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Hydrogeology and water chemistry of boreholes identified at the Hamadien continental / intercalary in the Zinder region in Niger

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Abstract

This work deals with the hydrogeology and water chemistry of the boreholes found in the aquifer of the Continental Intercalary in Zinder region, Republic of Niger. To do this, sixteen (16) sampling points, identified by GPS coordinates, were sampled during the year 2015, with a total of sixty four (64) samples analyzed. The characteristics of these waters were established on the basis of the Schöeller Berkaloff scheme. These waters present four types of facies, including chloride-type facies, which are present on 18.75% of the boreholes, with calcium and potassium sodic poles, and bicarbonate facies, which are observed on 81.25% of the boreholes with potassium and calcium sodium poles. All the drillings studied capture the aquifer of the Hamadien /Continental Intercalary.

Keywords: Hydrochemistry, Hydrogeology, Schöeller Berkaloff diagram, Zinder region, Niger.

Introduction

Water is a rare resource[1], common to all mankind[2]. This resource is distributed unequally throughout the world[3]. The largest reserves of liquid fresh water in the world are groundwater with[4] about eight (8) to ten (10) million km^3, accounting for 98% and 99% of the total of these groundwater in Niger, and in the Zinder region in particular as the main source of drinking water[5]. The Zinder Regional Water and Sanitation Directorate (ZRWSD), through these Departmental Hydraulics and Sanitation Directorates (DHSD), provide in part the supply of drinking water to the populations of Zinder.

Water is essential to the life and good development of a country. It is therefore essential to study this resource, in particular its vulnerability factors and the measures necessary for its better knowledge[6]. The present work deals with the synthesis of hydrogeology and chemistry from the boreholes identified in the Hamadian/ Continental Intercalary aquifer in the Zinder region.

Materials and methods

The region of Zinder is situated in the southern part of the country, ie in the center of the country, between 13°48' and 17°30' north latitude and 7°20' and 12°00' east longitude. Generally speaking, the relief of the Zinder region is formed of medium plateaus, low plateaus and low plains. The massifs of Zinder and Gouré, or the Damagaram and Mounio, constitute the two mountainous zones of eastern Niger between the basin of Lake Chad to the east and that of the Niger River (Iullemeden) to the west. These two reliefs spring from an eruptive or metamorphic pen plain covered with regs and granite balls to the north or a sandy cover to the south where the bas-relief forms the Korama basin[8]. Annual rainfall varies from 100 To 300 mm of rain per year[9].

Faure[8] described the geological history of the Damagaram Mounio zone, according to the following scheme: the oldest rocks are impure marls, dolomites and limestones with sandy zones and powerful conglomerate bedrock. This calcium series succeeds a thick siliceous series terminated by a calcareous recurrence. At the end, clays and sandstones are deposited alternately on a large thickness. The whole was metamorphosed, folded and crossed by several intrusive granites.

Thus, on the north side, the massifs of Damagaram Mounio behave like a barrier against which the Cretaceous deposits accumulate, while on the other side these massifs slowly sink to the South and the East under the products of Filling of the Lake Chad Basin. In the West and South-West, ferruginous sandstones with termite facies of the Continental Hamadien and the Continental Terminal.

Sampling and method of analysis: For the purpose of the study we selected sixteen (16) sampling points that already exist in the field, on which 64 samples were analyzed. These points can be divided into two types: cemented wells with human traction and boreholes equipped with a mini drinking water supply Clean Water Boreholes (CWB). Water samples taken for physico-chemical analyzes were carried out according to the rules described by L-BARRES[10]. A purge of one to two minutes is observed on these structures because they are in continuous operation before their sampling.

The physical, physico-chemical and chemical parameters investigated in our study are analyzed at the laboratories of Zinder Hydraulic and Sanitation Regional Directorate (ZHSRD) and the Water Exploitation Company of Niger (WECN).

Physical parameters such as electrical conductivity; Temperature and pH are measured in situ by potentiometry and / or electrometry using a wagtech WE 30200 pH meter and a wagtech WE 30210 conductivity meter. Cations such as sodium, potassium are analyzed by a Jenway PFP7 flame photometer, Total hardness, calcium, magnesia; the carbonates and bicarbonates are measured by the digital tetrameter and the calcium and magnesium ions are deduced by simple calculation.

Finally, colorimetry allows us to measure the anions such as: sulfate, nitrate, chloride, nitrite and fluoride ions as well as total iron from the DR 1900 and 2800 spectrophotometers.

The qgis 12.2 software made it possible to produce the different cards. To determine the characteristics of the waters, we used Microsoft excel to make representations of Schöeller Berkaloff in the form of binary diagrams. This technique was used by Bensaoula[11] to determine the functionality of the waters of the Zouia boreholes in Algeria, by Parfait 6 in the study of the water characteristics of the Abomey-Calavi boreholes in Benin, and in this study to interpret the result analysis.

Table-1: Explanatory table of geology.

ci	Tégama Ges Dibella and Achegour Formations
cmc1	Farakseries or formation
cr6a5	Area in nigericeras. Neolobiltesvibrajeani Zone
cr6b	White limestone series
cr7	Clays and marine limestones. Lakeside limestone
cr9-8	Upper sandstones. First transgression in Libycocerasismaeli. Lower sandstones. Cr9 Second transgression to Libycocerasismaeli. C8 Lower Sandstones
csc	Continental Hamadian
ct3	Clayey sandstone from the middle-Niger
qa	Alluvium with fine gravels giving sandy regs
qa1	Ancient alluviumwithpeebles Ancient terraces of Ténéré and Tamesna
2qd1	Old Erg with non-oriented dunes
qd2	Old Erg with transverse dunes
qm	Heterogeneous sand formations of piedmont, Sandstone of Mallaoua (lateral equivalents of the formations of Chad)
s	Formation of Tafourfouzète and Serchouf (Leptynites) and undifferentiated Suggarien.
sc	Micaschistes, cipolins, pargasite gneiss etc …
sq	Quartzites, schists
granite	granite

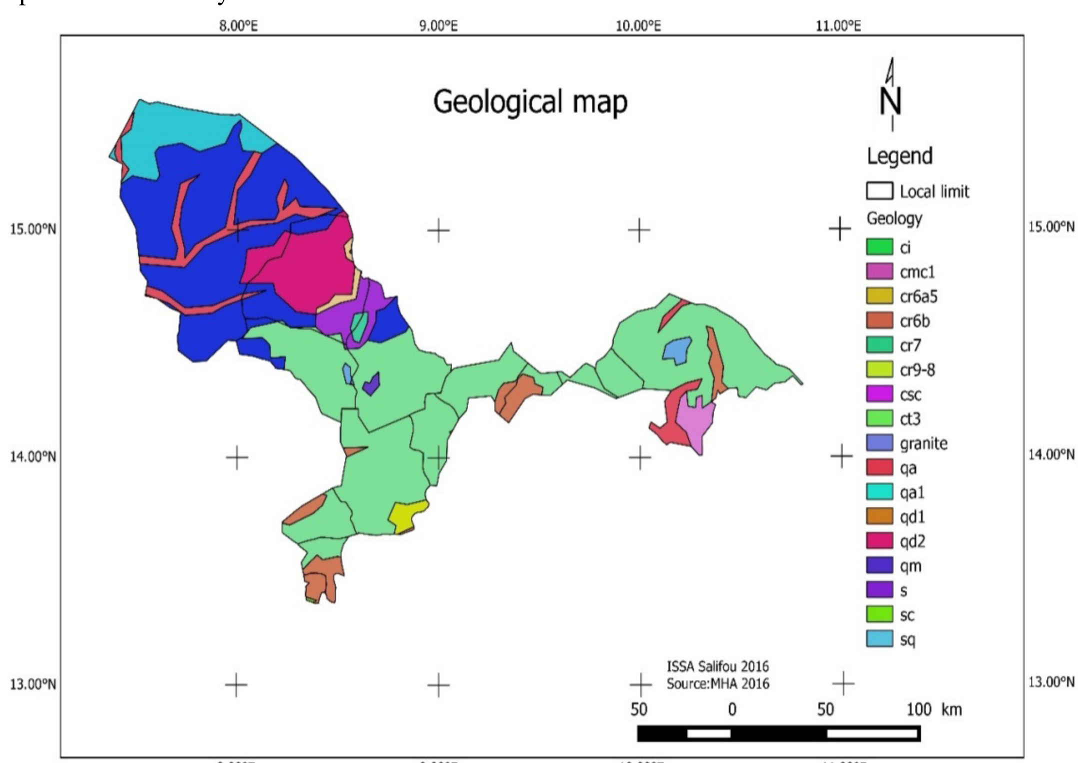

Figure-1: Geological map of the study area.

Results and discussion

Figures-3 to 18 shows the representations of the Schöeller Berkaloff diagram based on the results of the major ions of the boreholes.

The waters captured by the boreholes studied can be classified into four (4) categories: waters with a calcium chloride characteristic, chloride-sodium-potassium, potassium-sodium bicarbonate, and calcium bicarbonate. The waters which possess a chloride characteristic are those of the boreholes 7, 9 and 16. The chloride characteristic is related to the transgressions of the Chad formations, which have a seabed; this transgression is at the origin of the potassic-sodium characteristic. As for the calcium characteristic, it is linked to the solution of the geological formations such as limestones, dolomites with saturation indices below zero[12]. All the waters have a bicarbonate characteristic with the exception of those of F7, F9 and F16. This characteristic is related to the solution of geological formations such as dolomites whose saturation indices are less than zero[12].

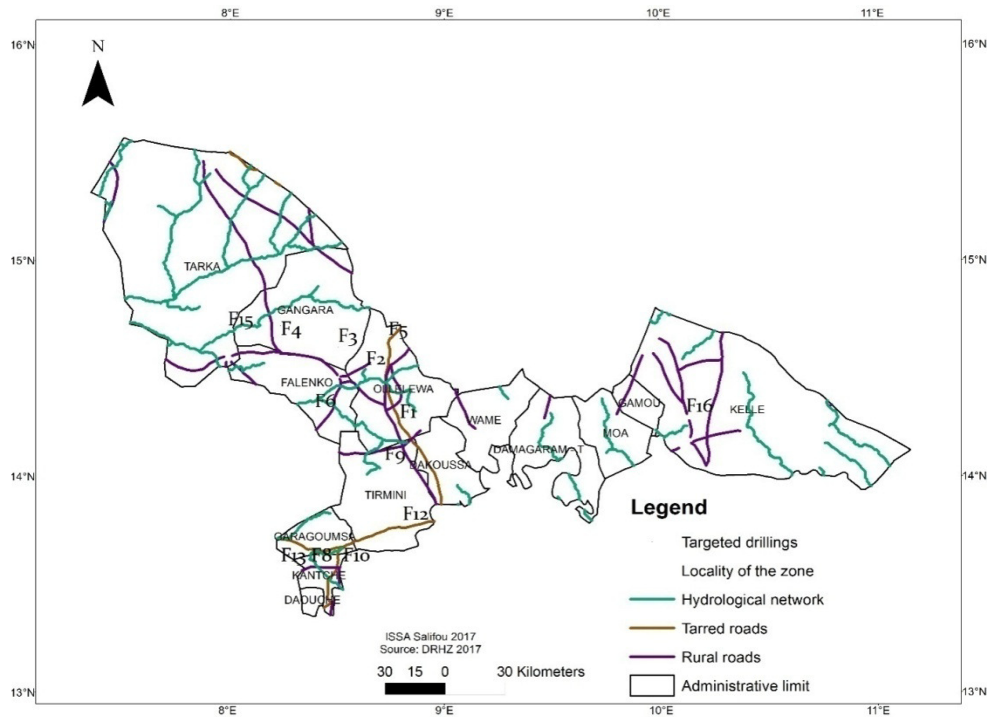

Figure-2: Distribution map of drilled wells.

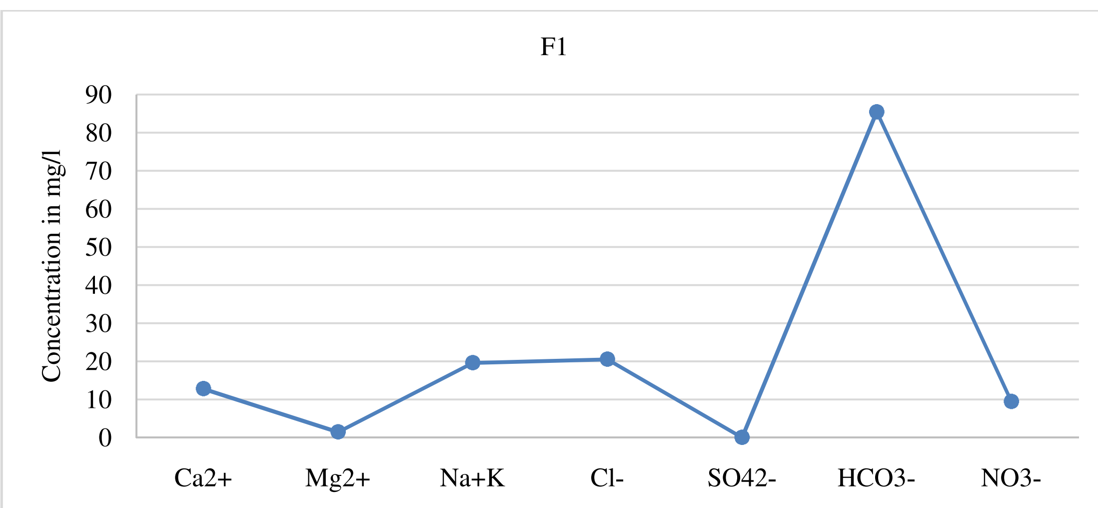

Figure-3: Representation of the Schöeller Berkaloff digraph of major ions in the borehole1 (F1) waters. The F1 water drill has bicarbonate sodium potassium characteristics.

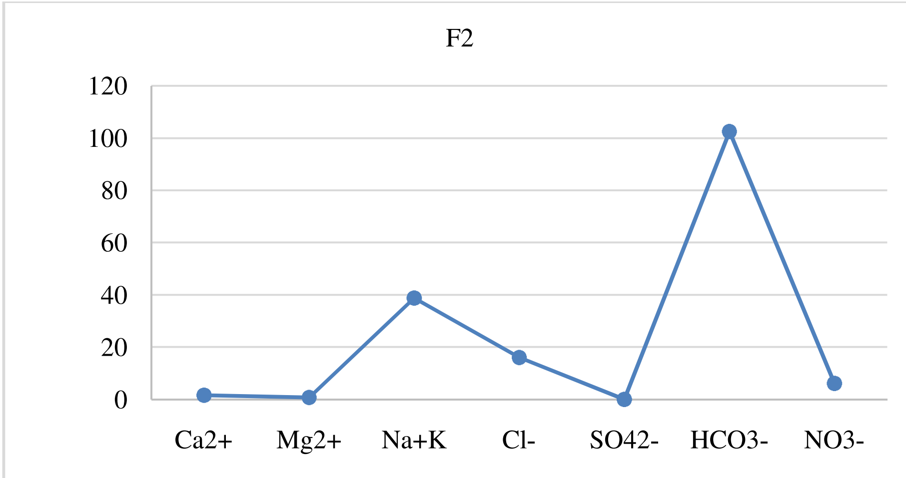

Figure-4: Representation of Schöeller Berkaloff's diagram of major ions in the F2 drilling waters. The F2 water drill has bicarbonate sodium potassium characteristics.

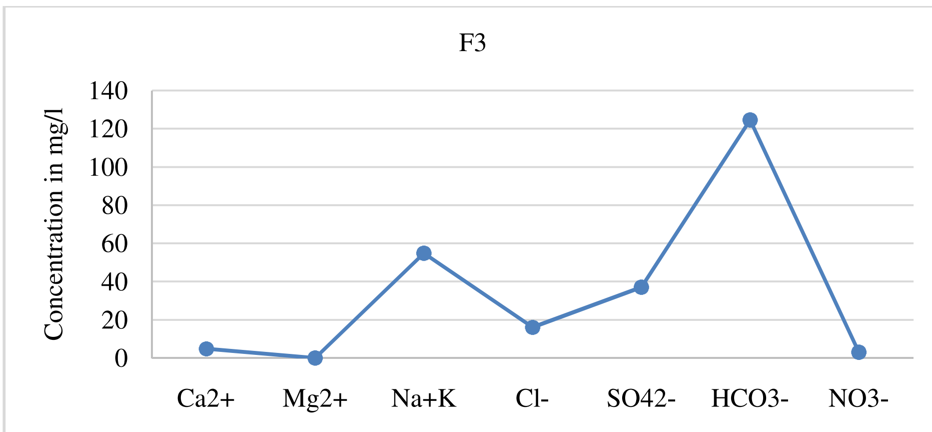

Figure-5: Representation of the Schöeller Berkaloff diagram of major ions in the borehole 3 waters. The F3 water drill has bicarbonate sodium potassium characteristics.

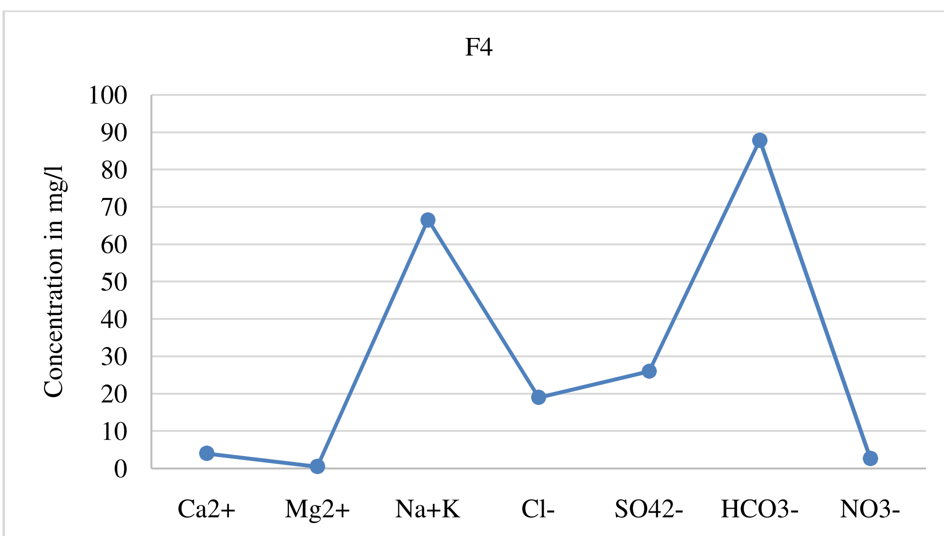

Figure-6: Representation of Schöeller Berkaloff's diagram of major ions in the borehole 4 (F4). The F4 water drill has bicarbonate sodium potassium characteristics.

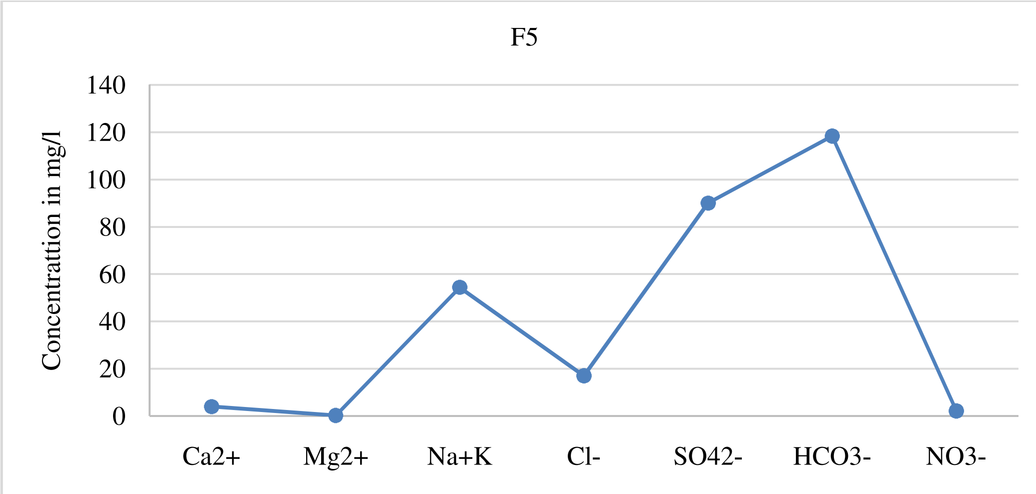

Figure-7: Representation of Schöeller Berkaloff's diagram of major ions in the borehole 5 (F5) waters. The F5 water drill has bicarbonate sodium potassium characteristics.

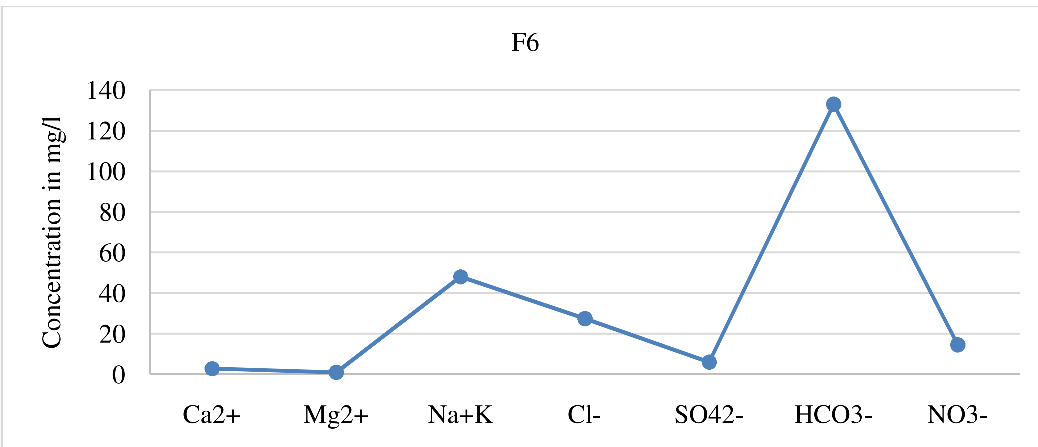

Figure-8: Representation of the Schöeller Berkaloff diagram of major ions in the waters of the borehole 6 (F6). The water from the F6 drill has bicarbonate sodium-potassium characteristics.

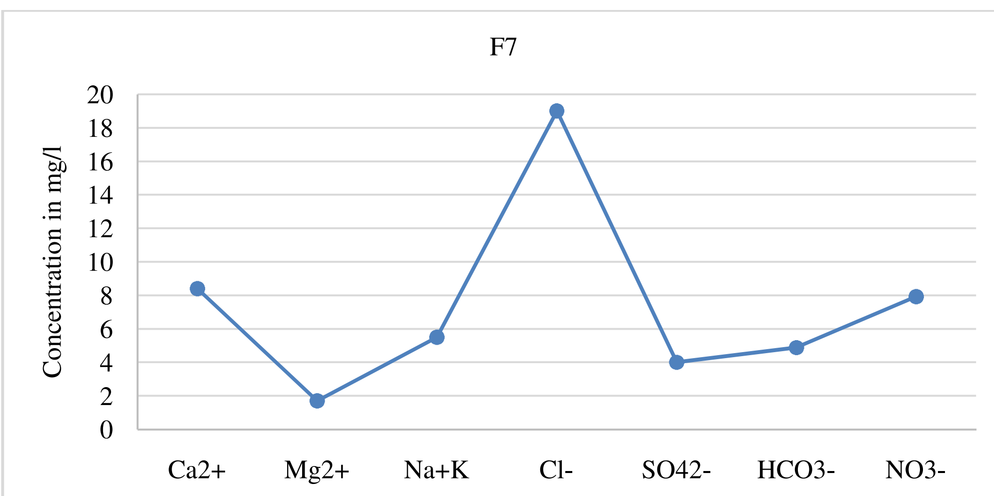

Figure-9: Representation of the Schöeller Berkaloff diagram of borehole 7 (F7) waters major ions. The borehole 7 waters possesschloride calcium characteristics.

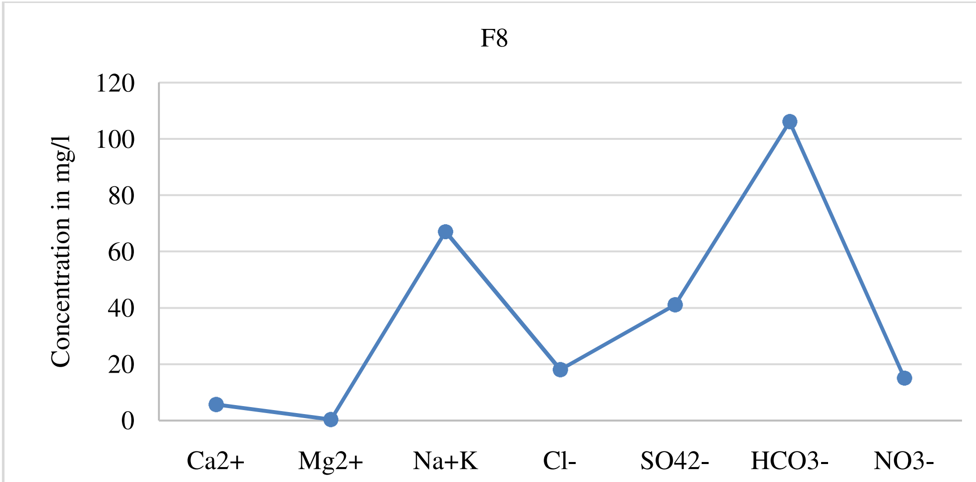

Figure-10: Representation of the Schöeller Berkaloff diagram of major ions in the borehole 8 waters. The F8 water borehole has bicarbonate sodium potassium characteristics.

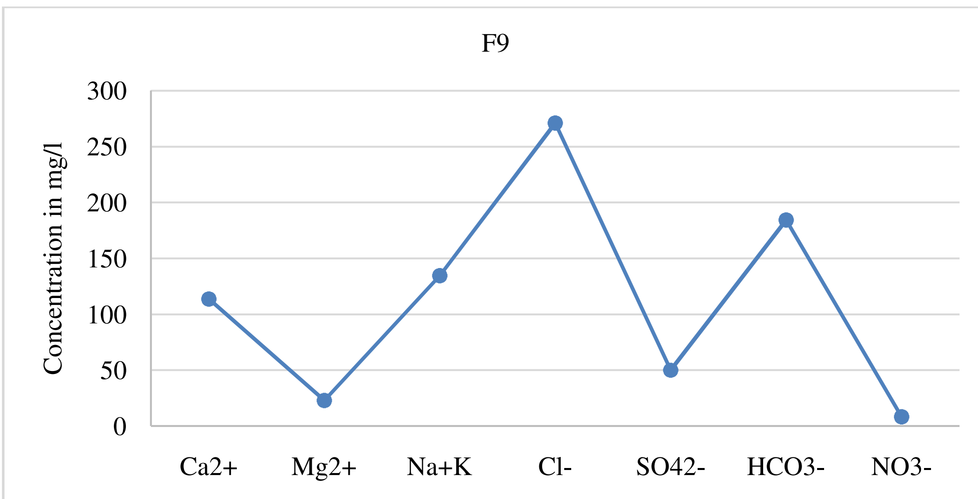

Figure-11: Representation of the Schöeller Berkaloff diagram of major ions in the borehole 9 (F9) waters. The F9 water drill has chloride-sodium potassium characteristics.

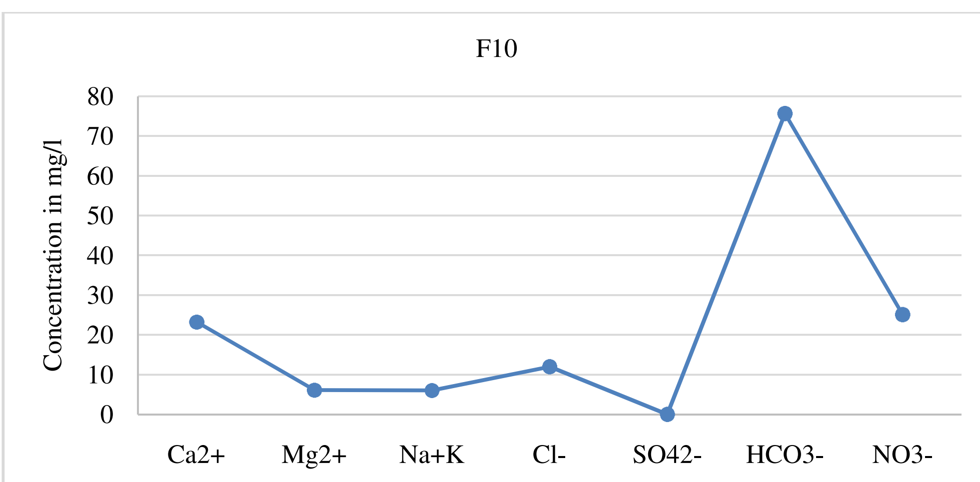

Figure-12: Representation of the Schöeller Berkaloff diagram of major ions in the waters of the borehole 10 (F10). The water from the F10 drill has bicarbonate calcium characteristics.

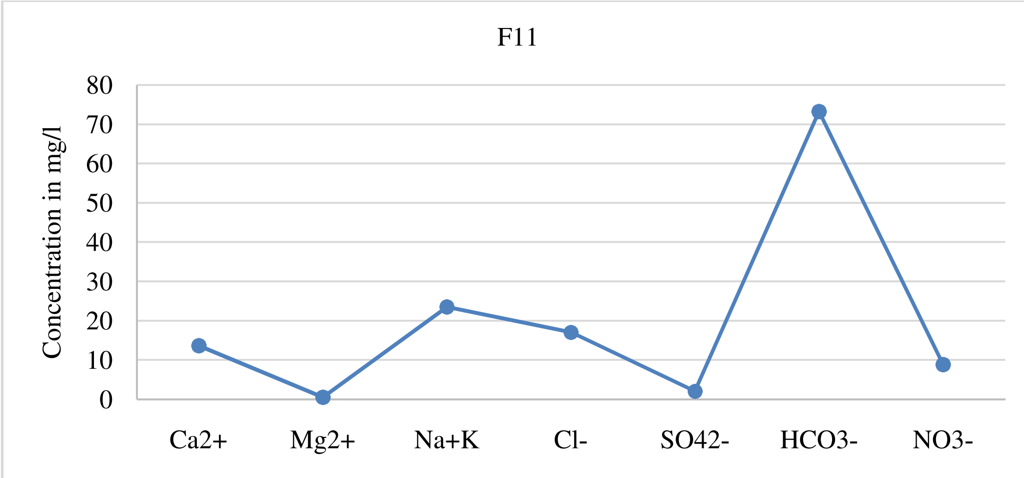

Figure-13: Representation of the Schöeller Berkaloff diagram of borehole 11 (F11) waters major ions. The borehole 11 waters possess has bicarbonate sodium-potassium characteristics.

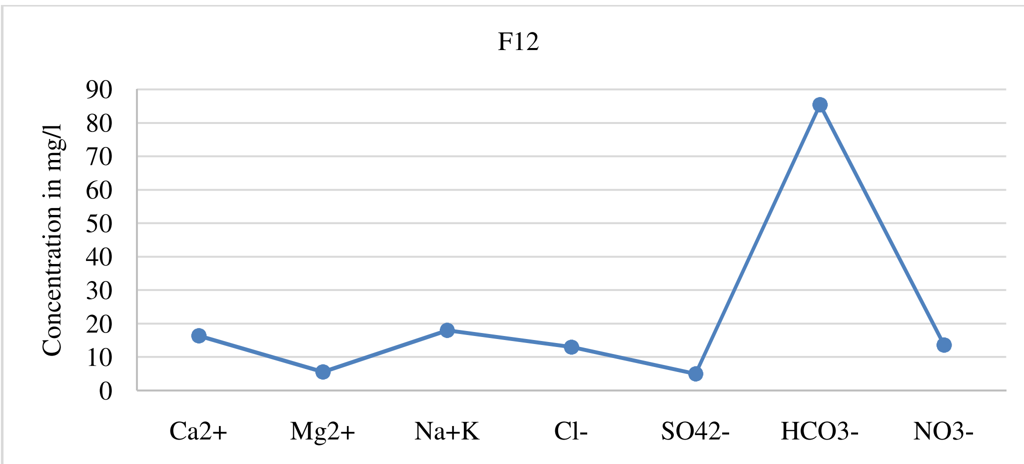

Figure-14: Representation of the Schöeller Berkaloff diagram of borehole 12 (F12) waters major ions. The borehole 12 waters possess chloride calcium characteristics.

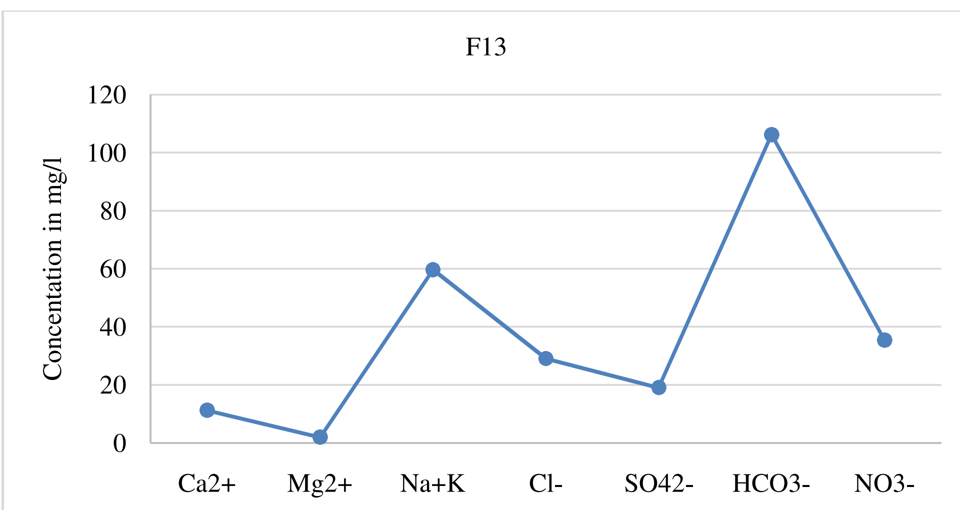

Figure-15: Representation of the Schöeller Berkaloff diagram of major ions in the waters of the borehole 13 (F13). The water from the F13 drill has bicarbonate sodium-potassium.

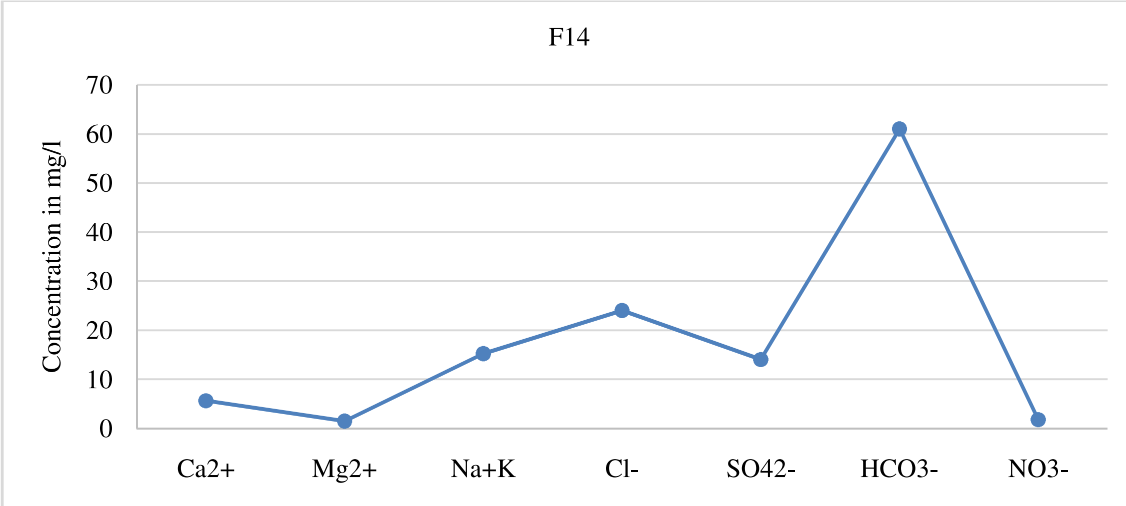

Figure-16: Representation of the Schöeller Berkaloff diagram of major ions in the waters of the borehole 14 (F14). The water from the F14 drill has bicarbonate sodium-potassium characteristics.

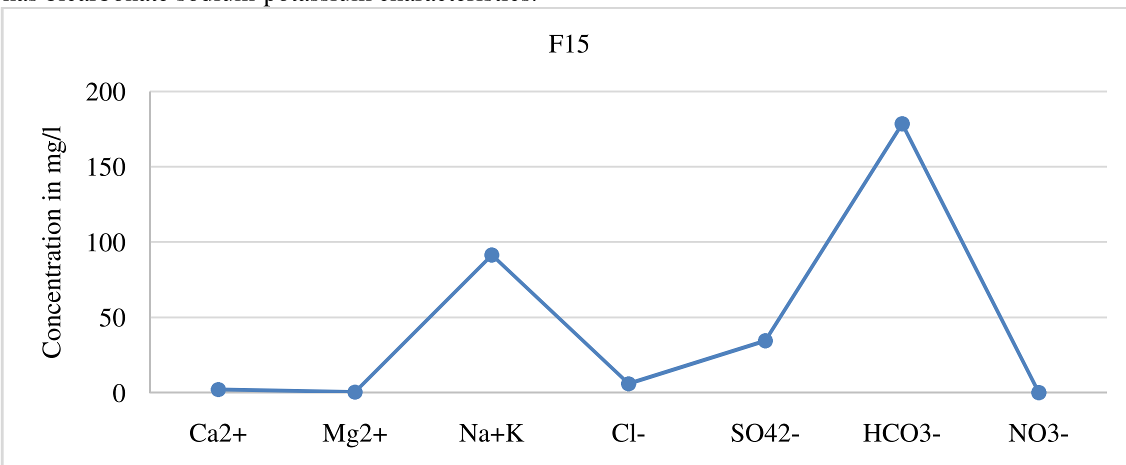

Figure-17: Representation of the Schöeller Berkaloff diagram of major ions in the waters of the borehole 15 (F15). The water from the F15 drill has bicarbonate sodium-potassium characteristics.

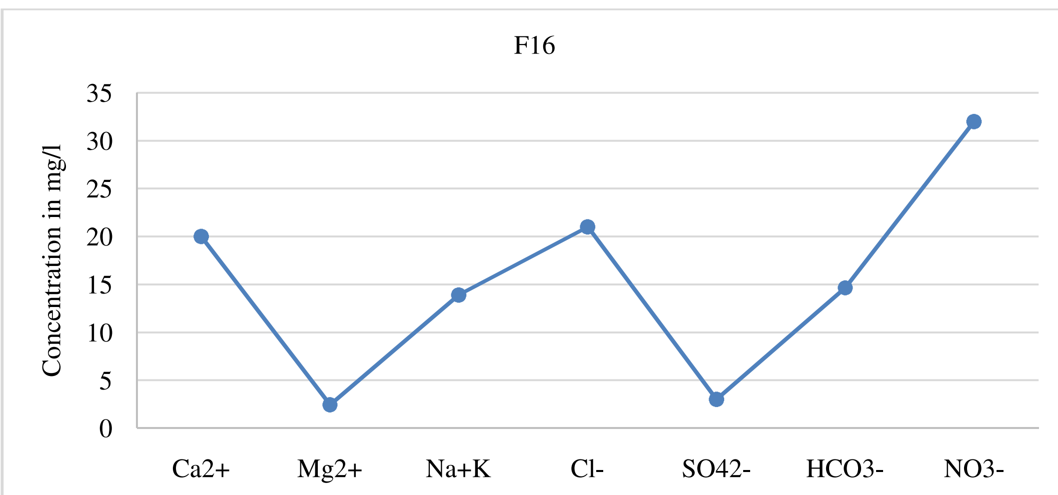

Figure-18: Representation of the Schöeller Berkaloff diagram of major ions in the borehole 16 (F16) waters. F16 water drill has chloride-calcium characteristics, with the presence of nitrate intrusion.

Conclusion

The results of the physicochemical analyzes show that the water collected by the different boreholes studied has the following characteristics: chloride of calcium on 12.5% of the boreholes, chlorureous sodium of potash on 6.25% of the boreholes, bicarbonate calcium on 6.25% and bicarbonate sodium-potassium on 75% of the boreholes. The bicarbonate characteristic predominates over chloride for the largest number of structures. Thus, for the same aquifer layer, the characteristic of the water varies according to the geological formations that exist in the zone and the spatial distribution of the sampling points. This indicates the importance of the hydro geochemical processes that govern the mineralization of these waters.

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