'll give you more explanations to enrich your understanding of the problem discussed in this paper and its context and objectives. Answers to your comments are as follows: 1. First, you did a serious location error and yet it is very clear and easy to



make a geographic location using the map. The study area is not located in the North of Algeria. It is located in the northern part of the Sahara. There is a big difference between Sahara and the North of Algeria from geographical, geomorphological and geological context point of view. For the instruments used: Sorry I do not understand If it you are speaking about pH, conductivity, temperature measuring instruments. I think these are universal devices used by hydrogeologist and hydraulic specialists and large laboratories specializing in water sampling and analysis. Likewise, for the methods of hydrochemical analysis of the various cations and anions. These are universal analysis methods according to the universal standards used by the most researchers who published in journals of high scientific reputation. For doubts concerning the reliability of the analysis, it is necessarily to indicate that the ionic balance on all the samples analyzed is less than 5% with R2 equal to 0.71 which means that the quality of the analysis is very good. 2. The samples were collected over a week: Technically a week is the duration of a sampling campaign and I don't think a sampling campaign requires more. From a hydological, hydrogeological and even climatological point of view, this time is the period of the aquifer recharge threshold (high water period). You should note that in a desert area, it is the best sampling period which corresponds to the zone of the groundwater recharge threshold, of which all the climatic and hydrological conditions to carry out the mission are insured in particular the absence of the sand wind which prevents the mission and the specialists of desert area know that. From a sampling point of view, there are many studies that have been done cited as references that can give some idea about the chemistry and quality of the water. The selective sampling done during this mission that I did myself, concerns a well delimited area and it is indeed the center of the region of Oued Souf with an area of 400km2. We purposely followed the trace of the Oued to see on its two parts (East and west) the hydrochemical behavior on the basis of an excellent geological knowledge of the groundwater host rock. Also, you spoke of sampling during the summer! the sampling campaigns are not limited to seasons, there are two distinct periods (high water period and low water period) and the month of May corresponds to the threshold of the high

water period in the Saharan areas. 3. For the calculation of WQI, in the additional excel document, there is the formula used and we can introduce this formula in the text if it gives more understanding. 4. For the statistical methods, it is clear that the groups have been classified according to their hydrochemical similarities regarding the dominance of the major canions and anions. So this classification should have exactly a geographical distribution significance of the water samples according to the geological interpretation of the host rock. For this, it is useful to pay attention that samples of groups 2 and 03 are the most mineralized, and are found in the western and southern part of Oued and therefore the significance is much more geographical than anything else. This geographical distribution is directly related to the evaporitic nature of host rocks (Senonian) in the South while towards the east the host is much more carbonated (Eocene dolomite) where group 1 presents a significant values of Ca2+, Mg2+ and HCO-3. For Piper diagram, there is no contradiction, if all the samples have a sulphate sodium-potassium character. This is due to the mineralization caused by the rock-water contact, and since the direction of water flow occurs from the Southwest to the Northeast, the impact of the enrichment in sulphated elements occurs much further in the south where the host rock is evaporitic. On the other hand, going north and east, the dolomitic hoste rock influences in addition to the sulphated mineralized water coming from the southwest. 5. For the unit, the major cations and anions are in mg / l. For the EC, it is per $\mu$s/ cm. 6. The WQI gives the degree of water potability. You should note that the hydrochemical analysis showed a mineralized water four times more than the standards of the WHO (2011) and this study aims to determine the origin of the excessive mineralization (salinity) and to make a zoning depending on the lithology of the groundwater host rock and therefore there is no overlap since the water is salty. 7. Dissolution of the dominant evaporitic minerals such as halite, gypsum and anhydrite, and other associated evaporitic minerals of halite such as the occurrences of sylvite, epsomite and bischofite allowed the enrichment of the water in sulfate and chlorate ". This is interpreted on the one hand through the significant values of the correlation matrix, between cations and anions (values close to 1) and on the other



hand through the interpretation of the sedimentological context of the evaporitic host rocks. It should be noted that the typical lagoon chemical sedimentation of the Senonian evaporites which allows the formation of the various minerals mentioned, is known in the potassium deposits of the Senonian formations of the Lower Sahara zone which has already been discussed by specialists in evaporitic rocks including the most important work of John K. Warren (2006). 8. Conclusion: "The water groups distinguished are enriched in mineralization according to the groundwater host rock. The carbonate host rock showed less mineralization of sulfate and chlorate, while the evaporitic layers produced abundant elements of sulfate and chlorate. This allows the postulate in the presence of two different mineralization corridors. I think in an academic study based on field data we can not claim and hypothesis are based on the geological and hydrogeological hydrogeochemical arguments. For rock-water behavior, if you cannot grasp this assumption, you just follow the logical interpretation given as follows: An aquifer in which the host rocks changes in lithology laterally is characterized by mineralization that varies according to the lateral passage of the groundwater host rock facies. If the host rock is evaporitic we should have a mineralization rich in chlorine, sulfate and manesian element. In case of carbonate host rock, we will find chemical elements dominated by calcium, magnesium and HCO3, by the effect of the contained minerals dissolution. The hypothesis of preferential dissolution corridors is not given from the imagination, but it is based on a simple underground mapping of the host rock lithology which favors this mineralization. Since evaporitic minerals have the most solubility in water compared to carbonates. A subterranean leaching occurs much more by the contact of water with the evaporitic rocks. The different dissolution zones were called dissolution corridors according to the chemical properties of the host rock minerals and their dissolution rate. 9. Conclusion: - "An osmosis phenomenon is a natural phenomenon that you can find in any two solutions of different ionic concentrations which are separated by a semi-permeable membrane. In our case, it occurs to homogenize the mineralization of Pontian and Mio-Pliocene groundwater. This mechanism allows ions circulation of the most concentrated waters in chemical elements towards waters

with less enrichment through layers of Pontian clay roof, which is considered as a semi-permeable membrane. - The interaction of the groundwater with Senonian evaporitic layers is regarded as subterranean preferential leaching. This action was accelerated with pumping rates, and risks inducing the gradual subsidence of the overlying sandy layers, and rising static levels of the groundwater by acceleration of the dissolution-subsidence cycle. You should note that water has a double action, it is an erosion agent and transport agent and therefore any solid evaporitic mineral which occupies a certain volume in the rock will leave a vacuum after its dissolution and the enormous quantities of minerals dissolved in water and besides which reappear again in the form of ephemeral minerals in the chotts (Merouane and Melgheir), will leave voids which are filled by the sands of the overlying layers. this induces a gradual subsidence, which cannot be seen due to the nature of the loose sandy desert material. Any subsidence creates by gravity effect a rise in the static level of the aquifer. For this point, this interpretation is not limited to the season, it is much more related to the rock-water behavior in the two different cases: evaporitic host rock and dolomite host rock. 10. We can add Algeria to the title. 11. We can improve more the figure quality.

Hope my explanation helped getting you back on track.

Regards.

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