Determination by Isotopic method of the origin of mineralization in the coastal aquifer Northest Tunisia

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Abstract:

Isotopes (^{18}O,^{2}H) are used to identify the mean process involved in the increase of mineralization.
In fact,the mineralization of the coast aquifer of Ras Djebel depends of seawater intrusion resulting from goundwater overexploitation,The evaporation and dissolution of the aquifer rocks, as well as thereturn flow of irrigation water.

Introduction:

The coastal aquifer is located in NE Tunisia,specially in SE of Bizerte (Fig.1). This coastal occupies an area of 50 Km^2 .It is limited by Djebels bouchoucha,Touchela and Bab Banzart in NW,Djebels Ennadour and Demna in South,the Mediterranean sea in the North and NE.
This zone is influenced by a sub-humid Mediterranean climate.The mean annual precipitations are about 534mm.The annual temperature is around 18°C.
The ETP, about 1197mm/year. This bassin is drained by many wadis.

Materials and Methods:

For the evaluation of groundwater quality,50 water samples were collected from the shallow aquifer of Ras Djebel plain during october (Fig.1). The groundwater samples were analyzed for chemical and isotopic compositions. Measurement of temperature,electrical conductivity and pH were measured in the field. Major elements (SO_4^{2-} ,Cl, NO_3^- ,Ca^{2+} ,Mg^{2+} ,Na^+ and K^+) were analysed at the laboratory of National Center for Nuclear Sciences and Technologies. These elements are expressed in mg/L^{-1} .Salinity was analysed by evaporating a specified volume of water sample in a graduated capsule for 24h in an incubator at 105°C.The dry residue concentration was determined by subtracting the final mass from the initial mass of the sample that was placed in the incubator.$Ca^{2+}$and Mg^{2+} were measured by titration method. NO_3^-,SO_4^{2-} and Cl^- were measured by liquid Ion Chromatography while $K^+$and Na^+were measured by flame photometer.

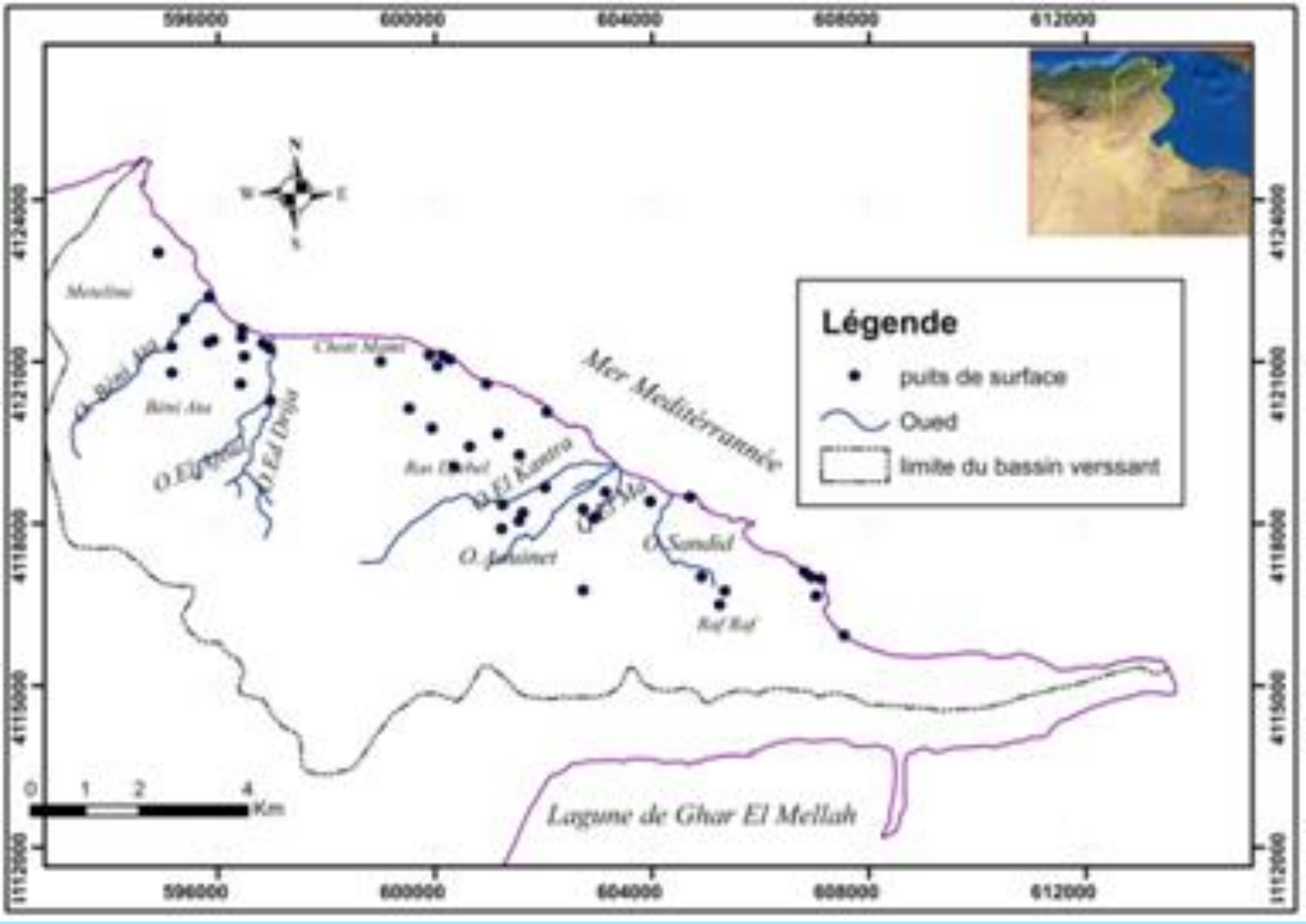

Fig.1: Localisation and sampling of Ras Djebel plain

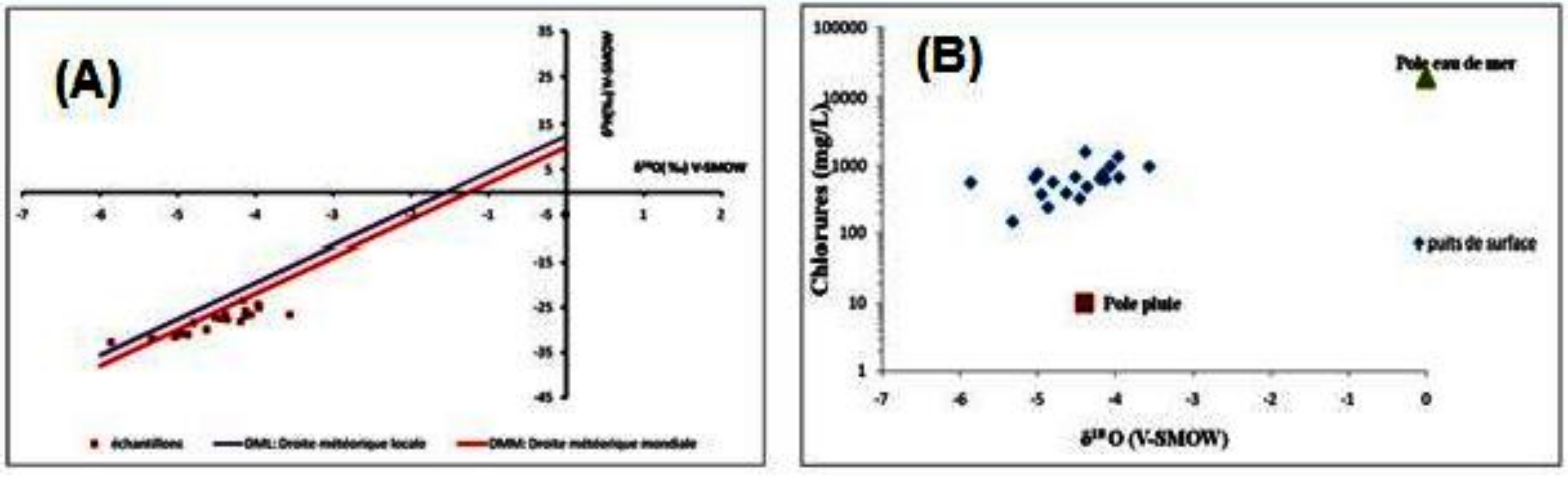

Fig.3:plots $\delta^{18}O$ versus $\delta^{2}H$ and $\delta^{18}O$ versus chlorides

Resultats and discussions:

1.Major elements:

To identify the origin and the processes contribution to groundwater mineralization,plots of Na^+ versus Cl^- , Ca^{2+} versus SO_4^{2-},Ca^{2+} versus Mg^{2+} and Br versus Cl^- are established.
The Na-Cl relationship (Fig.2A),which has frequently been used to specify mechanisms for acquiring salinity, demonstrates that the majority of points cluster along the halite dissolution line.Conversly, If Na+ was only derived from dissolution of evaporitic minerals, then Na^+ should balance Cl^-. The point fall either on or just above the line of sea water dilution (0.86) indicate a marin intrusion phenomenon.
The Mg versus Ca plot reveals an excess of Ca^{2+} ions (Fig.2B).The abundance of carbonate rocks and erosion rates in the study area suggest that the dissolution of carbonates minerals (probably the dolomite) may add significant amounts of Ca^{2+} and Mg^{2+} to the groundwaters.
The Ca^{2+} versus SO_4^{2-} plot (Fig.2C) illustrates that most points representing hill reservoirs are plotted on or just above the gypsum dissolution line. This result could be explained by a compound effect of gypsum or anhydrite dissolution and evaporation process.
Br-Cl ratio (Fig.2D) is not very discriminating.The samples situated near or on marin line can be explained by mixture of continental waters with sea water but also an influence on the spray infiltrated rain water.

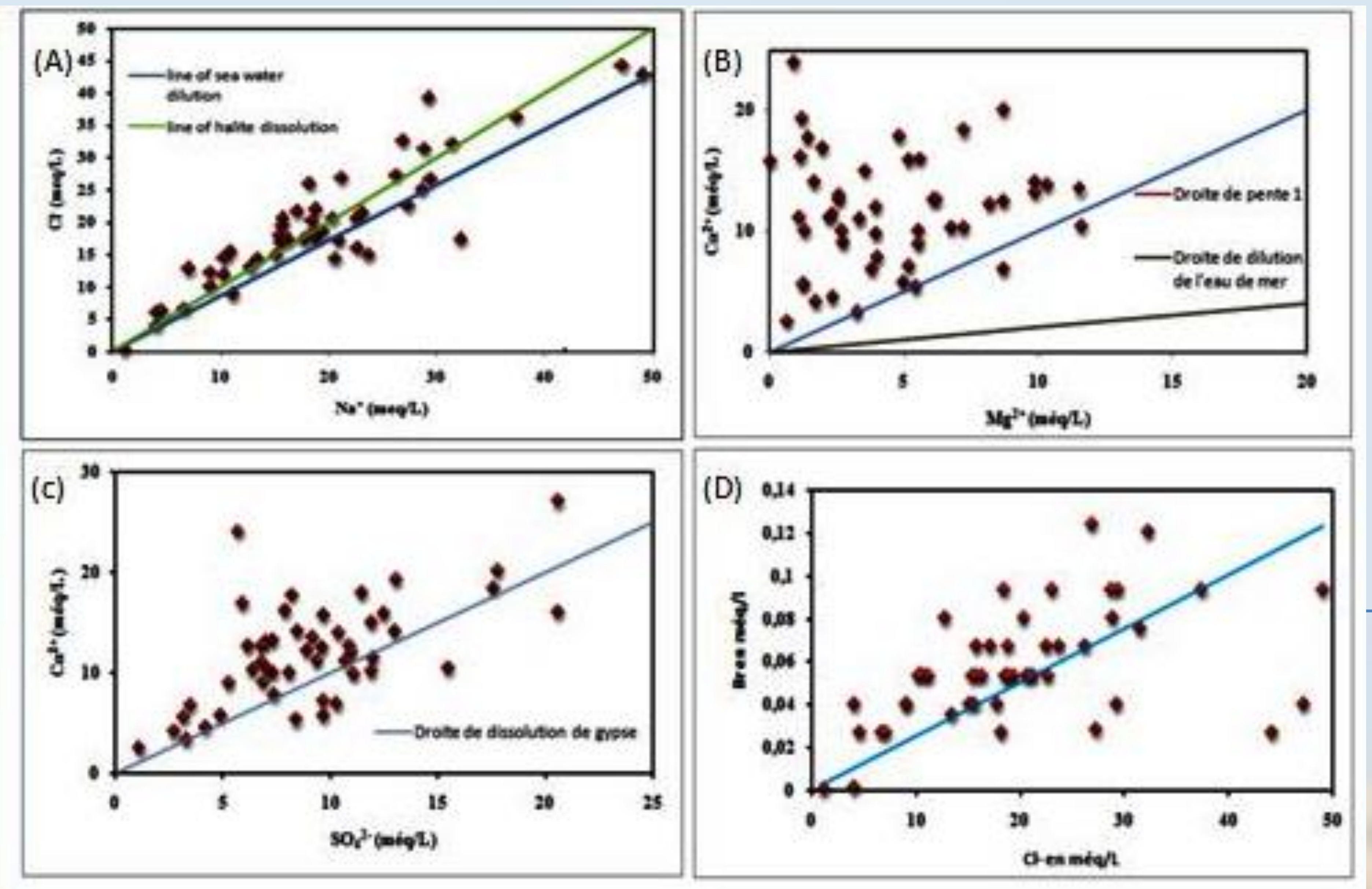

Fig.2:Relationships between major elements in the analyzed sampled water

2.Stable Isotopes

These groundwater samples (Fig.3A) can be further divided into two groups: The first group which is placed below the GMWL, is probably the consequence of the infiltration of an evaporated component likely deriving from the return flow of irrigation water. The second group,placed between the GMWL and the LMWL,shows that the precipitation ensuring the recharge of aquifer from a mixture of oceanic and Mediterranean vapour masses.
The plot of chloride versus $\delta^{18}O$ (Fig.3B) indicates the different processes responsible for the variation of groundwater salinity. Some water samples show a correlation between $\delta^{18}O$ and chloride, which confirms the contribution of evaporation in the mineralization. However , the majority of the samples show a poor correlation between these two elements. It is probable that the dissolution mechanism takes precedence over evaporation in the acquisition of the mineralization.