
# Integrated and Sustainable Management of Shared Aquifer Systems and Basins of the Sahel Region

RAF/7/011

# IULLEMEDEN AQUIFER SYSTEM

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# REPORT OF THE IAEA-SUPPORTED REGIONAL TECHNICAL COOPERATION PROJECT RAF/7/011

# IULLEMEDEN AQUIFER SYSTEM


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# 1. INTRODUCTION

The Iullemeden Aquifer System (IAS) shared between Algeria, Mali, Niger, Nigeria and Benin constitutes the main perennial resource of drinking water and a strategic resource for sustainable development of the concerned countries estimated to be 2000 km$^3$ (Fig. 1). The IAS faces multiple constraints in particular difficulties of access to water resources related to the excessive depth (over 600 m) in some regions. Moreover, the lack of sub-regional strategic water resources management has led to changes in aquifer hydro-dynamics and water quality degradation. These effects are caused by:

- Land use change, evaporation and outflow losses in the humid zones and recharge areas are important factors of the annual water balance.
- The increase in demand or overexploitation linked to population growth and economic development is hampered by the decline in the resources availability. The overexploitation level was crossed in 1995 according to primary estimates to 152 million m$^3$ per year.
- The aquifer is highly vulnerable to climate change impact from reduction of modern aquifer recharge.

The current knowledge level of the IAS including recharge and outflow areas, available resources and flow patterns is highly uncertain and comprised of uncoordinated and often contradicting country data. The uncertainty is further enhanced by international pressures, differences in country perceptions and potential conflicts over the shared aquifer resources. With high risk and scientific and policy uncertainties in a transboundary context, the approaches to joint management of the IAS need to be focused on reduced vulnerabilities and transparent responsibilities for identification, mitigation and accommodation and risk sharing.

### Previous studies on isotopes and hydrochemistry in the target area

Several regional projects have been supported by the IAEA and their focus has been on water resources shared by two or more countries. Over the last ten years, at the request of the concerned Member States (Mali, Niger and Nigeria), IAEA support has concentrated on the Iullemeden Aquifer. The RAF/8/038 project entitled “ Mise en valeur des systèmes aquifères des Iullemeden” as the continuation of the MSP/GEF regional project “Gestion des Risques

Hydrogéologiques dans le Système Aquifère d'Iullemeden" has been conducted by the IAEA (2007-2010) in order to improve the groundwater resources management in concerned countries of the IAS. Hydrochemical and isotopic techniques have been applied, in particular $^{2}H$, $^{18}O$, $^{3}H$, $^{13}C$, $^{14}C$ and the major chemical elements. These tools were used in the objective to identify the geochemical and isotopic signal of each aquifer, study the flow dynamics and identify the aquifer recharge periods (IAEA, 2010). One major outcome of this project has been to improve the understanding of the functioning of the Iullemeden basin aquifer system in Mali, Niger and Nigeria and to provide key parameters for the establishment of a groundwater flow model to help in the management of the water resources of the Iullemeden basin. The results from this project have led to the elaboration of awareness strategy elements in the management of transboundary risks. It has also reflected a well analyzed experience in the concerned countries, and assessed the scope for collaboration with current and future programs of participation and awareness in the field of natural resources or agriculture in each country.

From another hand, OSS (Observatory Sahara and Sahel) is carrying on the activities with support from the African development Bank in order to put in place tools for an integrated water resources management of the Iullemeden and Niger River, and is seeking collaboration and contribution of the Agency. The main results were the development of the numerical and hydrogeological model of the IAS (OSS, 2008).

## Objectives of the project RAF/7/011 in the target aquifer

The IAEA-supported project RAF/7/011 is an integrated approach to the efficient management of scarce water resources in West Africa. The long-term objective of the project is to promote the integrated management and sustainable development of the shared groundwater resources in the Sahel region. The specific objectives of the project are:

- Evaluation and better understanding of hydrogeological and geochemical processes controlling mineralization recharge conditions and flow pattern of Iullemeden Basin.
- Establishment of a common database between the countries through a data collection network for a better management of the shared water resources.
- Investigation of the vulnerability and climate variability /change impact on water resources of the IAS.

- Provision of scientific data for establishment of a Strategic Action Plan (SAP) in order to develop legal and institutional frameworks for better management and rational use of shared water resources.

# 2. STUDY SITES

## 2.1. Location, overall topography

The Iullemeden sedimentary basin, located in Mali, Niger and Nigeria, with minor areas in Algeria and Benin, covers a region of approximately 525 000 km$^2$ with about 31 000 km$^2$ in Mali, 434 000 km$^2$ in Niger and 60 000 km$^2$ in Nigeria. It extends for approximately 1000 km from 10$^\circ$N to 19$^\circ$N, and for about 980 km from 1$^\circ$E to 10$^\circ$E (Fig. 1). The current population in this area is approximately 15 million, with 65 % in Niger, 34 % in Nigeria and less than 2 % in Mali (OSS, 2008 and 2011).

The topographic relief comprises: mountain plateaus, semi-arid grassland and savannah plains, local and major flood plains covered by important dune systems. The Iullemeden aquifer system is dependent on the Niger River considered as the third longest River in Africa with a length of 4200 km. In Nigeria, the basin area is mainly undulating with depressions caused by wadis and water courses. The altitude of the land surface varies between 240 and 350m above sea level with resistant crusts of laterites and iron stones which outcrop the hills of the area. The two main rivers draining the Iullemeden are Rima and Sokoto rivers which flow into Niger which subsequently discharge into the Atlantic Ocean. These rivers all take off from the Mashika and Dunia highlands. In Benin, the altitude of Iullemeden varies between 160 (and 410 meters. High altitude values are recorded in the southern basin and these values decrease gradually toward the northern basin.

The Iullemeden aquifer system is multi-layered including a Cretaceous Continental Intercalary sedimentary aquifer at the bottom, overlain by three layers of Tertiary Continental Terminal formations. The IAS is located in Mali, Niger, Nigeria, Algeria and Benin, while the Paleozoic aquifers in Algeria and Benin are non-connected and do not fall within IAS.

The sedimentary Iullemeden basin is defined by the surrounding major mountain ranges with the Air to the north, the Adrar to the north-west and the Jos Plateau in Nigeria towards the south. In the east, along a line from the Jos Plateau to the Air chains, the basin is partly separated from the confined aquifers in the Chad Basin by the south-north Continental Dorsal., To the West, in Mali and Niger, the system is bounded by the Hamadien Sandstone and may be connected to the Tamesna extension basin to the west of the Adrar highlands through the Gao Trench. In the Southwest, the basin limit follows the basement range along the Niger River.

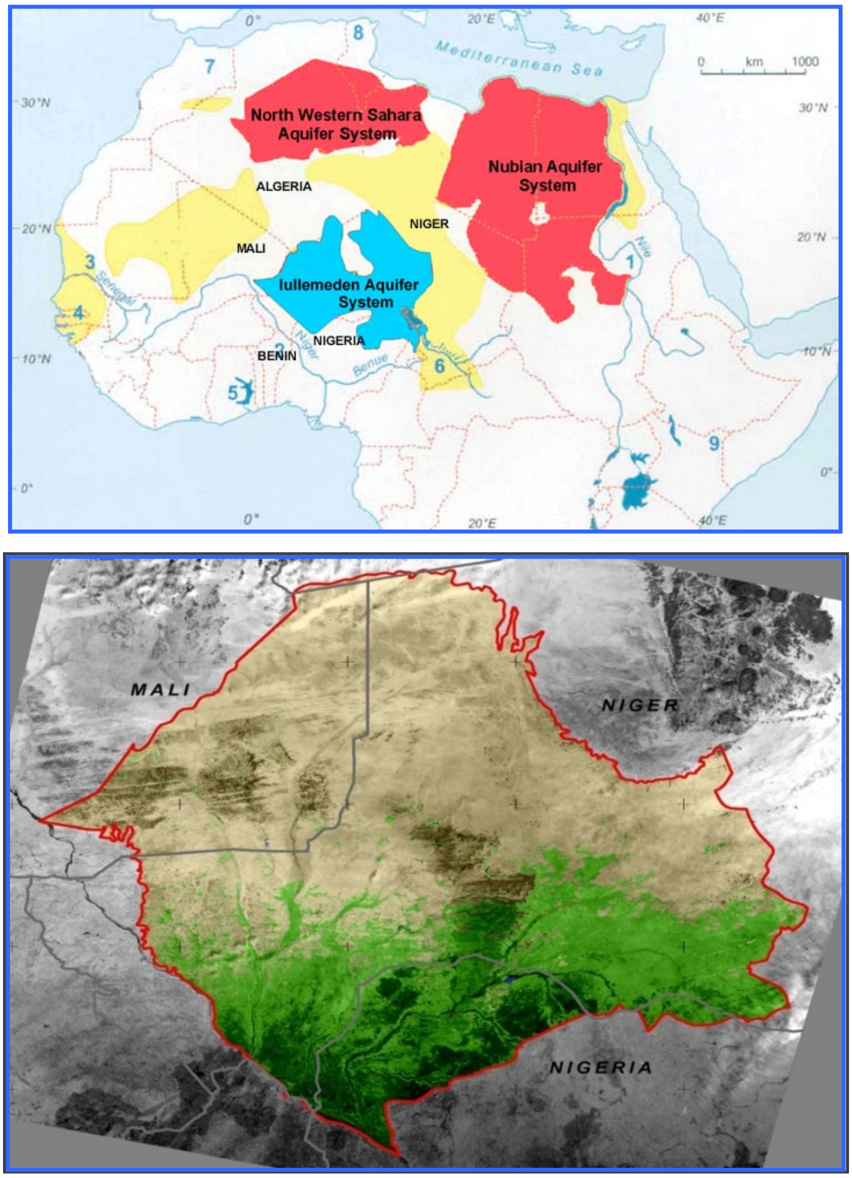



Figure 1: Location map of the Iullemeden basin (OSS, 2008)

## 2.2. Climatology

The land area overlying the Iullemeden basin is characterized by a tropical arid and semi-arid climate with a long dry season and a short and irregular wet season (Fig. 2). It corresponds to a portion of the water basin of Niger River, commonly known as "the Middle Niger". Rainfall in the Niger basin is marked by a strong gradient: less than 50 mm in the North to over 800 mm in the South. The position of the normal annual isohyets determined a following four climatic zones:

- Saharan zone (less than 150 mm);
- Sahelian nomads (between 150 and 300 mm);
- Sedentary (between 300 and 600 mm);
- Sahelian-soudanian zone (between 600 and 800 mm).

The basin area is prone to extended drought period. There are trends of long-term reductions in the rainfall and the 200 mm isohyets had advanced about 200 km towards the south during the Sahel drought, 1970-1985. Furthermore, the annual average rainfall in Nigeria is showing decline in rainfall amount (Fig. 2b).

The climate of the Iullemeden in Nigeria basin is tropical continental and dominated by two opposing air masses: tropical maritime humid from the Atlantic and dry tropical continental from the Sahara Desert. Temperatures are generally extreme with an average daily minimum of 19°C during the Hammattan periods from Decembers to mid-February while temperatures of over 40°C are common between June and September.

The rainfall in this area varies between 500-650mm annually. The wet season starts in May and ends around October while the dry season falls between October and May. In Benin basin, the climate is characterized by a unique rainy season from May to October with mean annual rainfall of about 973 mm and a mean temperature of 34.6°C. The annual mean potential evapotranspiration is 1668 mm which by far exceeds the annual rainfall.

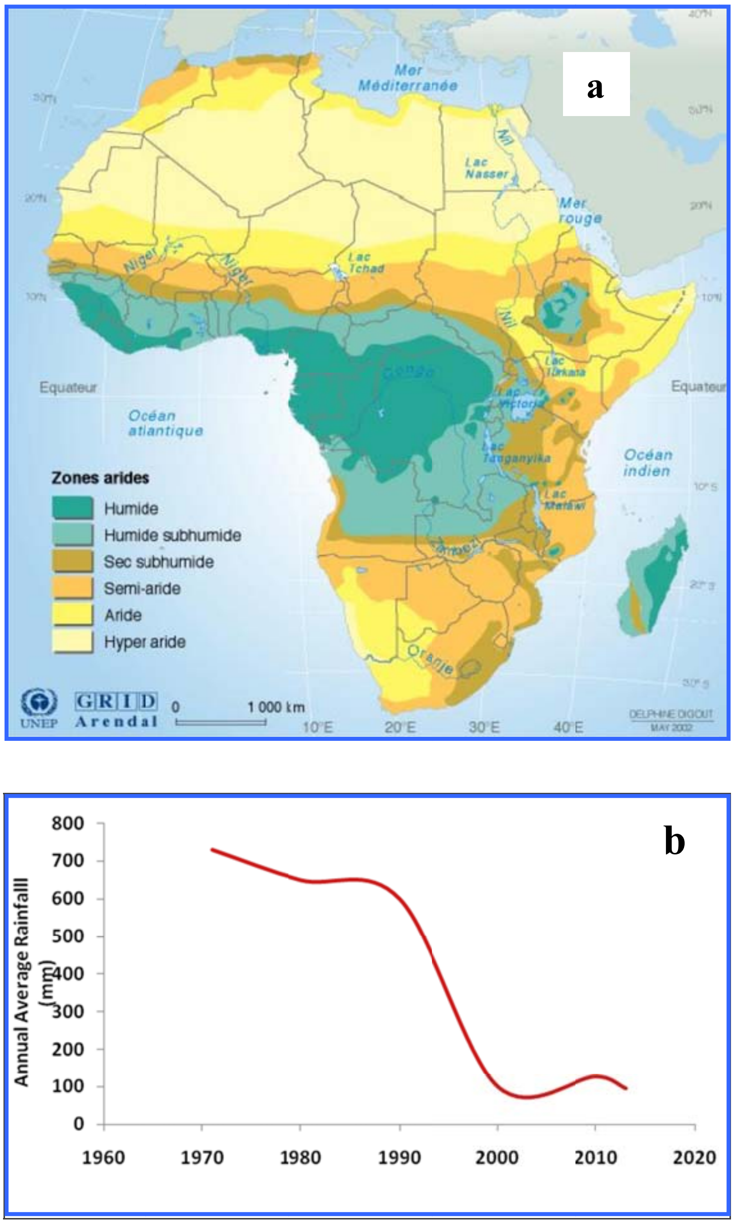



Figure 2: Spatial distribution of climate (a) and Annual Average Rainfall Distribution in The Iullemeden (Nigeria) Basin (b)

## 2.3. Land use and vegetation types

The soil moisture is subject to a large variation supported by seepage and evaporation from shallow groundwater tables in aquifer outflow areas. Changing land-use and deforestation are the main causes of land degradation and resulting loss of eco-systems, climate desiccation and dust production (Fig.3). Land use changes in recharge areas and humid zones influence aquifer recharge, modern water balance and the water quality of the aquifer resources. The related risks of change in water levels, loss of water resources and water quality degradation and salinization are also heightened with reduced precipitation increased temperature and high evapo-transpiration. Several states in Nigeria (Sokoto, Kebbi, Zamfara and Katsina) States have been identified under the Pan African Initiative (Great Green Wall Project) to be among the eleven frontline states in Nigeria suffering from the impact of drought and desertification. The consequence of a reverse trend with a raise in water levels on the other hand could lead to water logging and salinization with loss of land and water resources (GEF, 2003).

Figure 3: Droughts and water shortages induced by climate change in the Iullemeden basin

Consequently, the cultivated soils in Niger have a widespread organic matter and phosphorus deficiency. They are affected by a continuous fertility decrease, a trend to acidification, and sensitivity to water and wind erosion, a poor water retention capacity, alkalinization and salinisation events. It must be noticed that 80% to 85% of the lands suitable for cultivation are dunes and only 15% to 20% are hydromorphic and slightly clayey (SEDES, 1987). The mountainous areas and great plateaus (Aïr, Ader Doutchi, and Continental terminal) are dominated by litho soils. The fossil valleys (Dallols, Goulbi, Korama), the river valleys, the Komadougou, the lake Chad and the Manga basins are mainly dominated by hydromorphic soils and vertisoils (GEF, 2003; OSS, 2008; OSS, 2011).

The surveys on woody species likely to be lost by the National Agronomic Research Project in the departments of Diffa, Zinder, Maradi, Dosso and Tahoua, also reveal the effect of rainfall decrease on the extinction of many woody species.

## 2.4. Exploitation and water supply

The Iullemeden basin is being exploited by wells from 40 to 100 m, with a few deep exploratory and production boreholes up to 600 m depth, with flow rates generally between 20 and 100 $m^3$/hour. Significant current expansion in exploitation is taking place mainly in the southern part of the Mali section, in southern Niger and in the Sokoto basin in Nigeria. There are currently more than 23000 wells and boreholes including 400 active boreholes in Mali, 500 boreholes including 200 deep boreholes in Niger and more than 1200 registered boreholes in Nigeria.

The IAS is characterized by an irregular distribution of modern water points (boreholes and pastoral wells) and a high number of non-functional ones. The result is a concentration of people and livestock on these rare water points, resulting in increased pressure on water resources. To improve the population living standards and this important livestock particularly in the northern areas intended for pastoralism, highly vulnerable areas to recurrent droughts, drilling and especially pastoral, wells are increasingly realized. In Mali, for example, the area displays in 2006 170 wells and 251 modern wells for a total area of 31000 $km^2$ (with 33 445 inhabitants distributed in 170 villages and sites). The implementation of these wells in these arid areas helps to reduce the water potential of the Continental Terminal aquifer (GEF, 2003; OSS, 2008; OSS, 2011).

The water needs for industrial activities are both covered by the Niger River and groundwater from the Continental intercalary and the Continental Terminal aquifers. There is no industry in the part of the IAS in Mali. The annual water consumption from industries varies from a few thousand $m^3$ (most industrial units) to several hundred thousand $m^3$ (breweries and textile factories). Most of the water resources in Niger come from groundwater; most industrial and mining establishments have their own boreholes networks.

Regarding the area of Sokoto in Nigeria, groundwater exploitation estimated in 2000 for the industry, is about 800 million $m^3$ representing 10% compared to an annual total of 8 billion $m^3$ (GEF, 2003; OSS, 2008 and 2011).

## 2.5. Geology and hydrogeology of the Iullemeden Aquifer System

The Iullemeden Aquifer System is bordered to the North by the Hoggar, Aïr and "Adrar des Iforas mounts", which constitute the Tuareg shield, to the South by the plateau of Jos (in Nigeria) and to the West by Liptako-Gourma. In the eastern part, it is separated from the Chad Basin by the dorsal of the Damaga- Ram Mounio crystalline basement. This dorsal is not only a geological, but also a hydrogeological structure.

The IAS basin consists of sedimentary formations that range from the Cambrian-Ordovician to Tertiary and Quaternary. In this case, it is also shared by Algeria and represented the Cambrian-Ordovician formations. The main shared aquifers are the Continental Intercalaire aquifer (Cretaceous), the Continental Terminal (Tertiary) and the Quaternary (OSS, 2011) (Figs. 4, 5). In the southeast, northwestern Nigeria Basin, the Iullemeden aquifer system is known as the Rima Group with the Cretaceous Gundumi-Illo, Wurno and Sokoto group and the Tertiary Gwandu aquifers and the Kalambina limestone formation (GEF, 2003; OSS, 2011).

The IAS depths are generally large as evidenced from deep boreholes and geophysical records to 1500 – 2000 m below BSL. The upper limits of the aquifers are located at 100 to 400 m and reach beyond 1000 m near the Gao Trench. The water levels vary from 0 to 80 meters. In the North and middle section of the system, the aquifer is reached at 600 m with water level depth at 60 m which becomes artesian towards the South. The aquifer sections below 250 m BSL are not considered to present an active part in the modern hydrological cycle. The aquifers have medium to high permeability with a transmissivity, normally between $10^{-3}$ to $10^{-4}$ $m^2/s$ locally reaching $10^{-2}$ - $10^{-3}$ $m^2/s$ in the central part of the basin (OSS, 2008).

***The Continental Intercalaire***

The Continental Intercalaire (CI) aquifer is a set of the Gundumi and Illo geological formations in Nigeria. In both Mali and Niger, from bottom to top, the CI includes the Tegama sandstone, Farak clays and Continental Hamadien. In the western part of the Iullemeden Basin, the CI is covered by the upper marine Cretaceous formations or those of Continental Terminal aquifer. It is the largest multilayered-aquifer system in the Iullemeden basin. It is unconfined at its borders and confined at the center and the western part of Mali (Fig. 6). The groundwater is converging radially to the Niger River in the south-west of this area, the artesian aquifer is captive and the river is draining. The groundwater level in the unconfined part is generally quite deep, between 40 and 60 m. In Niger, in Tahoua and Dosso Departments (unconfined), groundwater levels are much shallower, often less than 20 m (Fig. 7). It has two drainage axes: the north-south at the base of the Azaouak wadi and the north-east/south-west at the Goulbi Maradi (Niger) - Sokoto (Nigeria). The respective average values of the hydraulic gradient are 2.6 $10^{-4}$ and 3.5 $10^{-4}$.

A highly transmissive sandy layer (average value about $10^{-2}$ $m^2$ /s) occupies the central part of the aquifer with its counterpart in the Sokoto Basin, Nigeria (Guindumi formation) (OSS, 2008; OSS, 2011).

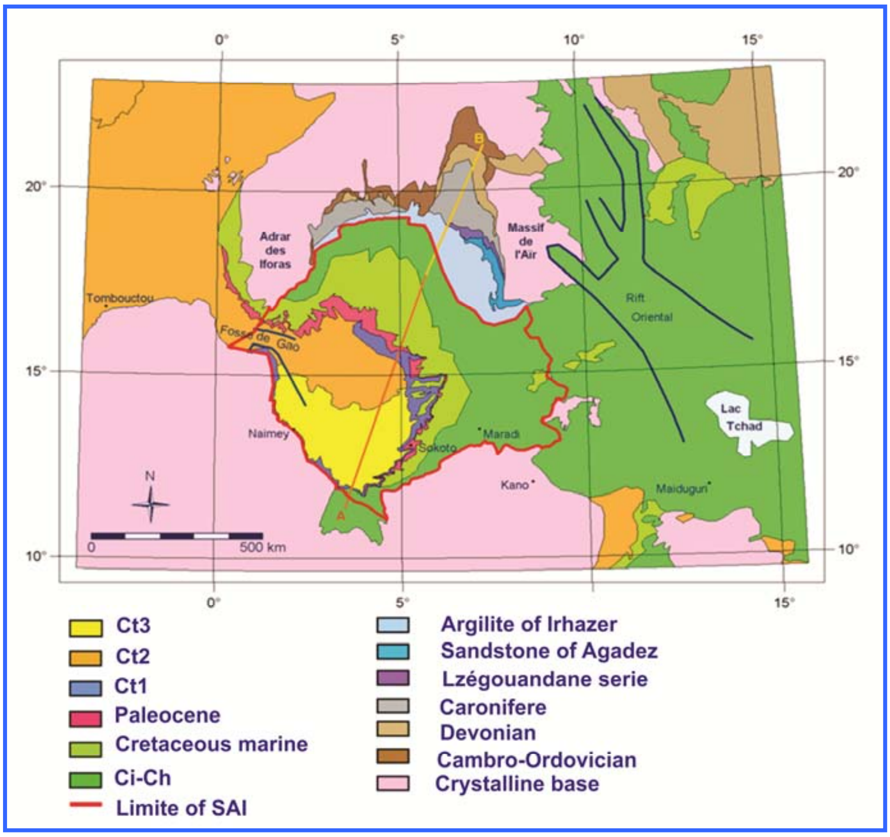



Figure 4: Geological map of the Iullemeden basin (OSS, 2011)


Figure 5: Extension of CT and CI aquifers in the Iullemeden basin (OSS, 2011)

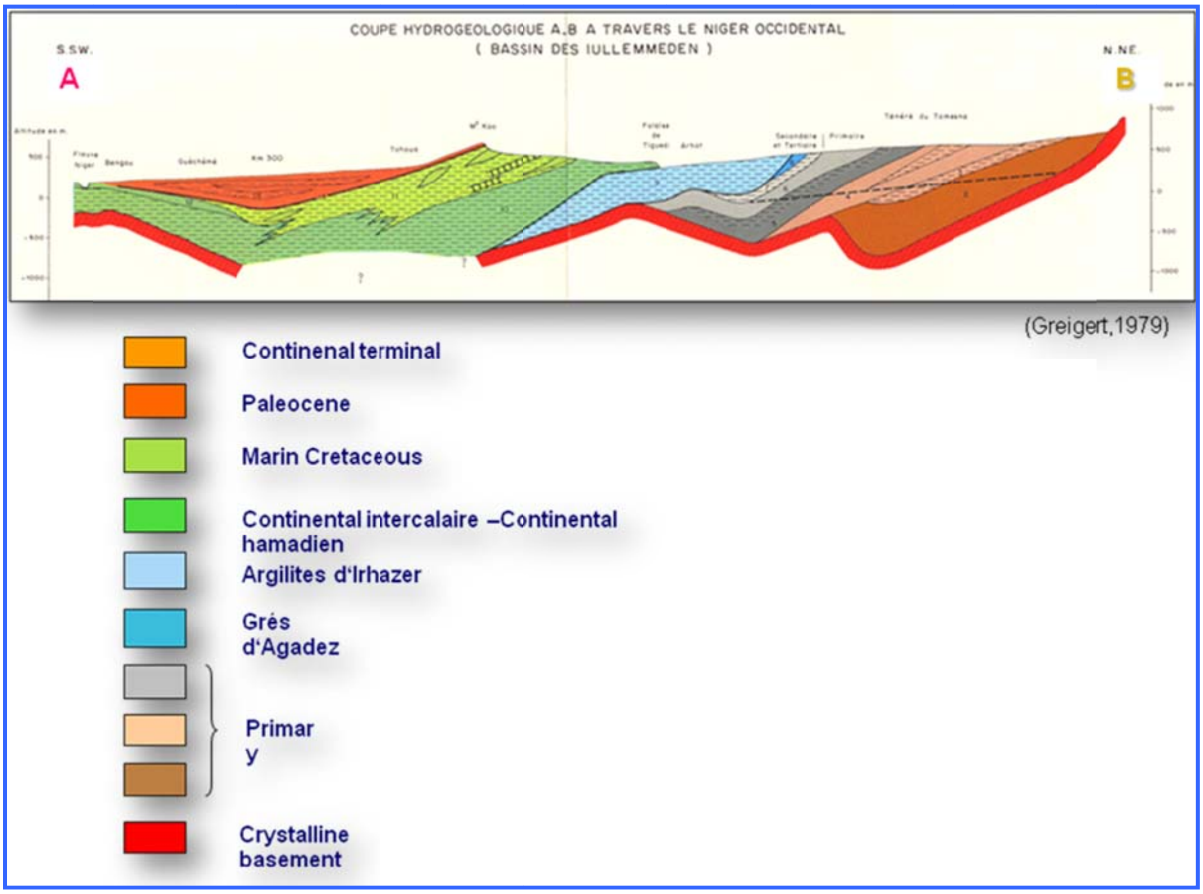



Figure 6: Hydrogeological cross section of the Iullemeden basin (OSS, 2011)

The specific yield ranges between 0.1 and 26 $m^3$/h/m in Niger. In the transmissive layer, it presents an average value of 13 $m^3$/h/m, with the minimum and maximum values of 7 and 26 $m^3$/h/m. In confined areas, the flows are almost higher than 50 $m^3$ by hour and may exceed 100 $m^3$ by hour. The major constraint of the economic perspective is the depth of the water point abstractions, especially in the confined aquifer: it ranges from 100 to 800m.

***The Continental Terminal***

The Continental Terminal (CT) is a multi-layer aquifer system in Niger, but only one layer in Mali and Nigeria (Gwandu). Much of the population lives on the CT area. Due to the easy accessibility and the good water quality, this aquifer system plays a fundamental role in the sustainable management of groundwater resources of the three countries. The Continental Terminal is contained in the Tertiary continental sediments constituted by alternating sand and clay with frequent rapid lateral and vertical changes of the facies.

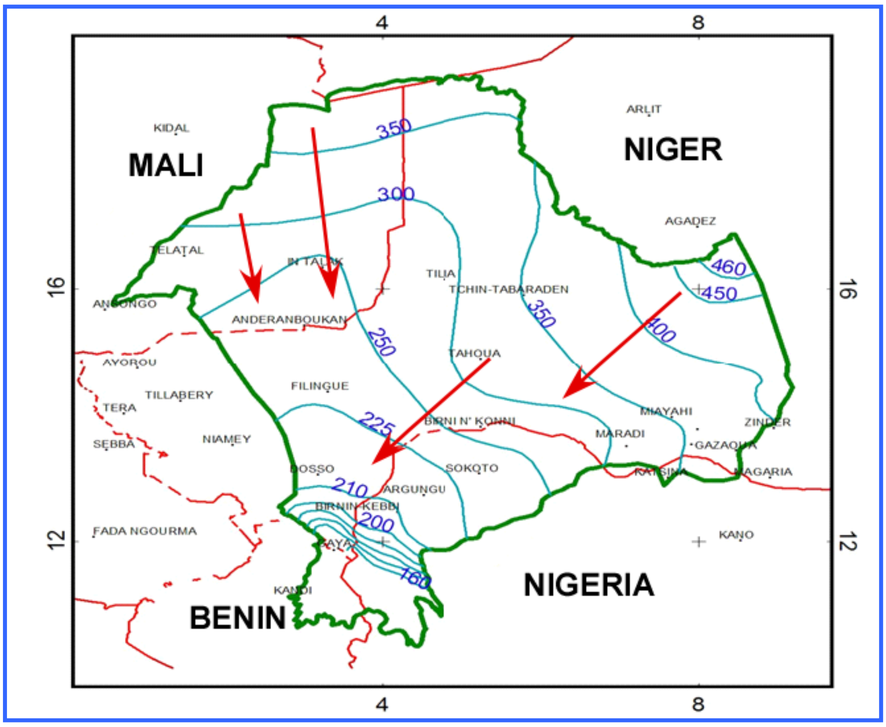



Figure 7: Potentiometric map of the CI (2007) (OSS, 2008)

**-Extension of geological and hydrogeological formations in the Niger basin**

In Niger, the Continental Terminal consists of three well recognized sets of aquifer formations: The Continental Terminal 1 (CT1) or "the Siderolithic Series"; the Continental Terminal 2 (CT2) or "the Clayey to sandy Series with lignite" and the Continental Terminal 3 (CT3) or "Series of clayey sandstone of the Middle Niger". Currently, these series are considered as formations as follow, from bottom to top:

- the lower sandy Series (CT1)
- the clays and greenish silts Series (CT2)
- the ferruginous oolites formation (CT2 or CT3)
- the clayey and silty gray Formation (CT3)
- the sandy or silty formation (CT3)

**a. The Continental Terminal 1 (CT1) (Confined)**

The CT1 is a confined aquifer except on its peripheral part. There is a sedimentological discontinuity in the western part. There is a hydraulic head dome elongated in a direction NW-SE, probably due to a recharge per vertical leakage (seepage). The general groundwater fluxes are oriented NE-SW and NW-SE. The groundwater level is still shallow and artesian, except in the western Tahoua where it can exceed 35m depth. In the Dallol Bosso and Maouri, the aquifer is artesian, where the heights of artesianism can reach 20 m. The average value of the hydraulic gradient is 4 $10^{-4}$. The transmissivity varies from $10^{-4}$ to $10^{-2}$ $m^2$ /s (Fig. 8).

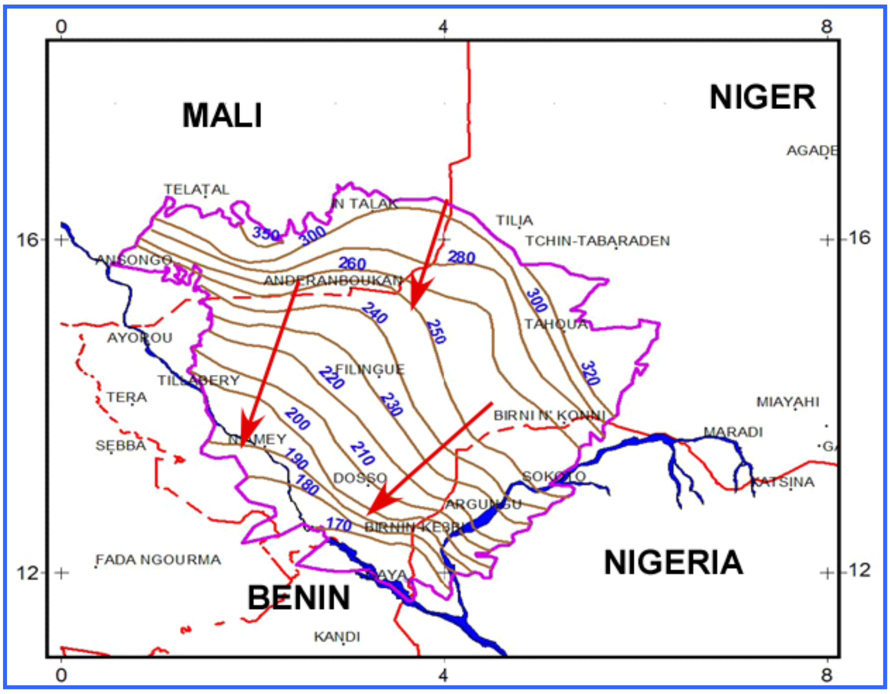



Figure 8: Potentiometric map of the CT (2007) (OSS, 2008)

**b. The Continental Terminal 2 (CT2) (Semi confined)**

To the west part, the lithology of the aquifer becomes sand- clayey and composed by the ferruginous sandstone with oolites. The aquifer is confined and radial convergent with major flux oriented NW-SE and NE-SW. Their respective average hydraulic gradients are 1.2 x $10^{-4}$ and 2 x $10^{-3}$. The potentiometric elongated dome is observed in the SE part of the aquifer in a NNE-SSW direction. The piezometric levels of this semi-confined aquifer are deep: between 30 and 60m except in the Dallols where the water level is less than 10m. At the plateau areas with the effect of topography, water level depth can be more than 80m. This aquifer is never artesian. The transmissivity values range from $10^{-3}$ to $10^{-2}$ $m^2$ /s.

**c. The Continental Terminal 3 (CT3 ) (Unconfined)**

The main drainage axes for this unconfined aquifer are oriented NW-SE and NE-SW. Their respective hydraulic gradients are 2 x $10^{-4}$ to 3.2 x $10^{-4}$. The CT3 aquifer is characterized by hydraulic head domes and depressions. The groundwater level ranges generally between 20m and 50m. In the lower "Dallols", it is very close to the surface; many permanent ponds are linked to the groundwater table. On the plates, the level is usually beyond 60m. Seasonal fluctuations of groundwater level have average amplitude of 65 cm. They reach 4m locally.

The exploitation of this aquifer is possible with wells. Outside "Dallols" areas, wells should be deep enough, until fifty meters in general., The aquifer is reached by the traditional wells, but the abstraction is not especially easy, either by the traditional system or by hand pump. However, the aquifer is vulnerable to pollution. Particular attention should be paid to the ancillary facilities of wells (curbs, anti-quagmire, and anti-slough, drinkers) to maintain water quality (GEF, 2003; OSS, 2008).

**-Extension of geological and hydrogeological formations in the Nigeria basin**

The north-western Nigeria sedimentary basin, representing the south eastern sector of the Iullemeden Basin and known locally as the Sokoto Basin, covers an approximate area of 6400 km$^2$. The sedimentary consist predominantly of a gently undulating plain with an average elevation varying from 250-400m above sea level. The sedimentary formations of the Sokoto basin range in age from Cretaceous to Tertiary constituted by some limestone, with the beds dipping gently towards the northwest (Fig.9). A laterite cap is overlying all the formations usually up to 12 m thick in some localities yielding water to most wells in the area. The distribution and occurrence of groundwater in Nigeria is based on the various geological units identified. The extent of any given area is defined by the limits of a group of rock types, geological formations or group of formations with similar hydrological conditions.

| SYSTEM | SERIES | GROUP | FORMATION | THICKNESS (m) | LITHOLOGIC CHARACTER | WATER BEARING PROPERTIES |
|---|---|---|---|---|---|---|
| **Quaternary** | Recent and Pleistocene | | | 0 - 15 | Unconsolidated silt and sand with some gravel in Fadama of Sokoto and Rima rivers | Yields small to moderate supplies of potable water to shallow wells. |
| **Tertiary** | Post-Eocene and Eocene | | Gwandu | 0 – 305 | Semi-consolidated fine to coarse sand and clay | Basal sand member yields moderate supplies to boreholes under artesian pressure. |
| | Paleocene | Sokoto | Kalambaina | 0 – 49 | Semi-consolidated clayey limestone and marl | Limestone yields small to moderate supplies to shallow wells and springs in outcrop area. |
| | | | Dange | 0 – 43 | Semi-consolidated blue to grey, plastic shale | Yields little, Forms confining bed for artesian water in the Wurno Formation. |
| **Cretaceous** | Upper Cretaceous (Maestrichtian) | Rima | Wurno | 0 – 46 | Friable sandstone and sand | Yields moderate supplies of unconfined water to boreholes under artesian pressure |
| | | | Dukamaje | 0 – 27 | Dark-coloured fossiliferous shale, etc. | Yields little or no water to wells and boreholes |
| | | | Taloka | 0 – 183 | Semi-consolidated fine-medium grained sand, etc. | Yields small to moderate supplies to boreholes. Under artesian pressure down dip |
| | Lower Cretaceous | | Gundumi and Illo | 0 – 305 | Semi-consolidated fine-coarse grained sand, etc | Yields small to moderate supplies of unconfined water to wells in outcrop area. |
| **Precambrian** | | | Basement Complex | Basement Rock | Granite-gneiss, phyllite and quartzite | Yields meagre supplies of water to wells in outcrop area. |

Figure 9: Stratigraphy of Iullemeden formations in the Sokoto Basin (Parker, 1964).

**a. Basement complex :**

Groundwater occurs in the weathered decomposed portion, the fractured areas and the portions associated with dykes.

**b. Gundumi Formation (CI) :**

Sedimentary rocks of Cretaceous age dipping westward and southwestward overlies this basement rock, the oldest member of the sedimentary series is the Gundumi Formation of cretaceous age. It consists principally of lacustrine deposits of Continental origin made up of quartz feldspar pebble, gravel and gritty clay sand. Groundwater recharge into the aquifer is mainly by infiltration of rain water and effluent streams. The groundwater potential is high with an average specific capacity about 57 $m^3\ d^{-1}\ m^{-1}$. The aquifer is shallow on the eastern side, while it is artesian in the western side.

**c. Illo Group (CI):**

Although similar in lithology to the Gundumi Formation, Illo group includes non-marine cross bedded pebbly sand and clay that underlie an area of about 6400 $km^2$ in the south western part of the Sokoto basin.

**d. Rima Group (CT):**

The Rima group is a transitional sequence from terrestrial deposits of the cretaceous Gundumi formation to the overlaying marine calcareous deposit of the Tertiary Sokoto Group. It is represented by marine deposits consisting of fine grained sand, loosely cemented sandstones mudstones and shale. The Rima Group thikness is estimated to be 220m at Sokoto and 300m at Gudu area (as artesian with free-flowing height of 9m). The outcrop area which is a strip from Goronyo to the east of Jega constitutes the main recharging area for the Rima Group aquifers covering an estimated area of about 13,600 $km^2$.

The Rima group could be subdivided into the Taloka, Dukamaje and Wurno formations with the Dukamaje which is a shale unit separating two aquifer units of underlying Taloka formation from the overlaying Wurno Formation. The Dukamaje formation in South of Sokoto River wedged out hence impossible to separate the Taloka and Wurno formations by surface mapping due to similar lithologies.

The Wurno formation consists of fine to coarse sand, silty sand, shale and sandstones with many layers of clay/shale within latter. It represents a moderate water yielding aquifer in the Sokoto basin (maximum thickness about 180m). The formation is a continuous layer with no clay intercalations in the vicinity of Sokoto. It is encountered between 80m-120m with borehole yields between 13.64-18.18 l/h at Kajiji and 40m at Yabo.

The Taloka formation consists of fine sand at Gwadabawa, Kyadawaand particularly around Ilela and Gada. The thickness of this aquifer is estimated to 90m at Aleiro. A decline in water table noticed around Sokoto metropolis was a result of over abstraction from numerous boreholes tapping the aquifer.

**e. The Sokoto Group (Paleocene) :**

The Sokoto Group is made up of marine deposits of Dange formation at the bottom and the limestone of the Kalambaina formation at the top which is the main aquifer. However, the Dange formation of the lower Sokoto Group could be stated to be more or less an aquitard. Many boreholes are tapping the Kalambaina aquifer but yield varies a lot seasonally and from place to another according to the clay contents. The fluctuations of water levels are very high. During, 1994-1998, 11 boreholes in Sokoto recorded average water table decline of 4.2 m.

**f. The Gwandu Formation (Eocene)**:

The Gwandu Formation uncomfortably overlies the Kalambaina and the other older formations in the northern and central parts of the basin. It crops out over 13600 km$^2$ in the Western part of the basin with sediments of Tertiary age made up of interbedded semi consolidated sands and clay. Four aquifers have been identified logged in sand layers in between clay layers designated as Upper Zone I, Upper Zone II, Middle Zone and the Lower Zone. This formation has the most reliable aquifers in the Rima basin with an average specific capacity ranging from 50-100m$^3$/d/m. Decrease in groundwater level over the years ranging from 70-150m has been observed in the northern fringe of Nigeria and Niger which had mainly been attributed to preponderance of wells resulting in over pumping. Generally, the Gwandu and the Gundumi-illo formations are the most prolific aquifers for groundwater development in the basin.

**Extension of geological and hydrogeological formations in the Kandi basin**

The Kandi basin is geologically a continental basin, of Paleozoic to Mesozoic age, with Cenozoic relics (Alidou, 1983; Boukari, 2007) (Fig. 10). The north-western part is larger (more than 2/3 of the basin) than the south-eastern part. The Kandi fault (direction N20-E) is the major fault in the basin. It corresponds to a major crustal fault in the scale of West Africa. Konate (1996) has established that this fault corresponds to a late Panafrican reverse to dextral strike-slip zone, which was reactivated successively as a normal, sinistral normal fault during first Paleozoic N65-E striking extensive event and the second Paleozoic N100-E striking extensive event, then as a sinistral and reverse fault during the Cretaceous (N-S to N140-E striking strike slip compressive event) (Fig. 10).

In this basin, the Paleozoic sediments are generally inclined 10° WNW (Konate et al.,, 1994). In the Precambrian formations, four stratigraphic units were identified based on the lithological, sedimentary and paleontological indicators from Cambrian up to the relics of the Continental Terminal (IRB, 1982; Alidou, 1983; Konate, 1996). Among these units, two main aquifers could be discriminated from the bottom to the top (Boukari, 2007). The first one is the Cambro-Ordovician aquifer known as Wèrè formation. It is composed essentially of conglomerates, breaches and fluvial sandstones (Konaté, 1996). The second aquifer is the Terminal Ordovician-Silurian aquifer known as Kandi formation. It is composed of tidal fine sandstones with a microconglomeratic bottom and siltites. In addition to these two aquifers, there is the Quaternary aquifer which is composed of alluviums deposits and could be found mainly along Niger River.

The Continental Terminal is constituted by coarse sandstones of the Mio-Pliocene. Even though it is called aquifer in some cases, it is not really a productive aquifer in the essential part of Kandi basin since it is not a geologically and hydraulically continued layer. Hence it is not exploited. However, the Continental Terminal appears to cover wider areas in Niger and Nigeria parts of the Iullemeden basin, therefore it is hydraulically a continued and an exploitable aquifer in Niger and Nigeria. The Cambro-Ordovician aquifer is usually semi-confined, but becomes unconfined in the western peripheral and the southern areas of the basin where it outcrops (Boukari, 2007). The areas where it outcrops correspond generally to the transition zone between the basin and the formation of the Proterozoic Panafrican basement.

The depth of boreholes in the basin ranges from 27 to 102 m (Achidi et al., 2012). The deepest ones are found around the township of Kandi and in the central basin. Most of these boreholes did not reach the Panafrican basement. The basin is less populated and borehole drilling stops once the obtained yield is considered sufficient to supply the population surrounding the boreholes. Borehole specific yields in the basin range from 0.005 to 19.8 $m^3$/h/m with highest values obtained along the Sota River, where the sediment deposits are thicker and the transmissivity varies between $2.10^{-6}$ and $7.10^{-3}$ $m^2$/s (Achidi et al., 2012).

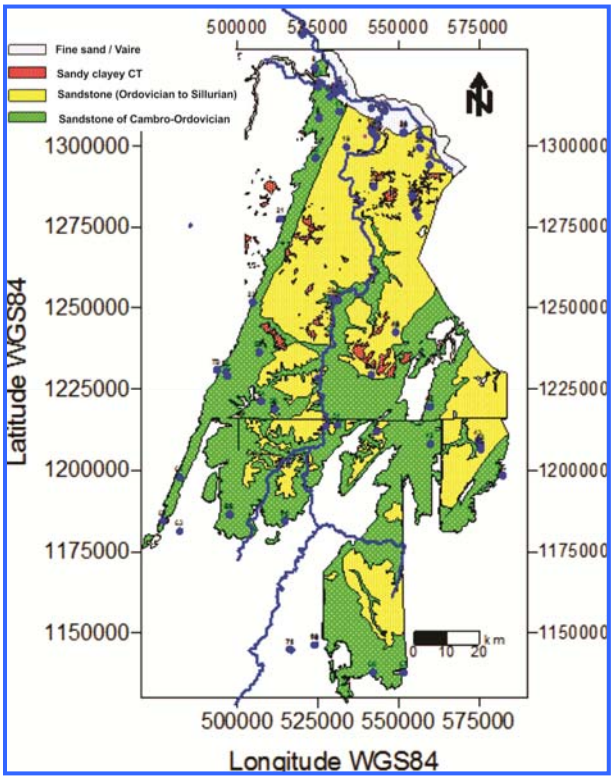



Figure 10: Geological map of the Kandi basin (Benin), (Kegpli et al., 2015)

The potentiometric map of the shallow water table shows that the hydrostatic groundwater level varies between 380 m and 150 m. The highest values are observed in the south and the lowest values in the north (Fig. 11). This highlights that recharge occurs mainly southern basin and groundwater flows towards the north, in *direction* of Niger River valley which constitutes the main natural discharge area (Kegpli et *al.,* 2015*).*

The Niger River is the biggest river that exists in Kandi basin (as its northern limit). It has two tributaries in the basin that are from West to East Alibori and Sota, all characterized by a permanent flow. Sota river actually finds its source in the southern Kandi basin, at an elevation of more than 400 meters a.s.l. (above sea level), on a hill around Kalalé township. It flows throughout and drains the whole basin with a minimum yield of 3 to 6 $m^3/s$ occurring in April or May (Le Barbé *et al.,* 1993). Its maximum yields recorded so far at four stations (usually in September) are between 250 and 400 $m^3/s$ (Vissin, 2007). It is connected to several intermittent rivers such as Tassiné and Bouli (Fig. 11) and finally discharge into Niger River around Malanville Township.

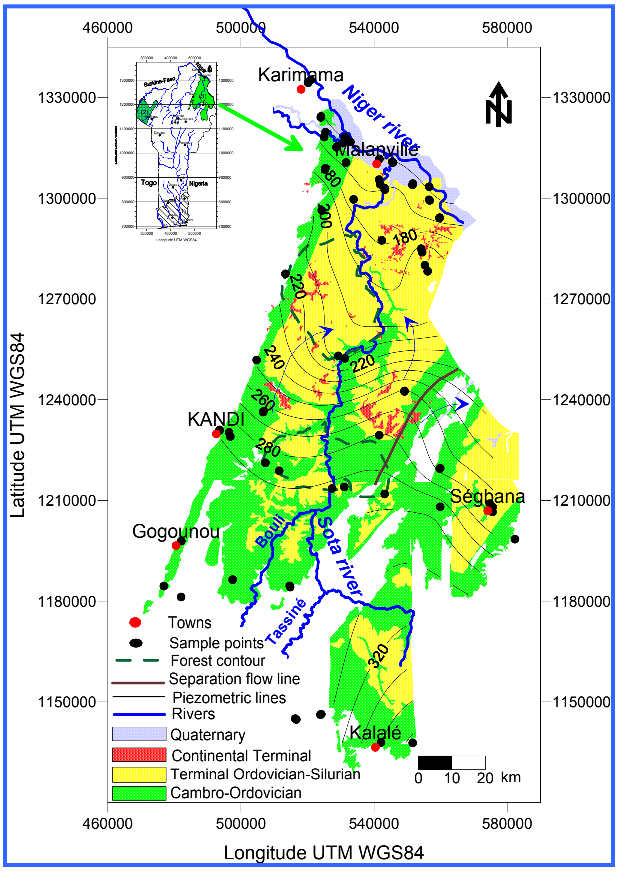



Figure 11: Potentiometric map of shallow aquifer of the Kandi Basin in 2013 (Kegpli and *al.*, 2015)

## 2.6. The Iullemeden Aquifer System: Water balance

The total exploitable water reserves of IAS are estimated to about 2000 $km^3$, corresponding to about 4000 mm over the entire basin area. IAS is an important strategic reserve of high sub-regional significance that equals 50 years of the flows in the Niger River. The storage ratio in the confined areas is generally high, 25,000 $m^2/km^2$ along the Mali-Niger border and 15 000 $m^2/km^2$ in southern Niger and Nigeria. The annual modern recharge is substantial, however the total water resources comprise to a great extent large volumes of fossil water replenished under the earlier wetter climate conditions in the Pleistocene and Holocene. A similar relation of large storage reserves and substantial modern recharge had been confirmed for the IAS in

Nigeria. The conditions for planned, sustainable groundwater mining vary over the basin but form an important management option that will be addressed under project. The approximate annual water balance for IAS in Niger between the total inflow from recharge of 70 $m^3$/sec and the outflows as: (a) evaporation losses, 50 $m^3$/sec, (b) current water abstractions, 10 $m^3$/sec and (c) drainage outflow, 10 $m^3$/sec to the Niger River, of high importance for maintaining dry season and drought low flow in the Niger River and other surface water courses. The Iullemeden water balance reflects the importance of the modern recharge and the ecologically important evaporation and outflow losses in the humid zones (GEF, 2003; OSS, 2011).

# 3. DATA ACQUISITION AND METHODOLOGY USED

Sampling of groundwater and surface waters within the study area was carried out intermittently at several periods and has concerned only three countries: Niger, Nigeria and Benin. Due to field security problems in Mali and Algerian territories, the water samplings were not realized. A total of 471 samples were collected from the Iullemeden Aquifer System. The spatial distribution maps of the sampling points were carried out using the software package of Arc GIS (Ver. 10.2), like this (Fig.12):

-Sampling in Niger (Dosso) area was carried out during 3 campaigns: Campaigns 1 and 2 were supported by the RAF 7011 project and comprise chemical and isotope analyses. However, the third Campaign was carried out by the Niger Water Resources Division and comprises only chemical analyses. A total of 157 groundwater samples were taken from the existing wells and boreholes of Niger in March 2013 (campaign 1) and January 2014 (campaign 2).

-Sampling in Nigeria was carried out during 3 campaigns. A total of 149 samples were collected from wells and rivers in July 2013 (campaign 1), April 2014 (campaign 2) and November 2015 (campaign 3).

-Sampling in Benin was carried out during 3 campaigns. A total of 165 samples were collected from wells and rivers in March 2013 (campaign 1), October, November, December 2013 (campaign 2) and April 2016 (campaign 3).

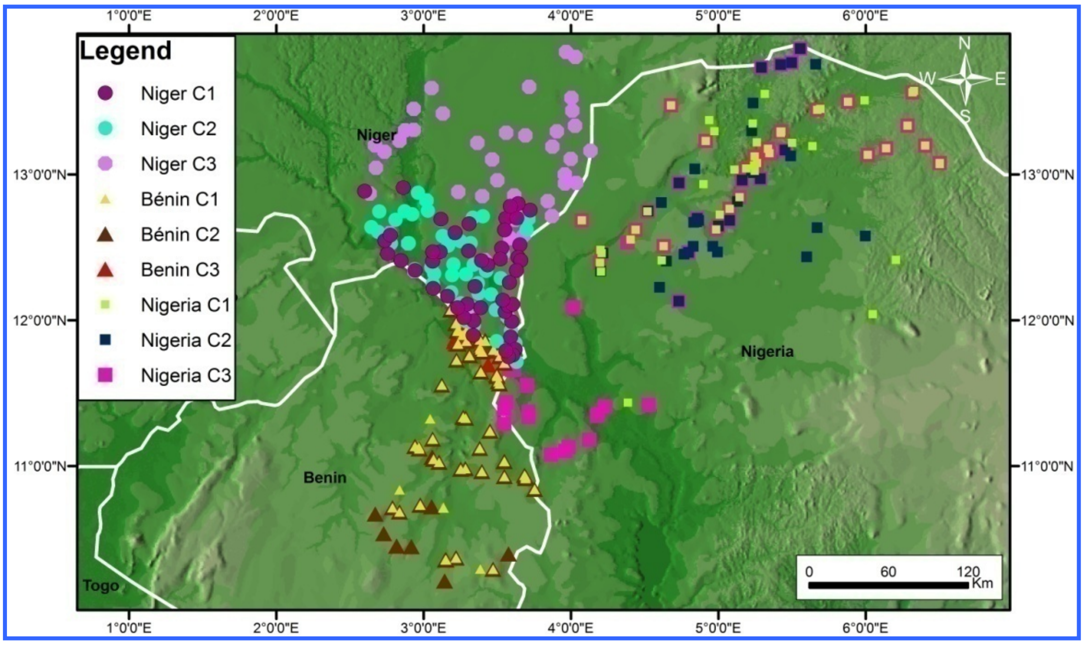



Figure 12: Location of sampling points within the Iullemeden basin.

In *situ* measurements of pH, temperature and electrical conductivity (EC) were performed (Annex). Water samples were collected in 1000 ml polyethylene bottles with poly–seal caps for major elements after the stabilization of pH, electrical conductivity and temperature. Chemical analyses and isotopic measurements were performed at the Radio–Analysis and Environment Laboratory of the National Engineering School of Sfax (Tunisia) and the isotope hydrology laboratory of CNESTEN (Morocco).

Major elements ($Na^+$, $Mg^{2+}$, $Ca^{2+}$, $K^+$, $Cl^-$, $SO_4^{2-}$ and $NO_3^-$), were analyzed by means of high performance ion liquid chromatography (HPILC) equipped with both columns for anions and cations. The overall detection limit for ions was 0.04 mg/l. The $CO_3^-$ and $HCO_3^-$ concentrations were analyzed in the laboratory by titration using 0.1 N HCl. The ionic balance for all samples was within ± 5%.

Stable isotope ratio ($^{18}O/^{16}O$ and $^{2}H/^{1}H$) analyses were performed using the Laser Absorption Spectrometer LGR DLT 100 (Penna et *al.,* 2010). Results are reported in ‰ versus V-SMOW standard (Vienna–Standard Mean Oceanic Water).

Tritium analyses were performed using electrolytic enrichment and liquid scintillation counting (Taylor, 1976). $^{3}H$ concentration is expressed in Tritium Units (TU). One TU is defined as the isotope ratio $^{3}H/^{1}H= 10^{-18}$.

Radiocarbon and $^{13}C$ analysis were performed only on 8 samples from Benin at Laboratory of Groningen University (Germany) using the RMS method. Carbon-13 analyses were carried out using a mass spectrometer and the results are expressed in $\delta$ values as ‰ relative to the Vienna-Pee Dee Belemnite standard (V-PDB).

# 4. RESULTS AND INTERPRETATION

## 4.1. Geochemical data of the Niger basin (Dosso)

### 4.1.1. Hydrochemical study of the Niger basin (Dosso)

The Dosso basin is part of the transboundary Iullemeden sedimentary basin (shared between Algeria, Niger, Nigeria, Mali and Benin). It is located in the SW part of the Iullemeden Basin belonging to Sahel zone and characterized by a semi-arid climate. The present IAEA-supported project RAF/7/011 has afforded a large geochemical and isotopic database (157 samples) in Dosso basin in order to identify, analyze and assess risks that may affect the groundwater resources in this area (Fig. 13).

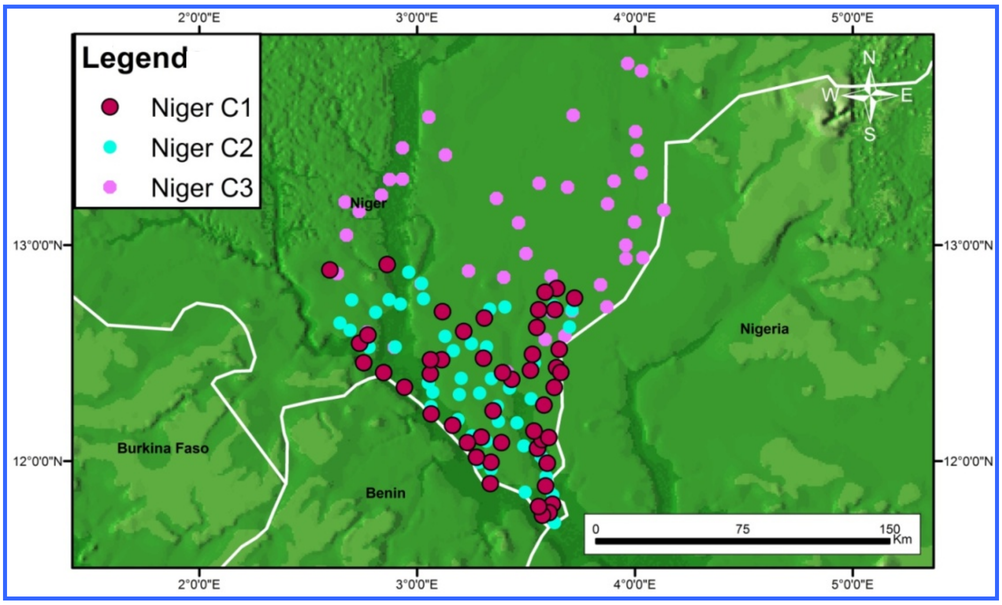



Figure 13: Location of sampling points within the Iullemeden basin (Dosso-Niger).

**- Electrical Conductivity**

The Electrical Conductivity (EC) varies from 13 to 2,700 µS/cm. The waters from the different geological formations show differences in the EC in terms of both mineralization and variability. CT3 groundwater shows the lowest mineralization and little variability. However, CT1 groundwater is the most homogenous with the highest mean value of EC of about 1000 µS/cm (Fig.14).

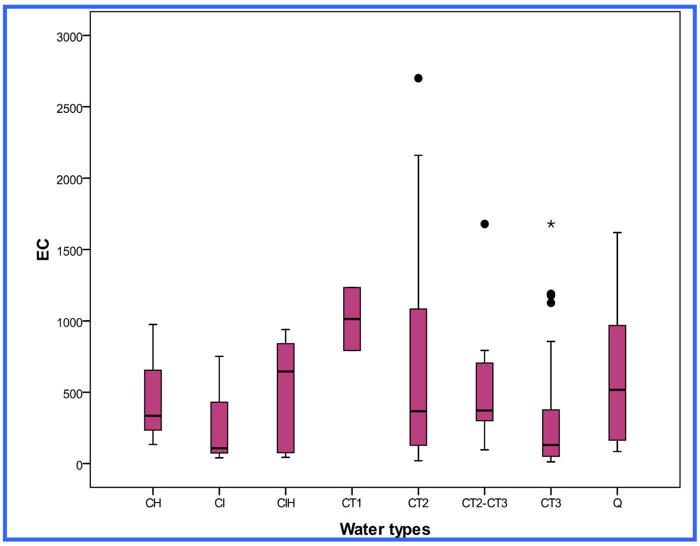



Figure 14: EC distribution in groundwater of the Dosso-Niger basin

**- pH**

The pH values vary from 5.4 to 8.5. Opposite to the behavior of EC, pH values cluster in 2 groups; the first shows basic pH values while the second neutral. The pH basic group traduces higher values for the total alkalinity which is probably due to a mineralogical source of Na (K) given alkaline bicarbonate or dissolved hydroxide in the water (Fig. 15).

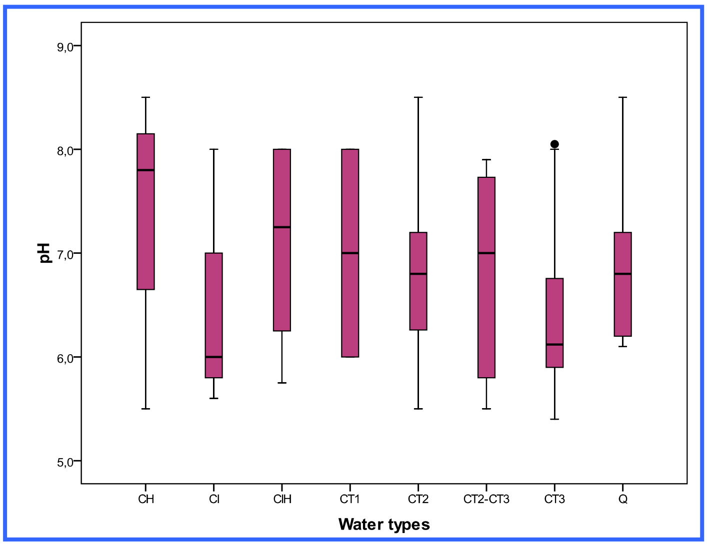



Figure 15: pH distribution in groundwater of the Dosso-Niger basin.

**- Temperature**

Groundwater temperature shows small variations; from 26.8 to 35.8°C which is consistent with the annual atmospheric temperatures in this zone. However, there is a systematic small bias on temperature measurement between the aquifers. Nevertheless, temperature seems to be measured in enough good condition, without excessive exposure to the atmosphere, with the exception of 4 points (Fig. 16).

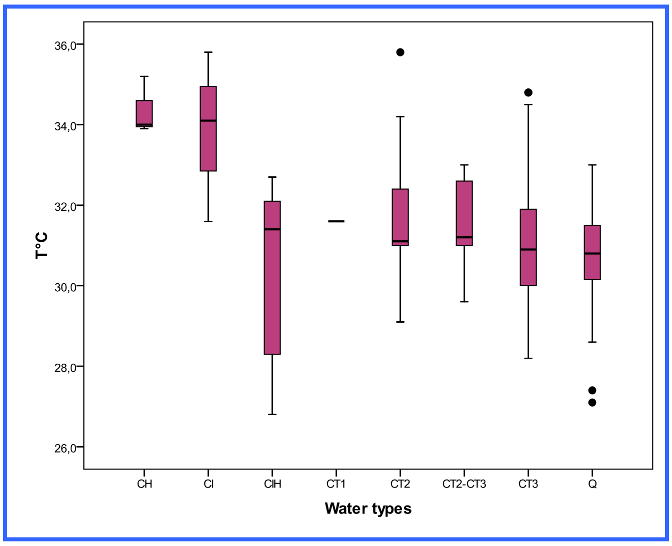



Figure 16: Temperature distribution in groundwater of the Dosso-Niger basin.

**-Total dissolved salts**

The values of total dissolved salts (TDS) measured on wells and boreholes of Dosso area range from 13 to 2700 mg/l. The lowest values are recorded in CT3 aquifer while higher values were observed in CT2 aquifer. Comparing TDS (Fig. 17) and Electrical Conductivity, there is a good agreement except 4 points, where the correlation is not fine. The two samples points, plotted above the general trend, show high contents in bicarbonate, sulfate and sodium which is not consistent with low EC measured in the field.

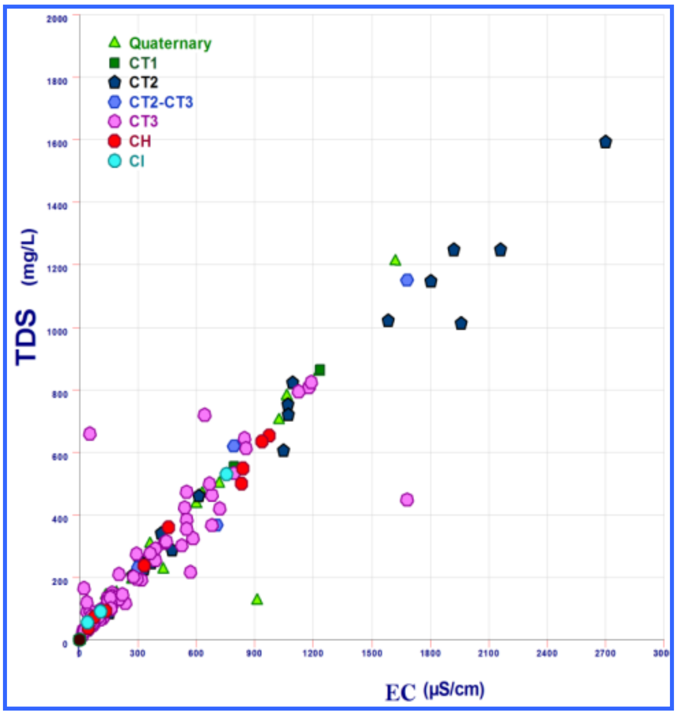



Figure 17: EC versus TDS in groundwater of the Dosso-Niger basin.

**- Cations**

Calcium shows lower values in continental Hamadian CH aquifer with a low variability. The others ground waters from Q, CT2 and CT3 have more or less mean calcium contents around 20 mg/l (Fig. 18). The whole formations have low magnesium contents which follow the same behavior as Ca (Fig. 19). Sodium shows mainly lower content in CT3 and higher content in CT1 (Fig. 20). All aquifer groundwater show very low potassium content (Fig. 21).

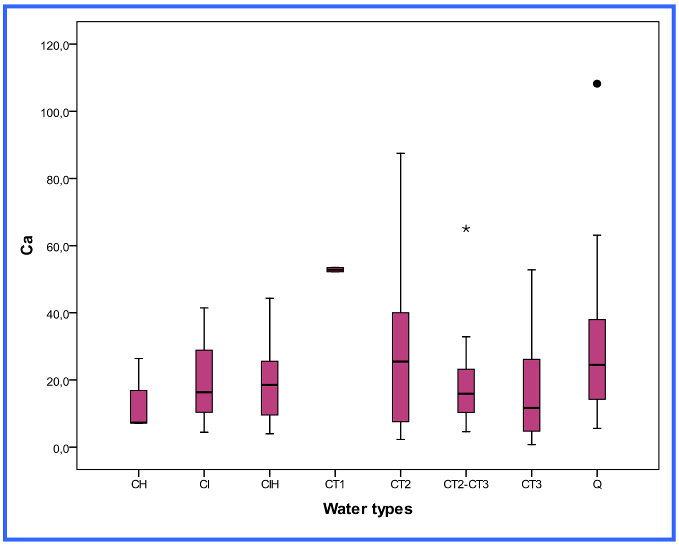



Figure 18: Variability and distribution of Ca in groundwater of the Dosso-Niger basin.

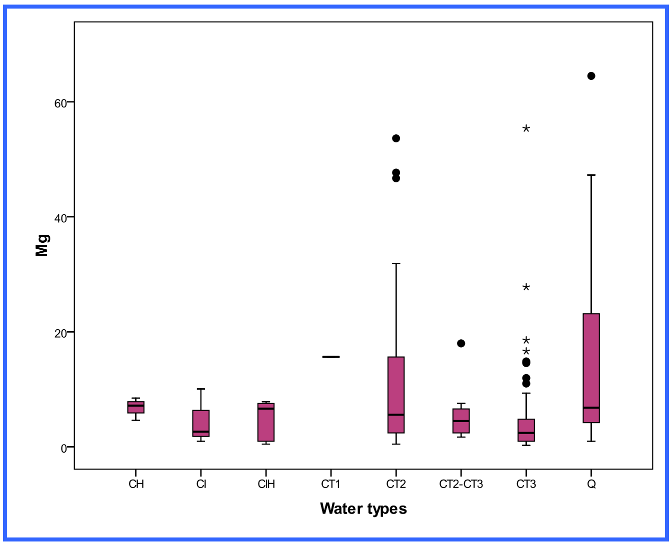



Figure 19: Variability and distribution of Mg in groundwater of the Dosso-Niger basin.

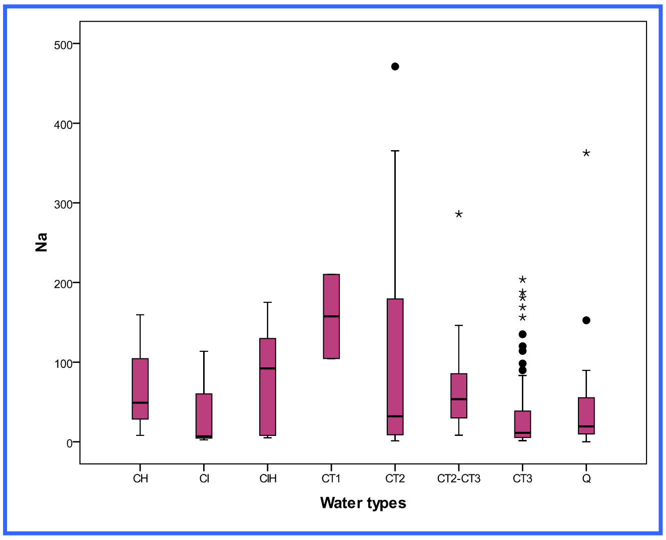



Figure 20: Variability and distribution of Na in groundwater of the Dosso-Niger basin.

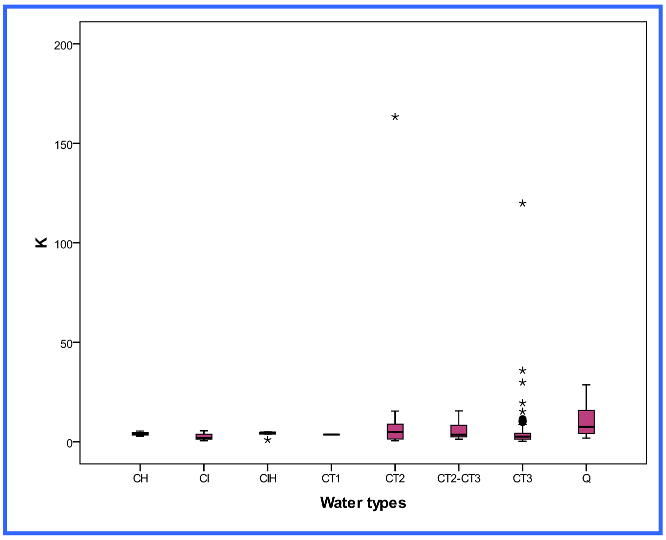



Figure 21: Variability and distribution of K in groundwater of the Dosso-Niger basin.

**- Anions**

Bicarbonate values (Fig. 22) range from 1.2 and 365 mg/l. CT3 groundwater show lower contents in correlation with the lower EC. CT1 and CIH show the highest values of bicarbonate contents. According to geological information of these two aquifer formations in the study zone, it seems obvious that the existing limestone contributes to water mineralization.

Chloride contents of CT3 show low values corresponding to the natural level (< 10 mg/l) (Fig. 23). For CT1, CT2 and CIH almost values show a higher level (30-210 mg/l). It seems that their higher content in sodium is linked to bicarbonate and chloride contents either.

Sulfate contents (Fig. 24) show high values for CT1 ground waters (62.9-278.9 mg/l) which have the highest EC and low values (< 50 mg/l) in CH, CI, CT2-CT3, CT3 and Quaternary. In CT1 formation, sulfate concentrations reach 278.9 mg/l, anion prevailing in this groundwater associated in this case with a high content in sodium, which may be linked to evaporitic minerals locally (gypsum, thenardite or glauberite).

The nitrate contents in the groundwater of the investigated aquifers of Dosso are generally low to moderate (< 40 mg/l) (Fig. 25). Only few groundwater samples from the Quaternary and the CT3 aquifers showed high nitrate concentrations exceeding 50 mg/l, the maximum value recommended for drinking water by the WHO organization (WHO, 2006). These high nitrate concentrations were found at very shallower depths (varying between 2.1 and 22.6 m) (Fig. 26) and their tritium contents range between 1.5 and 5.7 m.

In general, nitrate contents in the Sahelian region is naturally occurring in the soil with specific vegetation like acacias which is a nitrogen-fixing tree, termite also can produce nitrogen and the groundwater can show high content in nitrates (Ngugi and Brune, 2012).

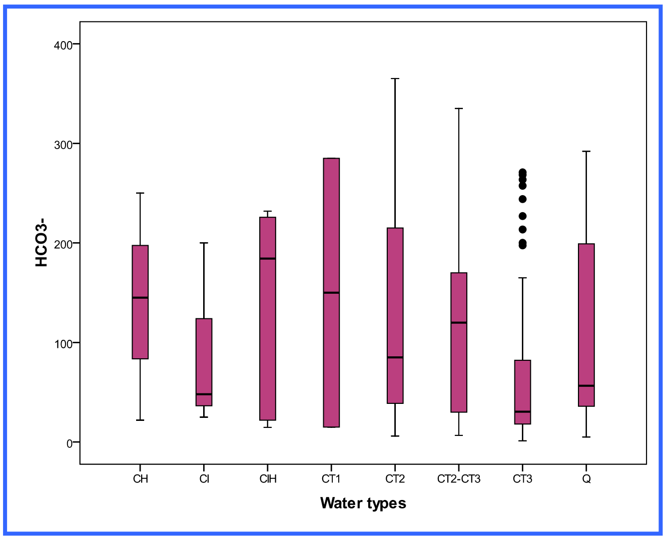



Figure 22: Variability and distribution of $HCO_3$ in groundwater of the Dosso-Niger basin

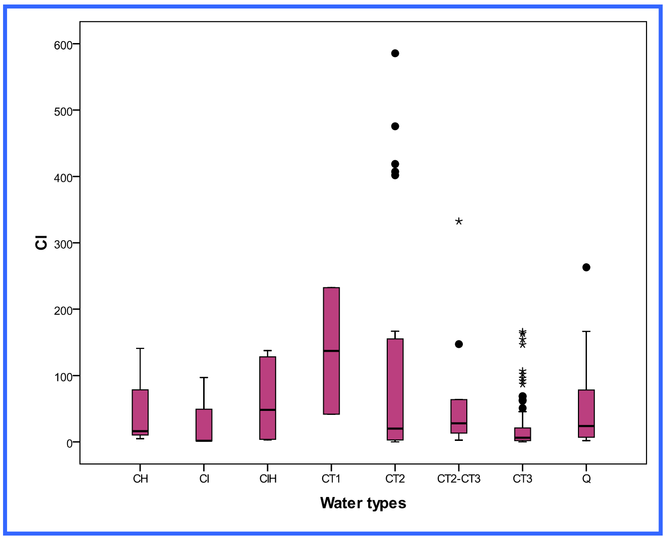



Figure 23: *Variability and distribution of Cl in groundwater of the Dosso-Niger basin*

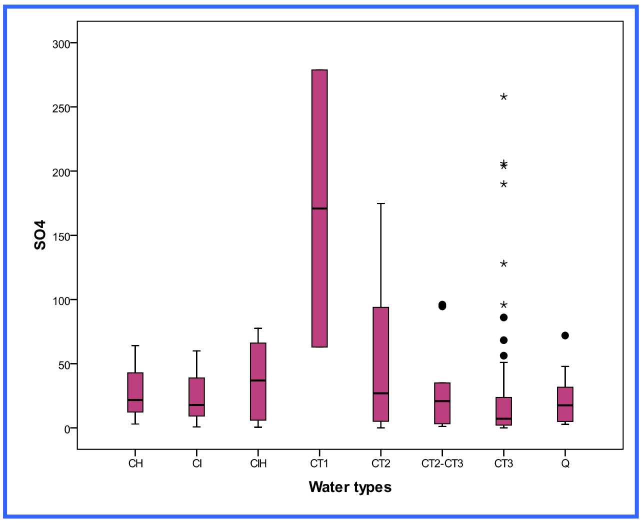



Figure 24: *Variability and distribution of $SO_4$ in groundwater of the Dosso-Niger basin*

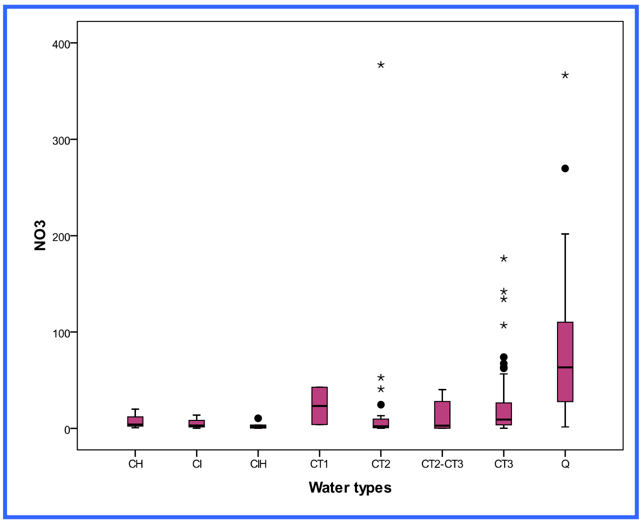



Figure 25: *Variability and distribution of $NO_3$ in groundwater of the Dosso-Niger basin*

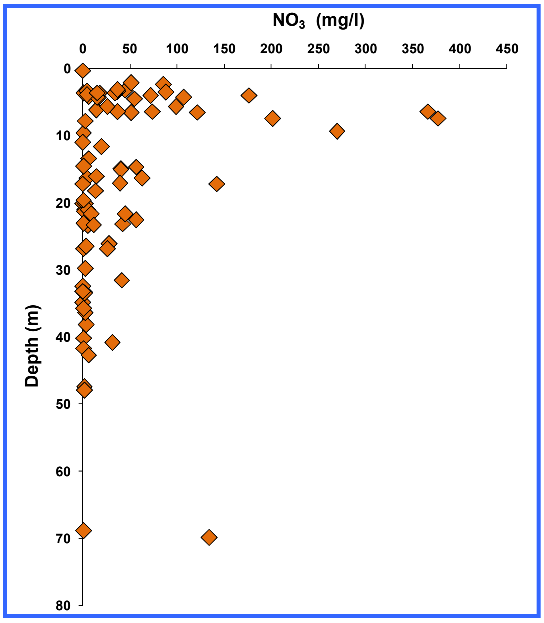



Figure 26: Nitrate distribution with depth in groundwater of the Dosso-Niger basin

**- Hydrochemical facies**

The chemical composition of the analyzed samples was plotted on the Piper trilinear equivalence diagrams shown in Figure 27. The general distribution in cations diagram shows a slight enrichment in sodium comparing to other cations. In anions diagram two general trends could be identified (i) between $HCO_3$ and Cl-$NO_3$ poles and (ii) between HCO3 and SO4. In details, several water types could be identified:

- Ca-Mg-$HCO_3$ water type;
- Na-K-Cl water type;
- Ca- Cl - $SO_4$ water type;
- Na-K-$HCO_3$ water type.

The large spatial variability of hydrochemical facies observed in the analyzed water samples could be related to physical and chemical weathering reaction of minerals.

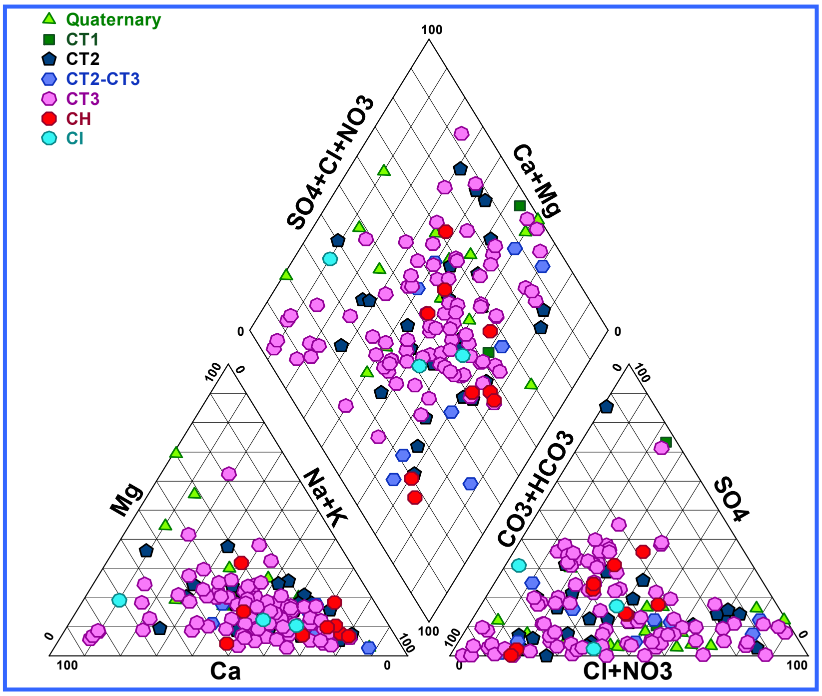



Figure 27: Piper diagram of the analyzed groundwater samples (Dosso-Niger)

**- Origin of major ions and mineralization processes**

The relationships between major elements and total dissolved solutes (TDS) were investigated in Figures 28 and 29. The Ca, Na, Mg, K, Cl, $HCO_3$, $SO_4$ and $NO_3$ concentrations show systematic increases with TDS. These positive correlations indicate that the mentioned ions contribute significantly to the groundwater mineralization.

In order to determine the origins and the processes that control their concentration, several bivariate diagrams were plotted (Fig. 30). The chemistry of the groundwater samples in Dosso area represented by major ionic compositions of waters from repeatedly sampled wells appears to be dominantly controlled by the dissolution of minerals in the catchment's host lithologies as indicated by the calculated saturation indices (Fig. 31).

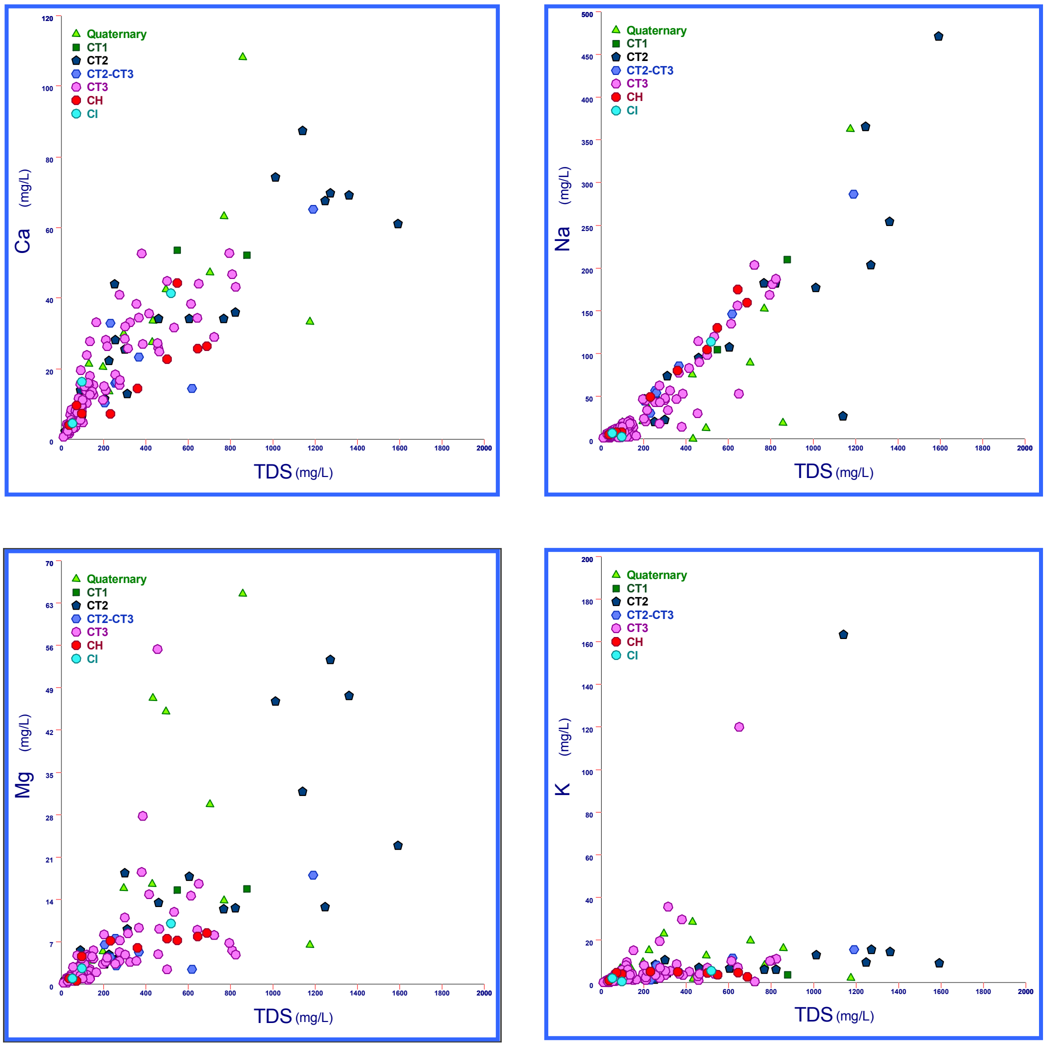



Figure 28: Relationships between TDS and major elements (cations) in groundwater samples (Dosso-Niger)

Figure 30 shows that points with $Na^+/Cl^-$ molar ratio equal to 1 indicate halite dissolution process. The increase of the $Na^+/Cl^-$ ratio above 1 in some samples of the CH, CT2 and CT3 aquifers would suggest some reaction of silicate minerals. The $Na^+/Ca^{2+}$ molar ratio has an increasing trend along the groundwater flow, which also indicates the dominance of reaction of silicate minerals derived mainly from weathering of sandstones in CT3 formation. Figure

30 suggests that most points representing CT3 and CH aquifers are plotted on or just above the 1:1 gypsum dissolution line. This result could be explained by a compound effect of gypsum dissolution and evaporation processes. Nevertheless, the CT2, CT3 and Quaternary groundwater exhibit a more pronounced loss of $SO_4^{2-}$ relative to $Ca^{2+}$. This excess of $Ca^{2+}$ is believed to originate from the probable dissolution of carbonate mineral, as confirmed by Figure 30, the points representing CT2, CT3 and Quaternary groundwater fall either on, or just above 1:1 stoichiometric equilibrium line. All other samples including Quaternary groundwater is above or below the line, indicating another source of $Ca^{2+}$ which may possibly be present from weathering and erosion of gypsum and/or clay minerals.

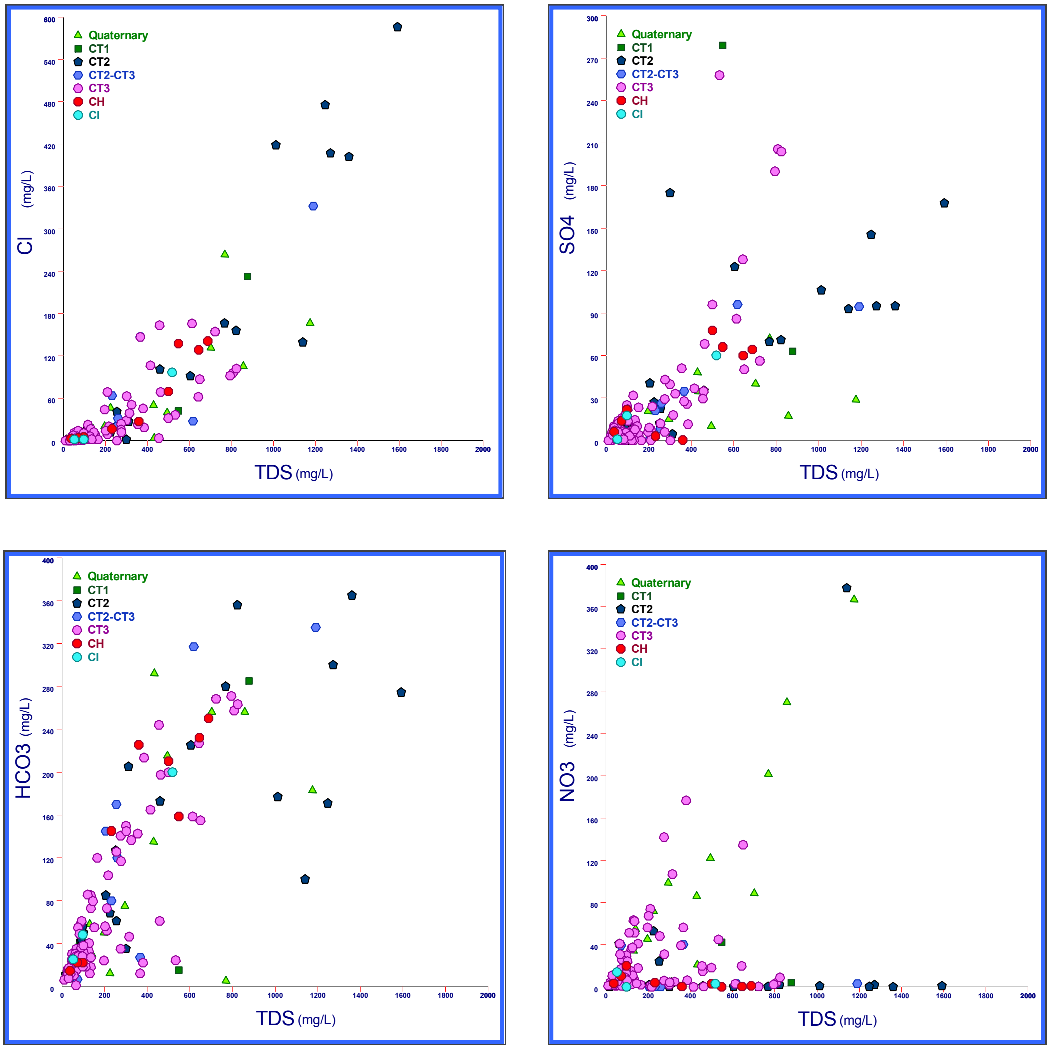



Figure 29: Relationships between TDS and major elements (anions) in groundwater samples (Dosso-Niger)

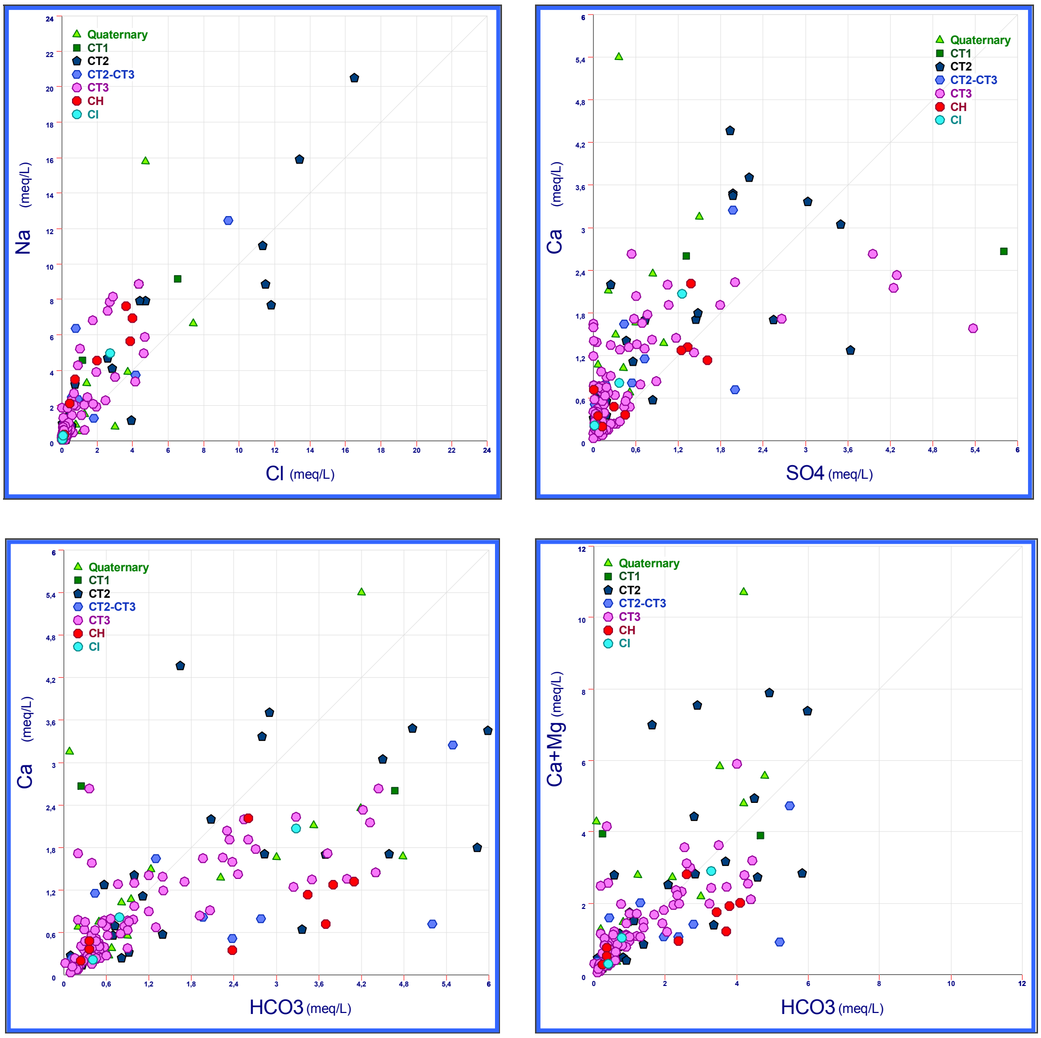



Figure 30: Correlation between major ionic species in groundwater samples (Dosso-Niger)

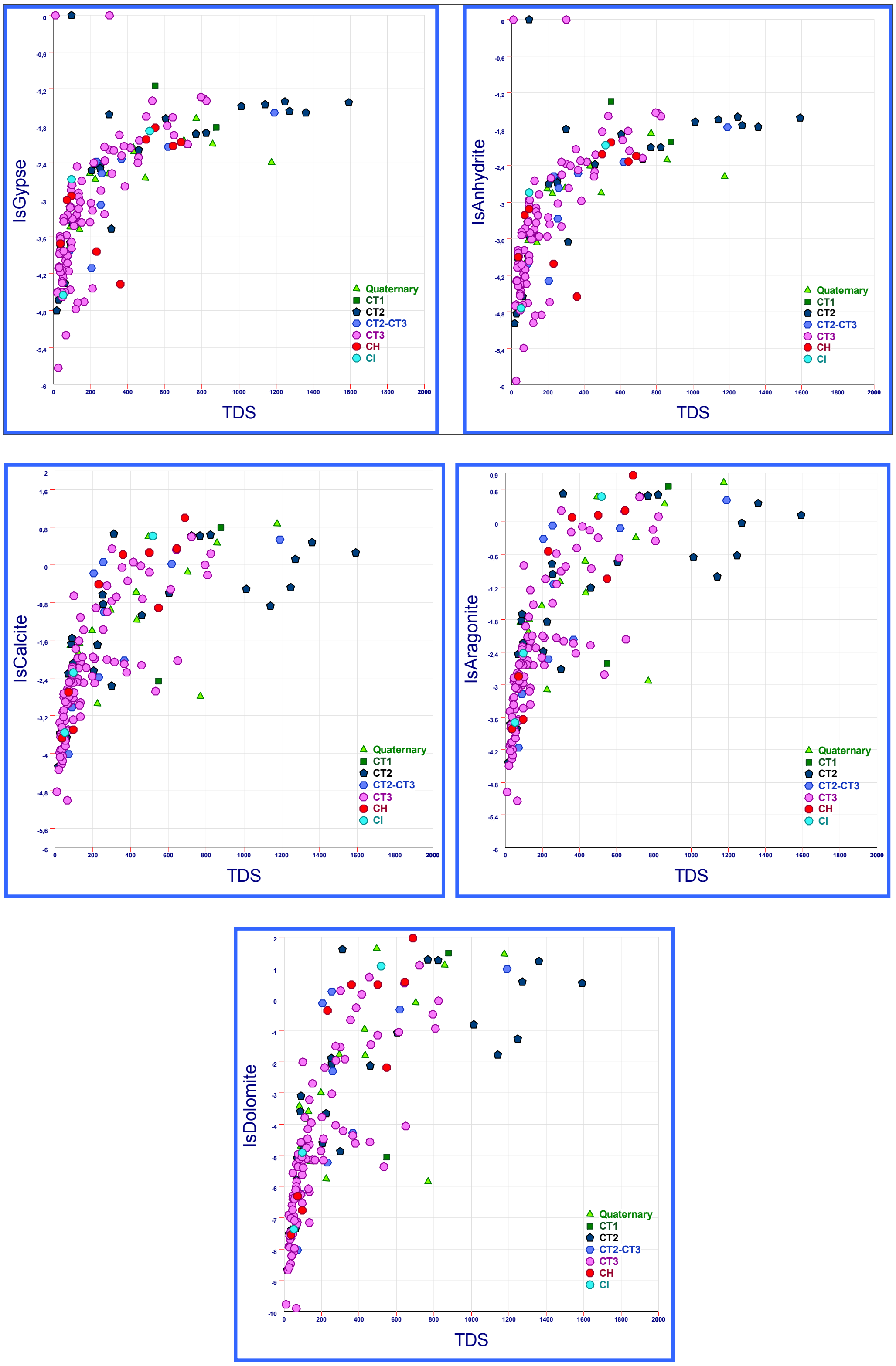



Figure 31: Correlation between saturation indexes and TDS in groundwater samples (Dosso-Niger)

### 4.1.2. Isotope data of the Niger basin (Dosso)

- **Isotope composition of local precipitation in Dosso**

In isotope hydrology, the first important step to characterize an aquifer is to compare the stable isotope signature of local rainwater with that of groundwater, which should reflect the mean weighted value of the successive rain inputs (Gat and Carmi, 1987). Hence, considering that rainwater constitutes the main input in a hydrogeological system, the knowledge of the isotopic composition ($\delta^{18}O$ and $\delta^{2}H$) of the atmospheric precipitation is an important tool for hydrological, climatological and meteorological applications (International Atomic Energy Agency IAEA, 1981; Rozanski et al.,, 1993).

Due to natural fractioning processes, it is possible to employ the environmental isotopes $^{18}O$ and $^{2}H$ to determine recharge characteristics to the aquifers. Rainwater, depending on the processes occurring before reaching the soil surface, has a particular composition of these isotopes. The International Atomic Energy Agency (IAEA) has published a Global Meteoric Water Line (GMWL) with a relationship of $\delta^{2}H = 8\ \delta^{18}O + 10$, which is an average of the rainwater composition worldwide. Although no rainwater isotope was measured during the implementation of the IAEA-supported project RAF/7/011, the IAEA database contains some values for Niamey station (1992-2013) to be able to determine the local water line (Fig. 32) that may be adopted for the Dosso area.

In this report, the local meteoric water line (LMWL) of Niger is defined for the first time, based on monthly data samples of precipitation collected from Niamey station located in Niger over the (1992–2013) period (Fig. 31). Both the slope and $\delta^{2}H$ intercept for Niamey MWL ($\delta^{2}H = 6.9 \times \delta^{18}O + 3.6$) are deviated from the global meteoric water line (GMWL) ($\delta^{2}H = 8 \times \delta^{18}O + 10$).

It is clear that the evaporation process in semi-arid Dosso region alters the original $\delta^{2}H – \delta^{18}O$ relationship of the rainfall, resulting in slope lower than 8 as reported in many arid or semi-arid regions (Gat, 1980) and deuterium excess values less than those of the GMWL, and perhaps indicating that much of the rainfall occurs at a mean humidity of less than 100% (Goni and *al.,*, 2001; Maduabuchi and *al.,* 2006).

Slopes lower than 8, in this station, could indicate some non–equilibrium evaporation processes during the fall of the drops below the cloud base (Dansgaard, 1964). In addition, deviations from the GMWL are found on a seasonal basis in many regions, mainly due to an enhanced partial evaporation of raindrops below the cloud base during summer months and/or seasonally varying conditions in the source area (s) for the vapor.

The deuterium excess calculated with a theoretical slope of 8 for the study period is 9.24 for the Niamey meteoric water line and it is clearly less than those of the GMWL. Hence the Niamey LMWL could not be adopted for this study. The isotope chemistry of rainfall in the Sahel region is extremely variable, both geographically and temporally, responding to atmospheric circulation patterns (Joseph et al., 1992) (Figs. 33 and 34). The source of precipitation for the Sahara-Sahel, including the Iullemeden basin, is the Gulf of Guinea (Taupin and *al.,* 2000). However re-evaporated water from the continent is an important source of water vapour as shown by the lack of continental effect and also a large deuterium excess at the beginning and the end of the rainy season (Taupin and *al.,* 1997; 2000).

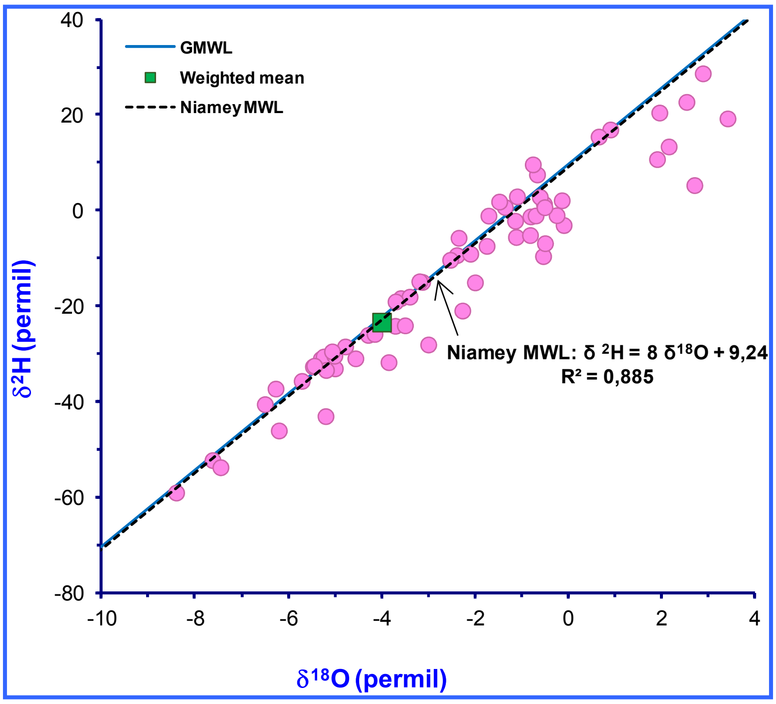



Figure 32: Local Meteoric Water Line for Niamey station (black line) using data from the IAEA compared to the Global Meteoric Water Line (blue line)

Although temperature is an important factor controlling the variation in the isotopic content of rainfall, it has been shown (Fontes, 1976) that there is often no clear relationship between temperatures measured on the ground and the isotopic composition of tropical rains, indicating that other processes must be involved. As storms develop, convection leads to low condensation temperatures at the height of the vertical cloud development (Fontes and *al.,* 1993; Taupin and *al.,* 1995).

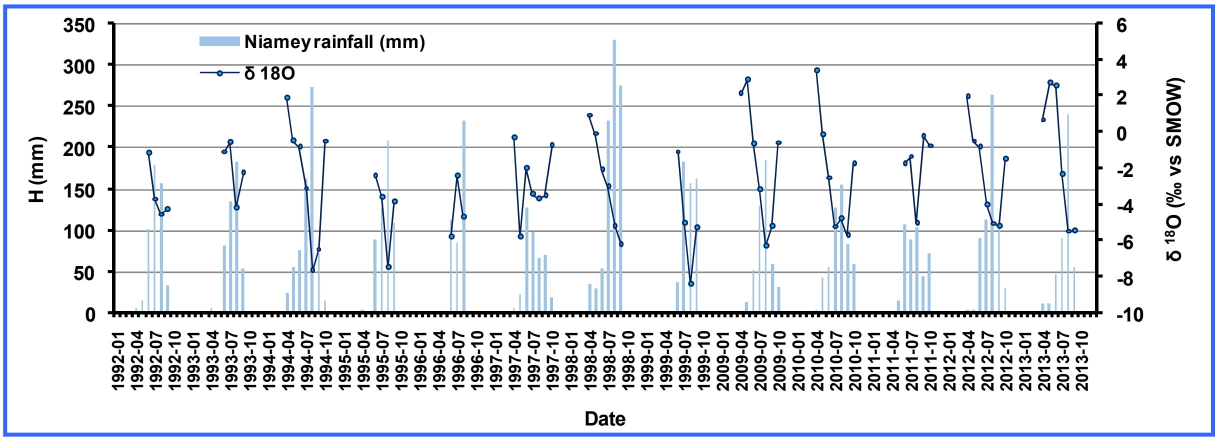



Figure 33: Monthly data of oxygen-18 and rainfall height for the Niamey station

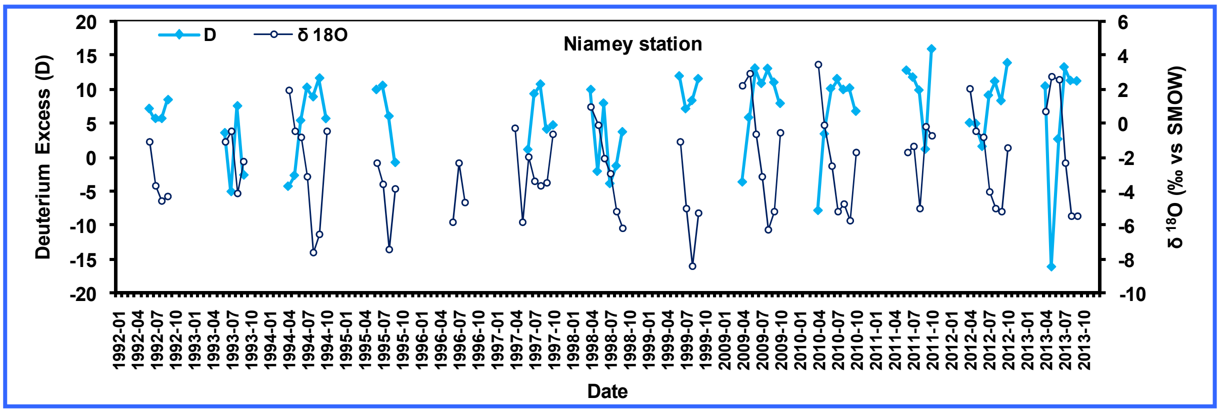



Figure 34: Monthly data of oxygen-18 and deuterium excess of rainfall for the Niamey station

## • Isotope composition of groundwater in Dosso

All groundwater samples collected from Dosso basin under the project RAF/7/011 were analyzed for environmental isotopes. Figure 12 shows the samples location map where the isotopes $^{18}O$ and $^{2}H$ have been measured.

**-Water isotopes**

The range of values in the whole aquifers of Dosso is between -7.76 and -1.77 ‰ for oxygen 18 and -57.35 ‰ and -13.23‰ for deuterium (Figs. 35, 36). Although that all aquifers present big variations, the comparison of their median values shows close contents in ($\delta^{18}O$) and

($\delta^2H$) which are consistent with the weighted isotopic value of annual rainfall. The $\delta^{18}O$ content of CI, CT1, CT2 and CH extend from-7‰ to -4‰ traducing the existence of different origins of water. In contrast the high variability and the enriched positive values observed in CT3 and Quaternary groundwater reveal the existence of other process such as mixing with surface water of Niger River or/and evaporation. This latter process could occur before the infiltration (endorheic local zone collecting surface runoff), during the infiltration depending on soil moisture, or directly from open well since most wells in Quaternary formation are shallow.

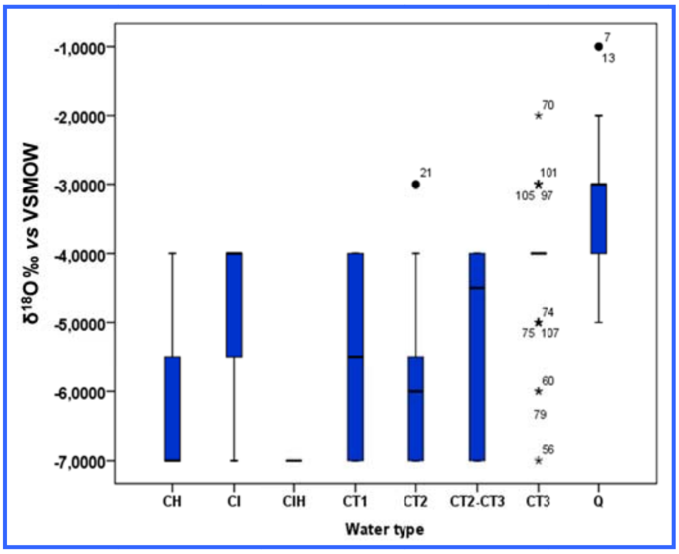



Figure 35: Variability and distribution of $\delta^{18}O$ in groundwater of the Dosso-Niger basin

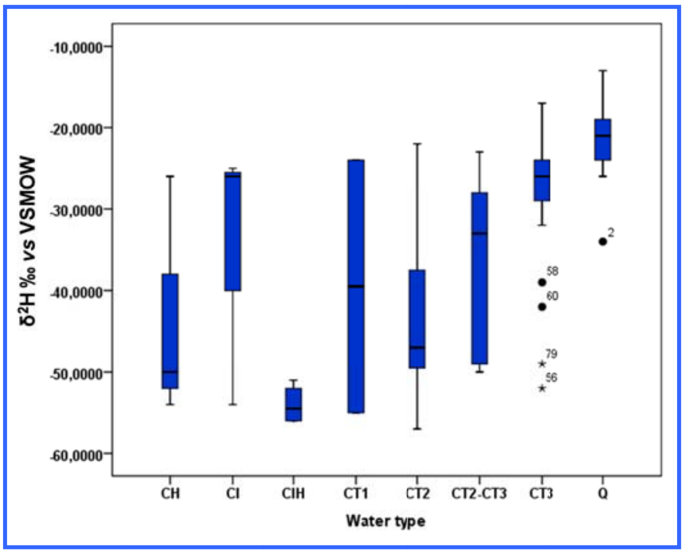



Figure 36: Variability and distribution of $\delta^2H$ in groundwater of the Dosso-Niger basin

Position of the points representing the analyzed water samples of Dosso on the $^{18}O/^2H$ diagram indicates three groups (Fig. 37):

- Depleted CI, CH, CT1 and CT2 water samples that have stable isotope compositions, which are different from present day precipitation. The low contents of $\delta^{18}O$ and $\delta^{2}H$ could indicate a paleoclimate effect suggesting that theses aquifers contain waters that were recharged at different period and have not been coupled to the present day hydrological cycle. This hypothesis is supported by very low tritium contents (Figs. 38, 41);

- Enriched water highlighting: (i) the significance of the Niger River water input in the evolution of the observed isotopic composition of the sampled waters collected from Quaternary aquifer, and /or (ii) the return flow of irrigation. These samples present high tritium and nitrate contents (> 50 mg/l) (Figs. 37, 25, 39);

- Mixture of water with stable isotope exhibiting signals that is between present day rainfall and palaeo water. This explains the plot of some data, especially CT3 samples between depleted and relatively enriched stable isotope; respectively interpreted as palaeowater and present day recharged water (Goni, 2006).

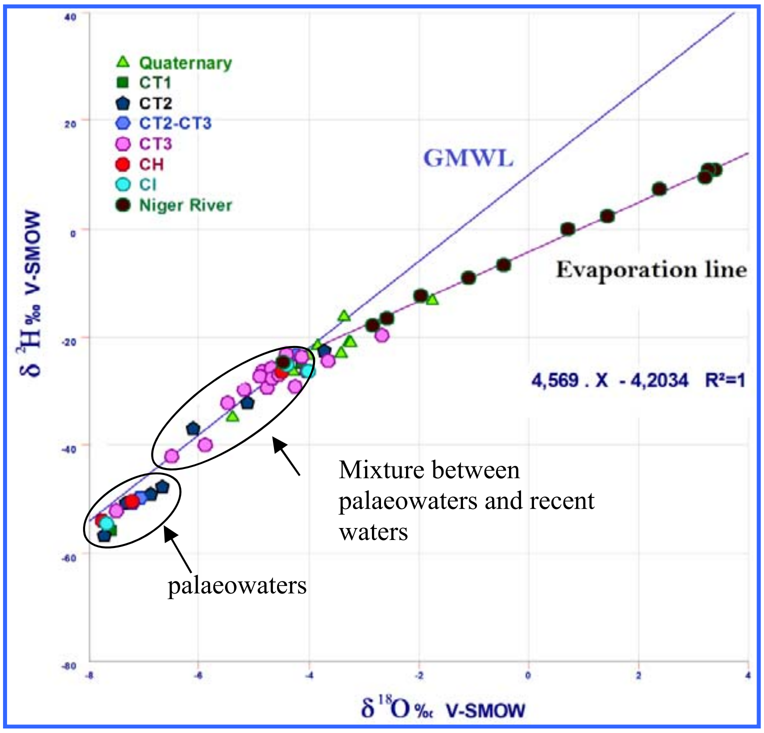



Figure 37: Plot of $^{2}H$ versus $^{18}O$ in groundwater samples of the Dosso-Niger basin

**Deuterium excess "d"**

There is a relatively large variability in the value of the Deuterium-Excess "d" especially notable for CT3 and Quaternary aquifers which present the lowest values (negative values) (Fig. 38). The enriched stable isotope content of CT3 and Quaternary aquifer and lowest values of "d" confirm that they contain evaporated water. However, for the other aquifers which show a low deuterium excess, especially CI and CT1 and CT2 waters with "d' smaller than 10‰ the evaporation process does not seem possible. Besides the problem of sampling and its conservation before analysis, the deuterium excess value is not so easy to understand. Considering the depleted stable isotope composition of these samples points a paleoclimate recharge with atmospheric circulation different from current conditions is possible which affects the deuterium excess. The heterogeneous spatial variation observed in stables isotope contents of the different aquifer is consistent with the high variation observed on excess deuterium. This variability is mainly related to palaeoclimatic effect for the most depleted groundwater and evaporation effect for the most enriched groundwater. Local conditions of infiltration and the strength of evaporation process which depends on the infiltration process (direct infiltration, infiltration after runoff, concentration in endorheic zone before infiltration) affect also the isotopic composition and deuterium excess of these aquifers (Fig. 38).

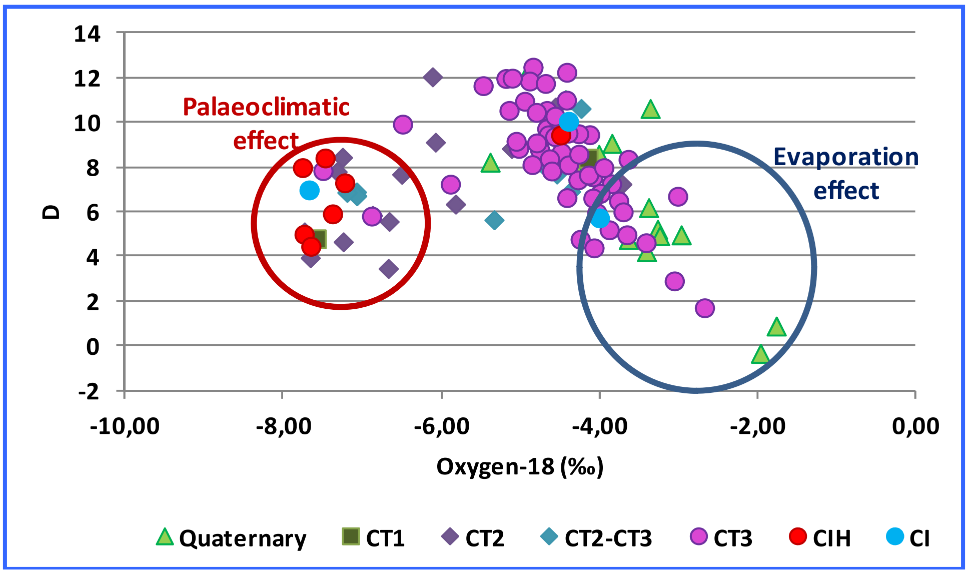



Figure 38: Plot of deuterium excess versus $^{18}O$ in groundwater samples of the Dosso-Niger basin

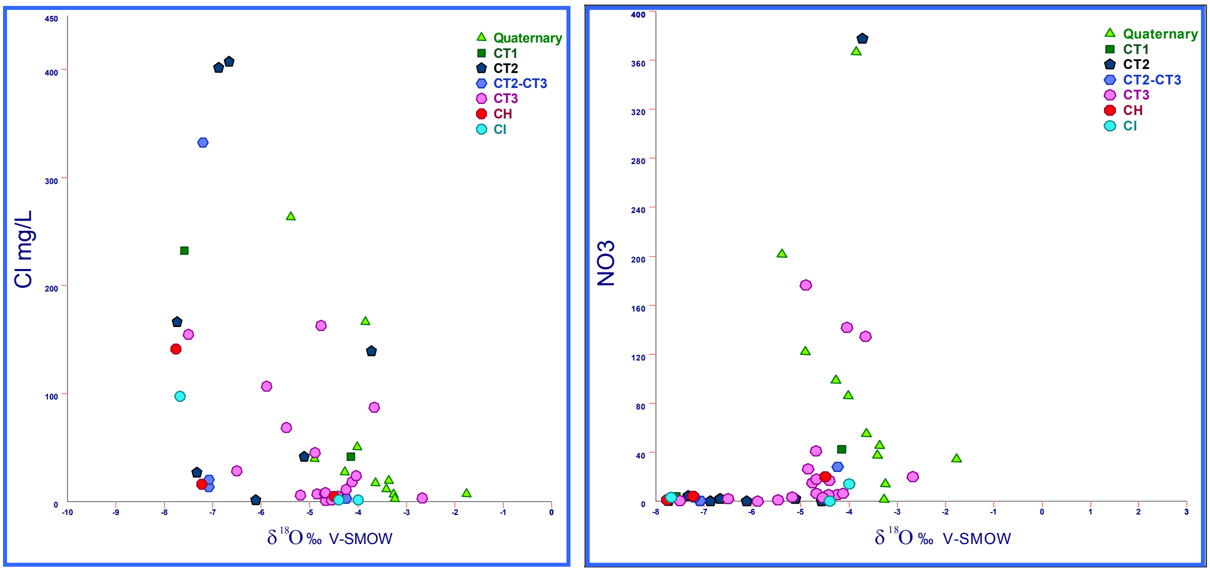



Figure 39: Plots of chloride versus $^{18}O$ and nitrate versus $^{18}O$ in groundwater of the Dosso-Niger basin.

**- Tritium**

Generally, the estimated annual value (natural level) in recent precipitation is 4 TU. Tritium content in groundwater depends on local condition of recharge (infiltration, water depth, …) and rainfall spatial distribution. CT3 and Quaternary groundwater show in most points a recent recharge over the last 65 years, with tritium content higher than 1.5 TU, the last 10-20 years and a content > 5-6 TU during the period of tritium peak (1955-1980). It can be noted that these samples show lower EC; in this case it is linked to rapid renewable water (Figs. 40, 41). However, CI, CH, CT1 and CT2 ground waters show a mixing water with recent recharge and a groundwater older than 1950.

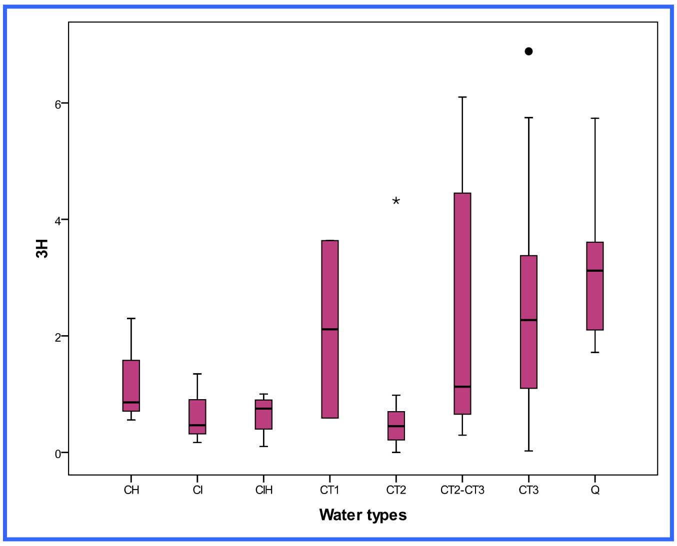



Figure 40: Variability and distribution of $^{3}H$ in groundwater of the Dosso-Niger basin

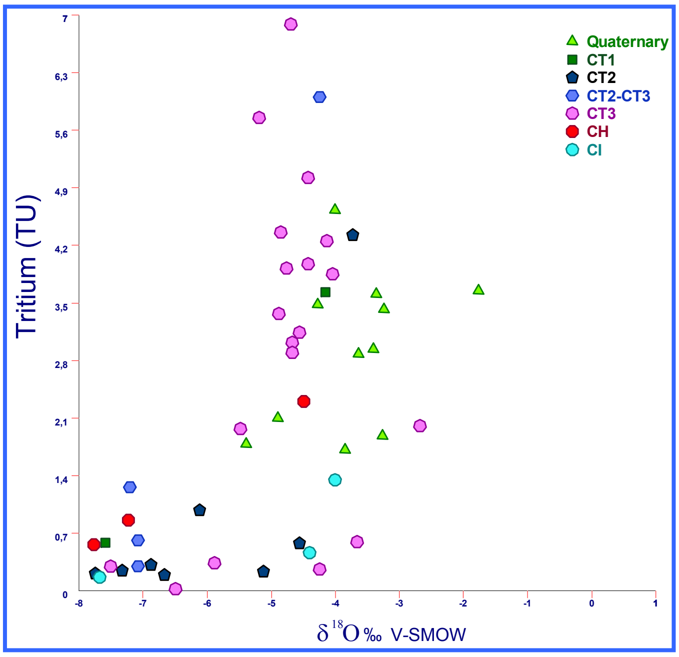



Figure 41: Plot of $^{3}H$ versus $^{18}O$ in groundwater of the Dosso-Niger basin

## 4.2. Geochemical data of the Nigeria basin

### 4.2.1. Hydrochemical study of the Nigeria basin

The Nigerian sector of the Iullemeden covers the regions of Sokoto and Kebbi state and northern parts of Katsina and Zamfara states. A total of 149 samples were collected from this basin in three sampling campaigns (Fig. 42).

The area lies within the tropics with predominant dry and rainy seasons, of varying durations. However, some portion of the area lies within the arid and sub-arid climate conditions with rainfall of less than 800 mm/yr. The Sokoto-Rima and its tributaries drain the area. These often have relatively large flood plains crossing the area with river valley slope declining from a height of 340 m to about 247 m at the valley floors. The flood plains are usually marshy during the rains and constitute valuable groundwater reservoirs during the dry season when most of the river channels are dry. Usually, towards the end of the dry season, these rivers, the tributaries are almost completely dry.

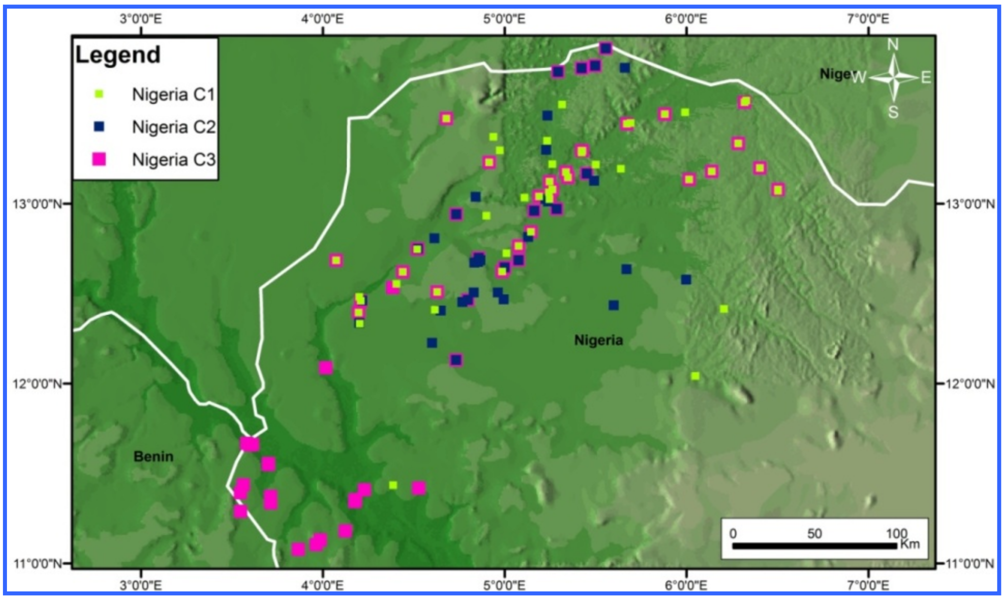



Figure 42: Location of sampling points within the Iullemeden basin (Nigeria)

**- Electrical Conductivity**

The values of electrical conductivity EC measured on wells and boreholes of Nigeria range from 10 and 2020 µS/cm. Those of rivers are more homogenous with low variability and vary between 10 and 490 µS/cm (Fig. 43). Results indicate that in general the groundwater is within WHO acceptable limits for drinking water. The water from the five geological formations does not show differences in the EC in terms of both mineralization and variability. CT groundwater shows the lowest mineralization and small variability with a mean of 185 µS/cm. The Upper Paleocene groundwater shows the highest mineralization and variability with a mean of 614 µS/cm. Comparing TDS and Electrical Conductivity (Fig. 44), there is a good correlation between the two parameters.

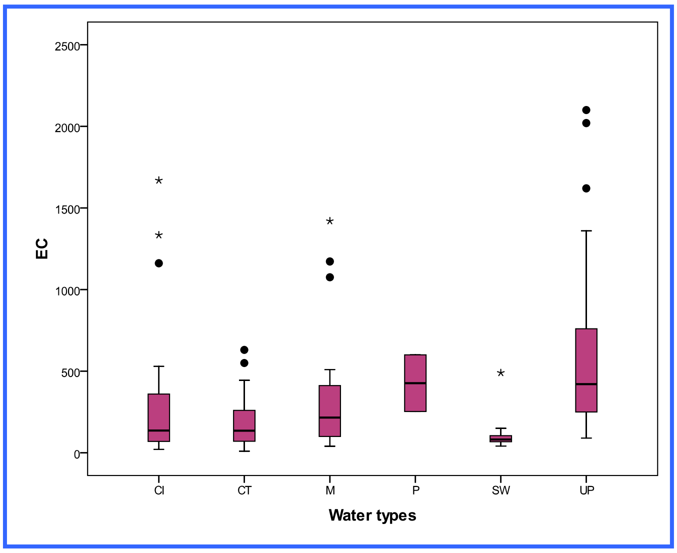



Figure 43: Electrical Conductivity in water samples of the Nigeria basin

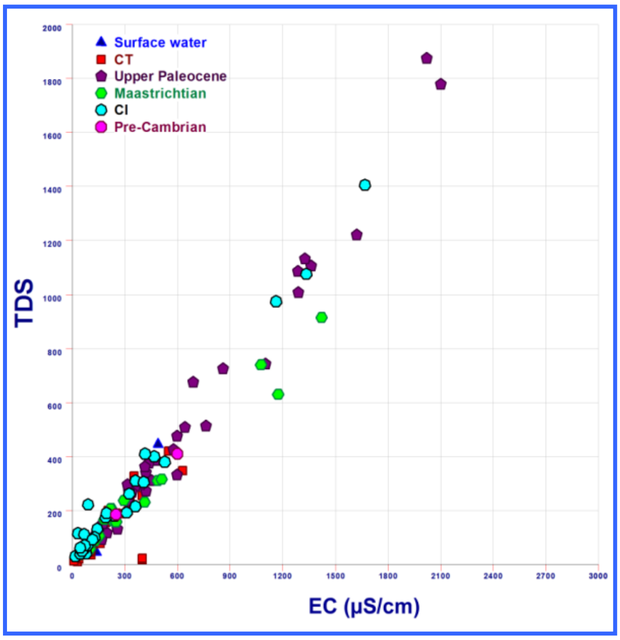



Figure 44: EC versus TDS in water samples of the Nigeria basin

**- Temperature**

The calculated mean water temperatures are homogeneous and show slight variation between the aquifers. However, some extreme values (Upper Paleocene, Maastrichtian and CT) which constitute outliers should be viewed cautiously in the use of the computation of saturation index and thermodynamic equilibrium. The lowest values were recorded in the surface water (Fig. 45) and are in the range of the annual atmospheric temperature value.

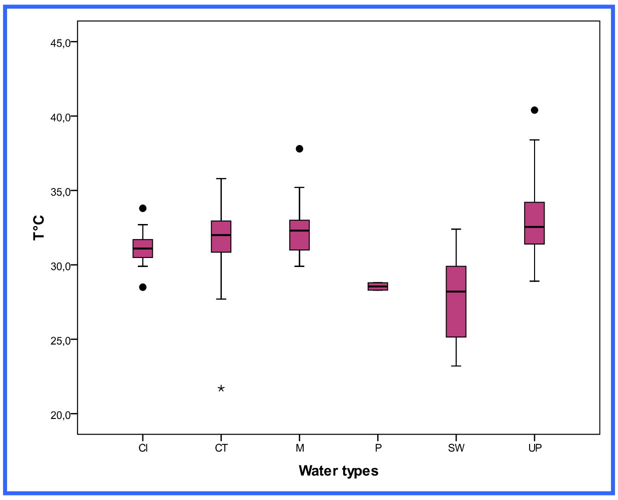



Figure 45: Temperature distribution of the analyzed water samples of the Nigeria basin

**- pH**

Surface water show basic pH values in accordance with the major ion chemistry which show a dominance of the bicarbonate ion. For groundwater samples, the measured pH is in the range of the neutrality with small variability and the majority of samples points are comprised between the pH 6 and 8. Some outlier values which should be viewed cautiously are recorded in the Upper Paleocene, Maastrichtian groundwater (Fig. 46).

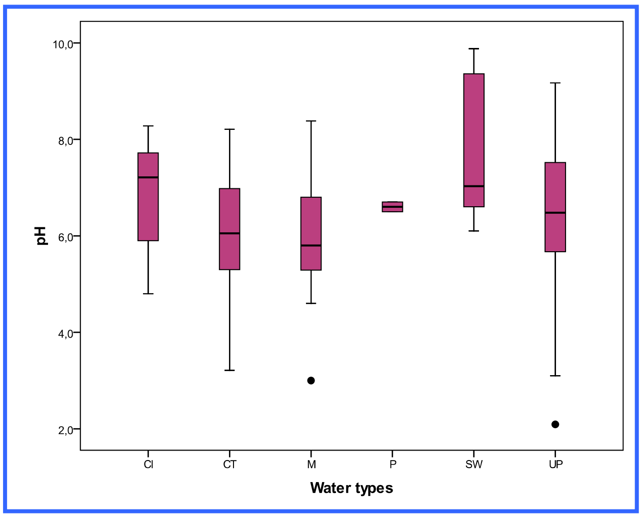



Figure 46: pH distribution of water samples of the Nigeria basin

**- Cations**

The measured calcium contents are homogenous and show low variability in CI, CT and Maastrichtian aquifer formations (Fig. 47) However, calcium concentration is higher in the Upper Paleocene with a high variability (mean=14.2 mg/l). Surface water shows the lowest values. Magnesium shows lower contents in mg/l for the whole formations. Upper Paleocene follows the same behavior than for Ca (Fig. 48).

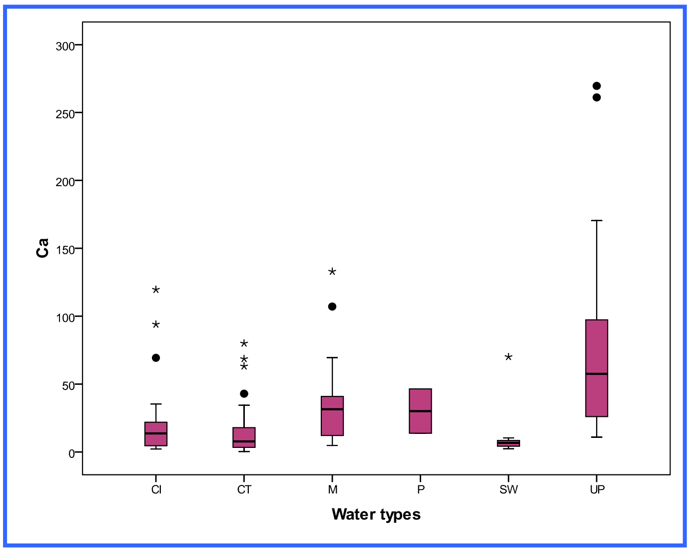



Figure 47: Variability and distribution of Ca in the water samples of the Nigeria basin

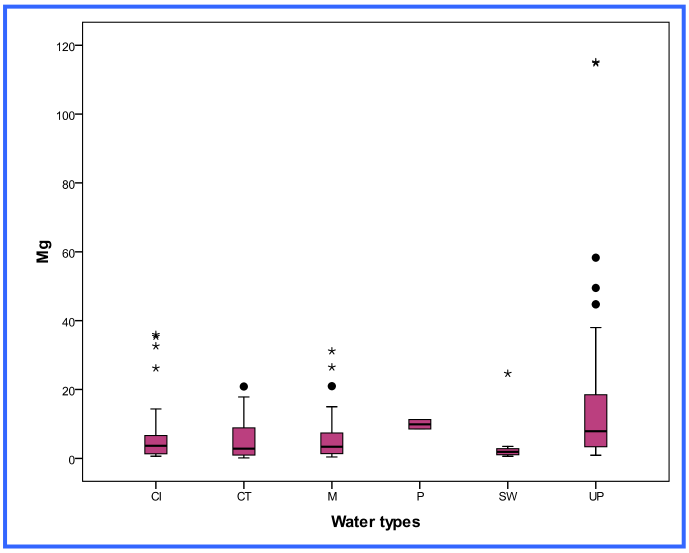



Figure 48: Variability and distribution of Mg in the water samples of the Nigeria basin

Sodium shows mainly homogenous and lower content for most of water samples collected from surface water, CT, Pre-Cambrian and Maastrichtian aquifers, it ranges from 0.24 to 50 mg/l (Fig. 49). A higher variability is observed for the Upper Paleocene and CI where the sodium concentrations in some samples could exceed 150 mg/l. Generally, potassium contents in the analyzed water samples are very low (Fig. 50), except some extreme values measured in the CI aquifer (>80 mg/l).

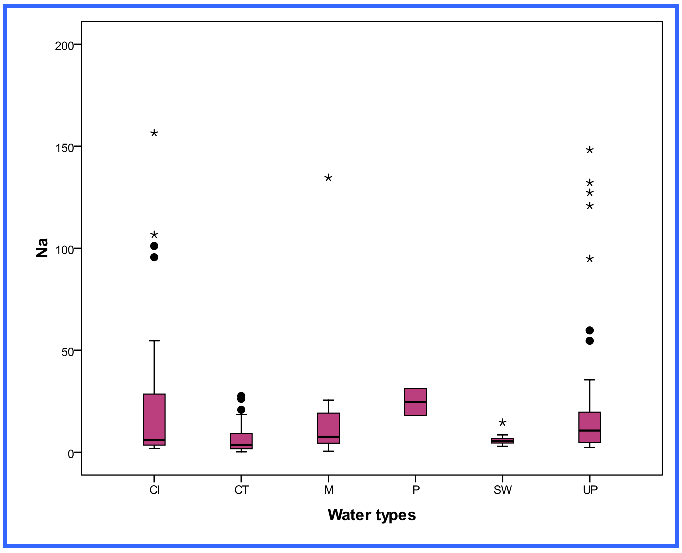



Figure 49: Variability and distribution of Na in the water samples of the Nigeria basin

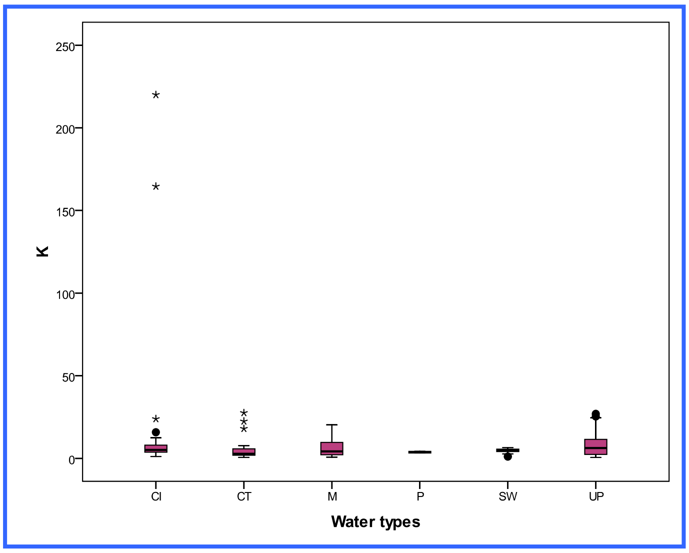



Figure 50: Variability and distribution of K in the water samples of the Nigeria basin

Values of the other ions do not increase, except nitrates which is high (>200 mg/l), an anthropogenic input seems linked to this K content.

**- Anions**

Bicarbonate (Fig. 51) is the predominant anion in the Nigerian sector. In fact, the highest $HCO_3$ contents were recorded in Pre-Cambrian aquifer while, the CI, CT and Maastrichtian groundwater reveal more homogeneous values and lower $HCO_3$ contents.

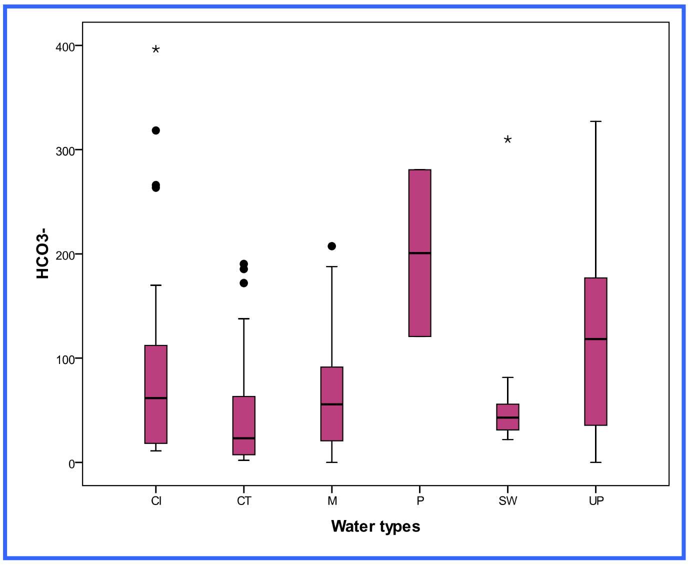



Figure 51: Variability and distribution of $HCO_3$ in the water samples of the Nigeria basin

Chloride distribution shows homogenous and low values as natural level for CT, M and P ground waters. In Upper Paleocene and CI groundwater chloride contents are higher and more variables with some outliers where chloride contents exceed (50 mg/l) (Fig. 52).

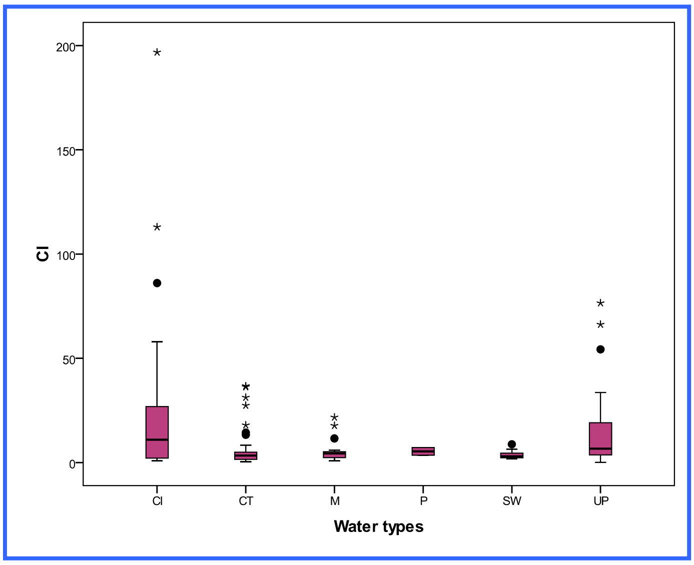



Figure 52: Variability and distribution of Cl in the water samples of the Nigeria basin

Sulfate contents (Fig. 53) show very low levels for CI, CT and P ground waters and surface water (< 20 mg/l). In Upper Paleocene formation, sulfate concentrations reach 1377 mg/l, anion prevailing in this water. In this case associated with a high content in calcium and sodium, sulfate inputs may be linked to sulfate minerals dissolution. The nitrate contents in the groundwater of the investigated aquifers of Nigeria are generally low to moderate (< 40 mg/l) (Fig. 54). Only CI aquifer showed mean nitrate concentrations (57.7 mg/l), exceeding the WHO limit. However, locally Nitrate concentrations exceed in many places high levels (> 50 mg/l). The local nitrate contamination could be explained by excessive use of fertilizer and animal manure.

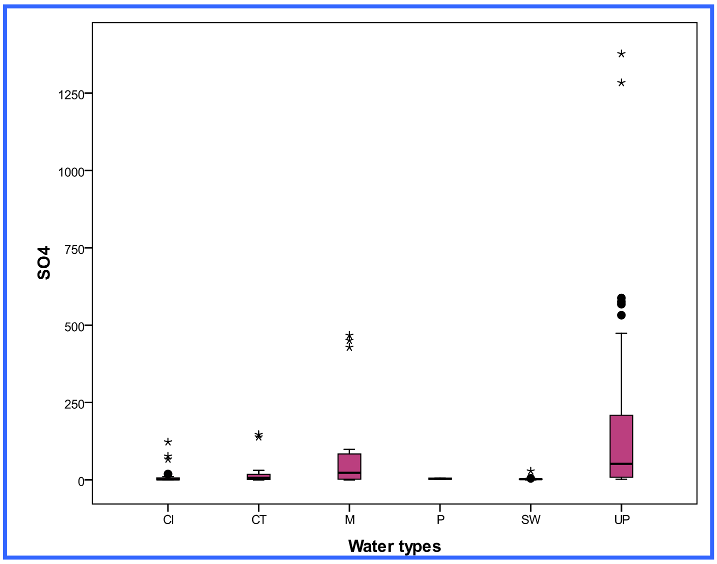



Figure 53: Variability and distribution of SO4 in the water samples of the Nigeria basin

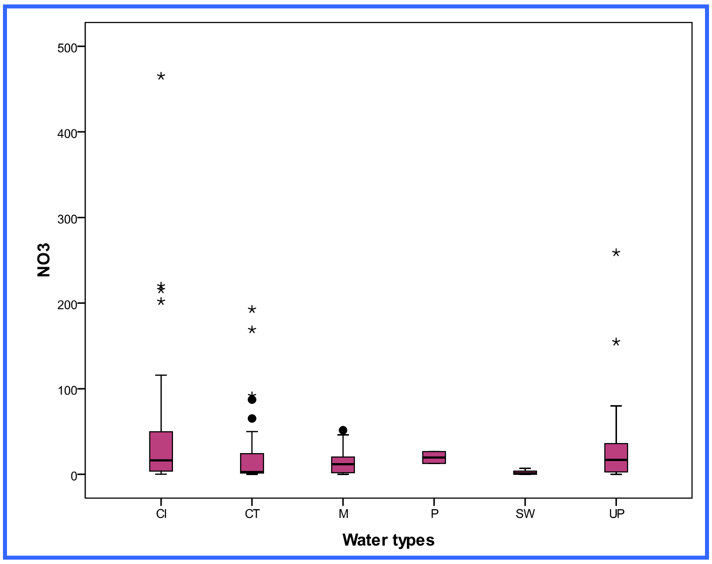



Figure 54: Variability and distribution of NO3 in the water samples of the Nigeria basin

**-Hydrochemical facies**

The chemical composition of the analyzed samples was plotted on the Piper trilinear equivalence diagrams shown in Figure 55. Two tendencies could be shown in anion diagram; (i) a general evolution from bicarbonate towards chloride for the CI groundwater and (ii) from bicarbonate to sulfate for the Upper Paleocene sampling points.

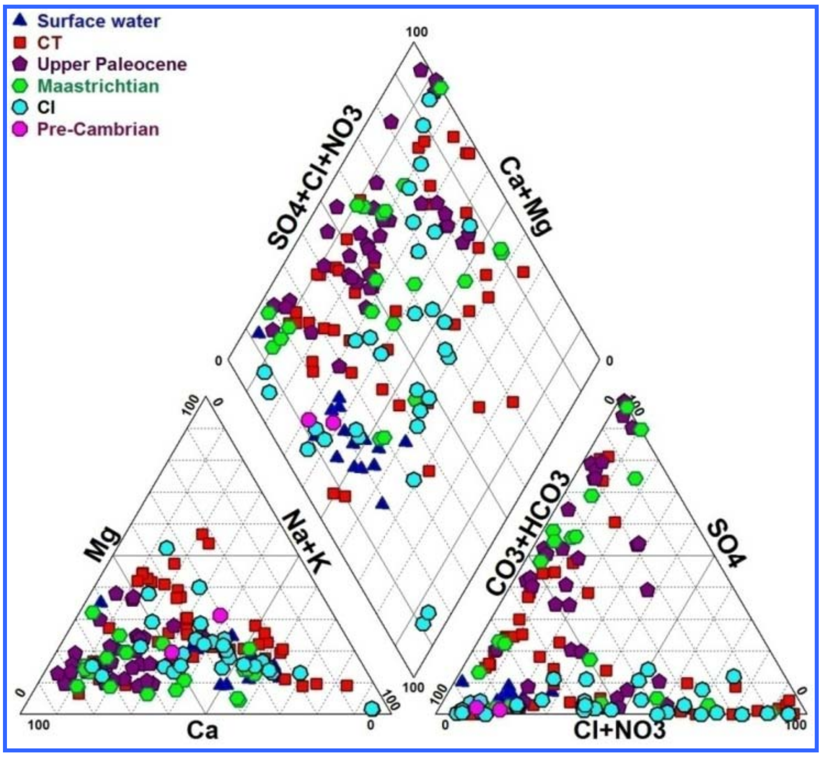



Figure 55: Piper diagram of the analyzed water samples of the Nigeria basin

Several major water types could be identified:

-Ca-Mg-$HCO_3$ water type; Na-K-Cl water type; Ca- Cl - $SO_4$ water type and Na-K-$HCO_3$ water type.

**- Origin of major ions and mineralization processes**

The relationships between major elements and EC were investigated in Figures 56 and 57. The Ca, Na, Mg, K, Cl, $HCO_3$, $SO_4$ and $NO_3$ concentrations show systematic increases with EC. These positive correlations indicate that the mentioned ions contribute significantly to the groundwater salinization

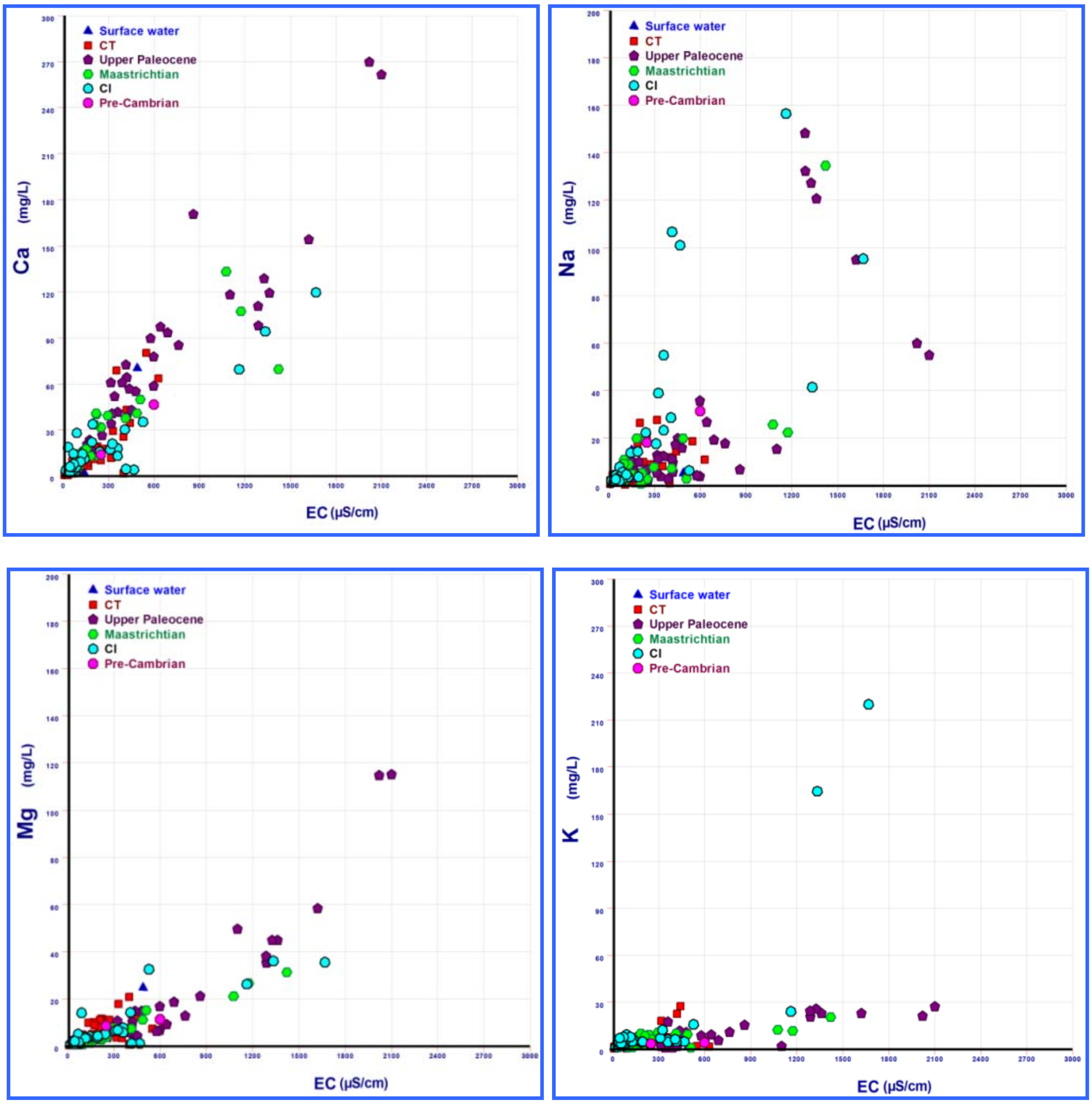



Figure 56: Relationships between EC and major elements (cations)

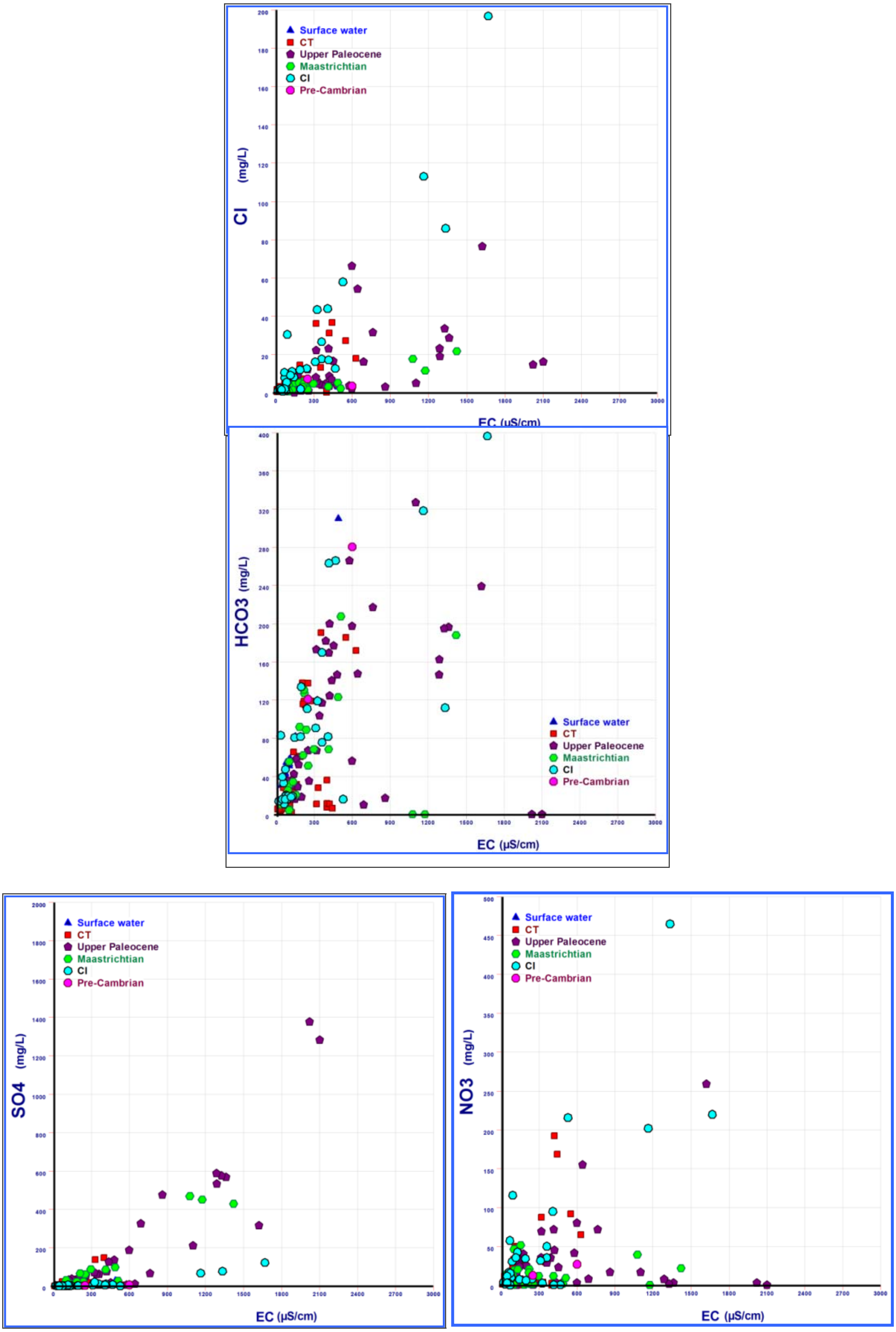
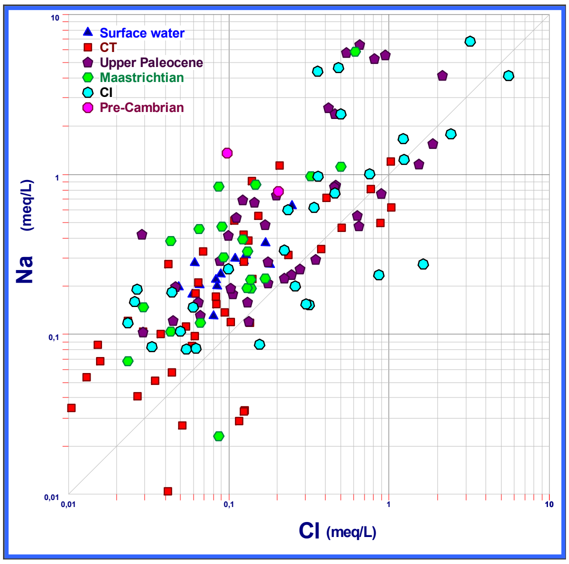


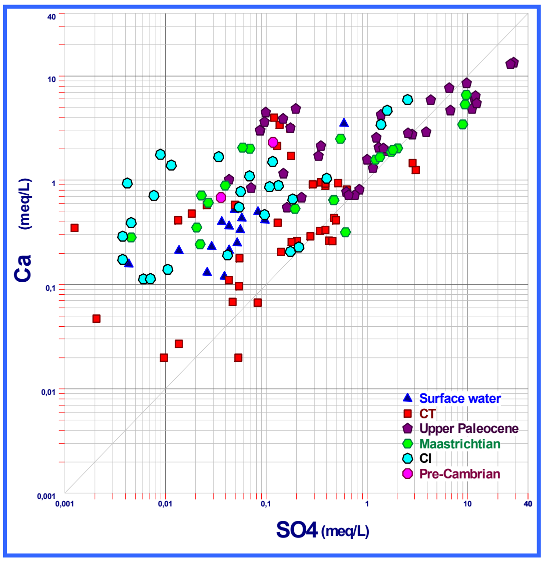

Figure 57: Relationships between EC and major elements (anions)

In order to determine the origins and the processes that control their concentration, several bivariate diagrams were plotted. The chemistry of the groundwater samples in Nigeria area represented by major ionic compositions of waters from repeatedly sampled wells appears to be dominantly controlled by the dissolution of minerals in the catchment's host lithology.

Figure 58 shows that points with $Na^{+}/Cl^{-}$ molar ratio equal to 1 indicate halite dissolution process. The increase of the $Na^{+}/Cl^{-}$ ratio above 1 in some samples of the M, UP and CI aquifers would suggest some reaction of silicate minerals. The excess of Na relative to chloride in CT groundwater samples could be related to cation exchange as suggested by Na/Ca relationship.

The $Na^{+}/Ca^{2+}$ molar ratio has an increasing trend along the groundwater flow, which also indicates the dominance of reaction of silicate minerals derived mainly from weathering of sandstones in detritic formations.



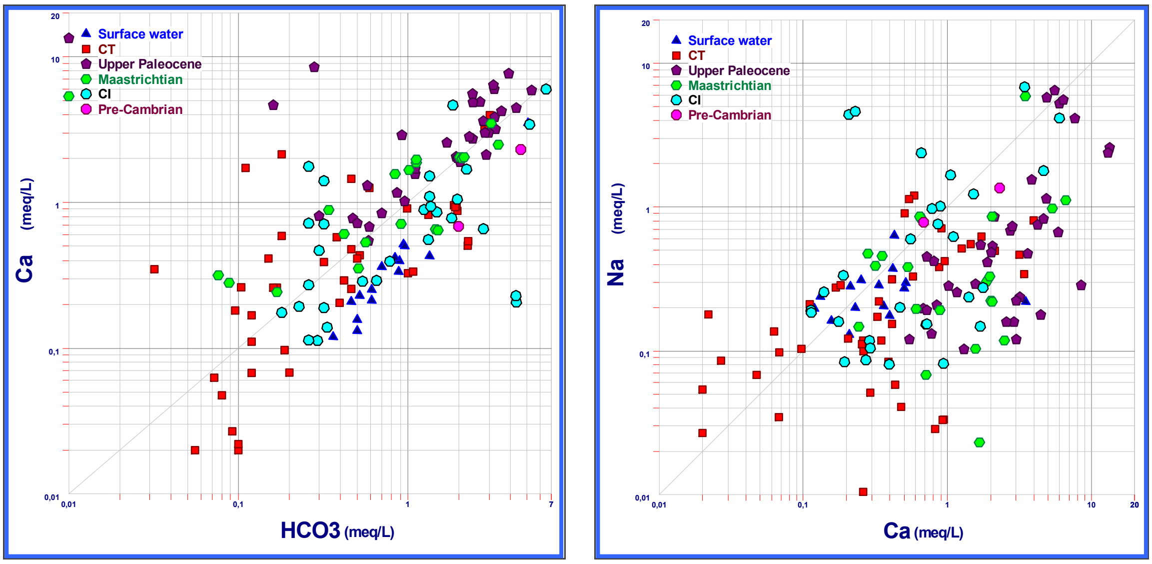
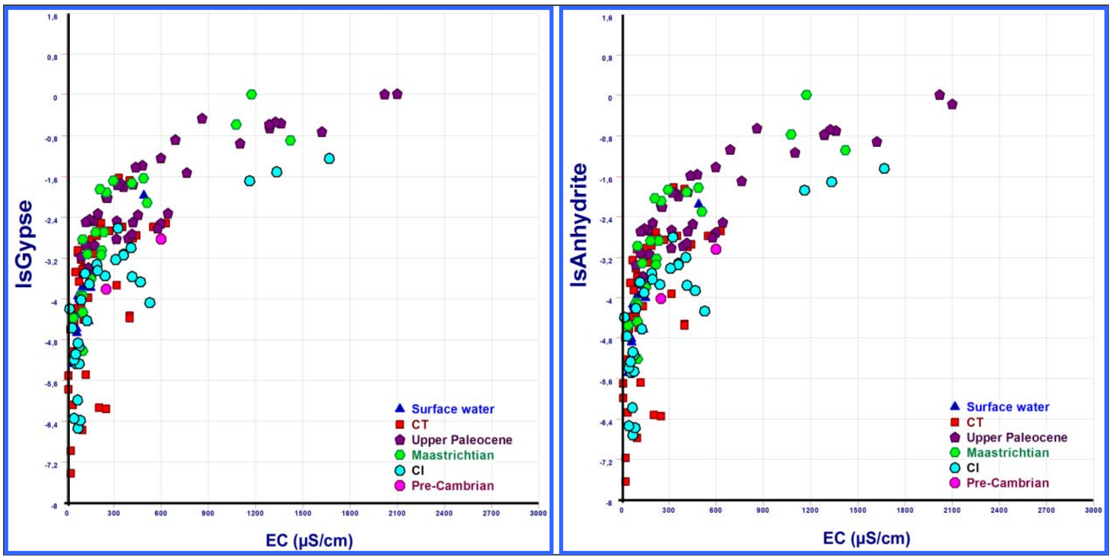



Figure 58: Relationships between major elements

Figure 59 suggests that most points representing UP and M aquifers are plotted on or just above the 1:1 gypsum dissolution line. This result could be explained by a compound effect of gypsum dissolution and evaporation processes. Nevertheless, the CI and CT groundwater exhibit a more pronounced loss of $SO_4^{2-}$ relative to $Ca^{2+}$. This excess of $Ca^{2+}$ is believed to originate from the probable dissolution of carbonate mineral. As confirmed by Figs. 58, the points representing M, UP, CI and CT groundwater fall either on, or just above 1:1 stoichiometric equilibrium line. All other samples are above or below the line, indicating another source of $Ca^{2+}$ which may possibly be present from weathering and erosion of gypsum and/or clay minerals.



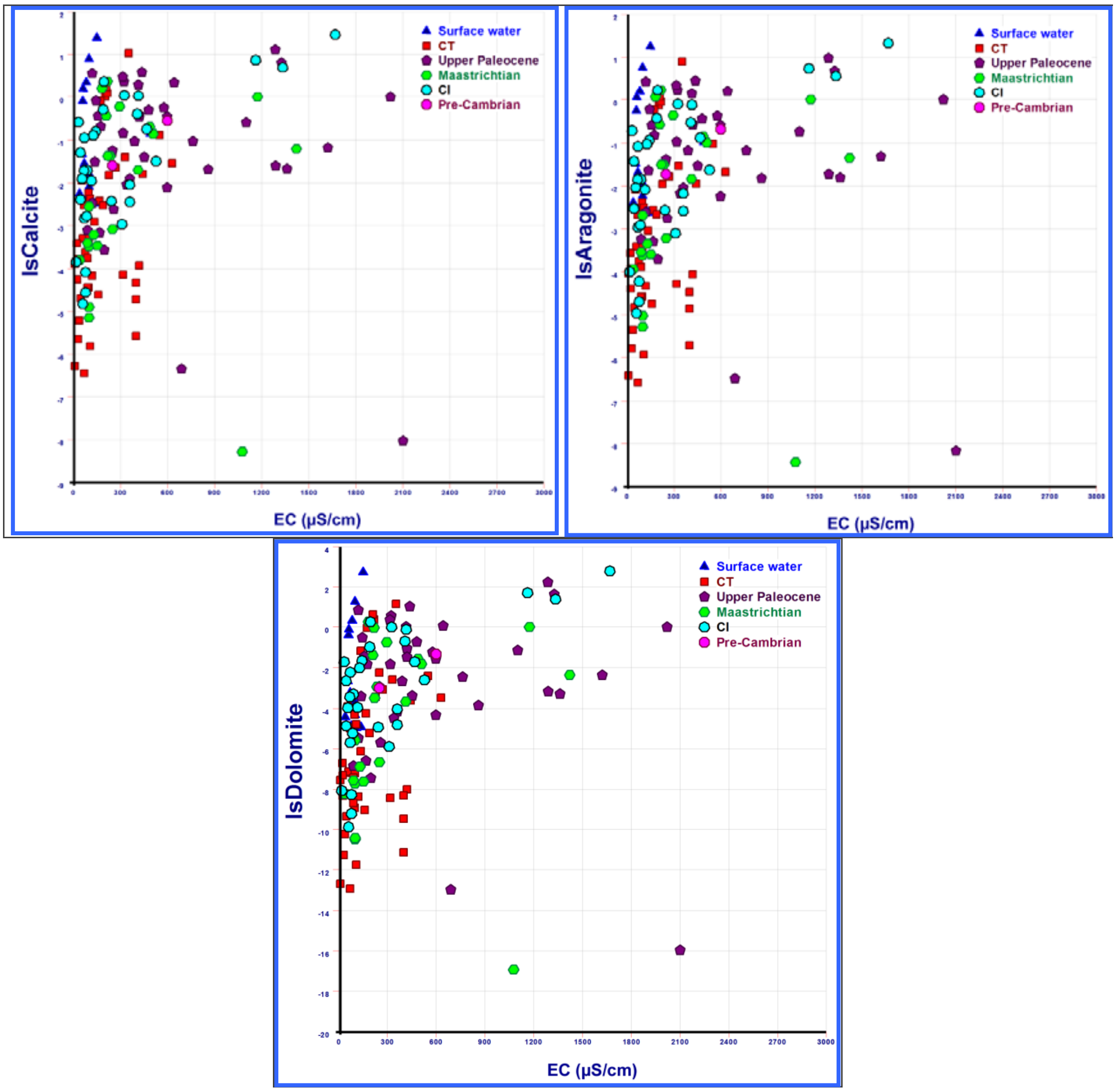



Figure 59: Relationships between saturation indices and EC

## 4.2.2. Isotope data of the Nigeria basin

- **Isotope composition of local precipitation in Nigeria**

Although no rainwater isotope was measured in the RAF/7/011 project, the database of the IAEA contains some values for Kano station (1961-1973) to be able to determine the local water line (Fig. 59) that will be adopted for the study area.

In this report, the local meteoric water line (LMWL) is defined for the first time, based on samples of precipitation collected from Kano station located in Nigeria (Fig.60). Both the slope and $\delta^2$H intercept for Kano MWL ($\delta^2H = 7.08 \times \delta^{18}O + 4.38$) are deviated from the global meteoric water line (GMWL) ($\delta^2H = 8 \times \delta^{18}O + 10$).

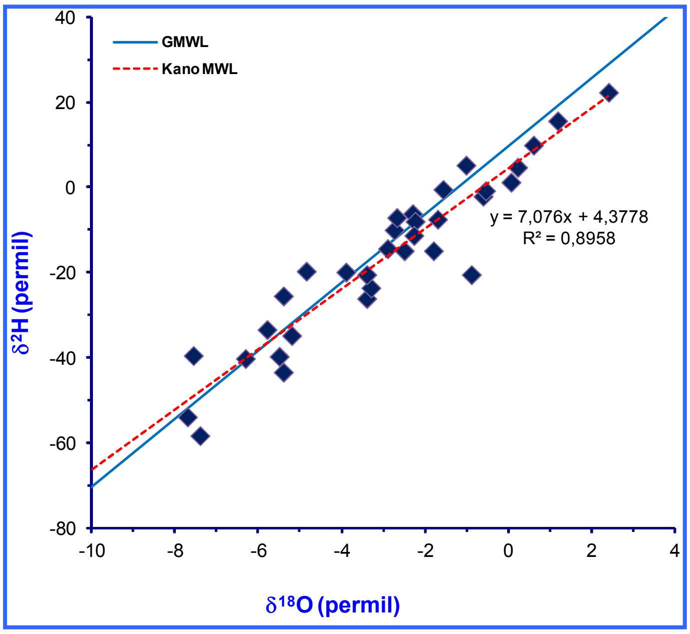



Figure 60: Local Meteoric Water Line for Kano station (red line) using data from the IAEA, compared to the Global Meteoric Water Line (blue line).

Taupin and *al.,* (2000) shows that rains in the Sahel and elsewhere at the peak of the season in August (Figs. 61, 62) are the most depleted in the heavier isotopes (Mbonu and Travi, 1994; Taupin and *al.,* 1997). The amount of rainfall in a storm event can also affect the isotopic signature. The relative humidity of the air column is also very important. Thus the extreme climatic and meteorological situations found in tropical monsoon regions can produce very different isotopic signatures for individual rain episodes (Goni, 2006) (Fig. 63).

The seasonal rainfalls in Iullemeden basin are controlled by the movement of the tropical rain belt (also known as the Inter-Tropical Conversion Zone, ITCZ) which oscillates between the northern and southern tropics over the course of a year, and brings rainfall to the southern regions of Niger when it is in its northern position between June and October, peaking in August. The average rainfall in the wettest (southernmost) regions at this time is an average 300mm per month but total rainfall decrease rapidly with increasing latitude. In the dry months between November and March, almost no rain falls at all.

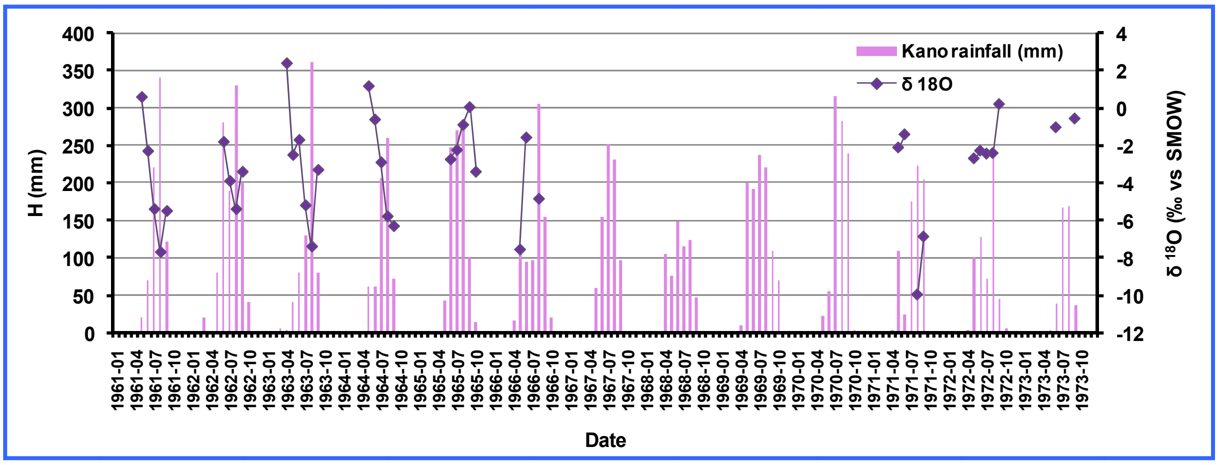



Figure 61: Monthly data of oxygen-18 and rainfall height in Kano station (1961-1973)

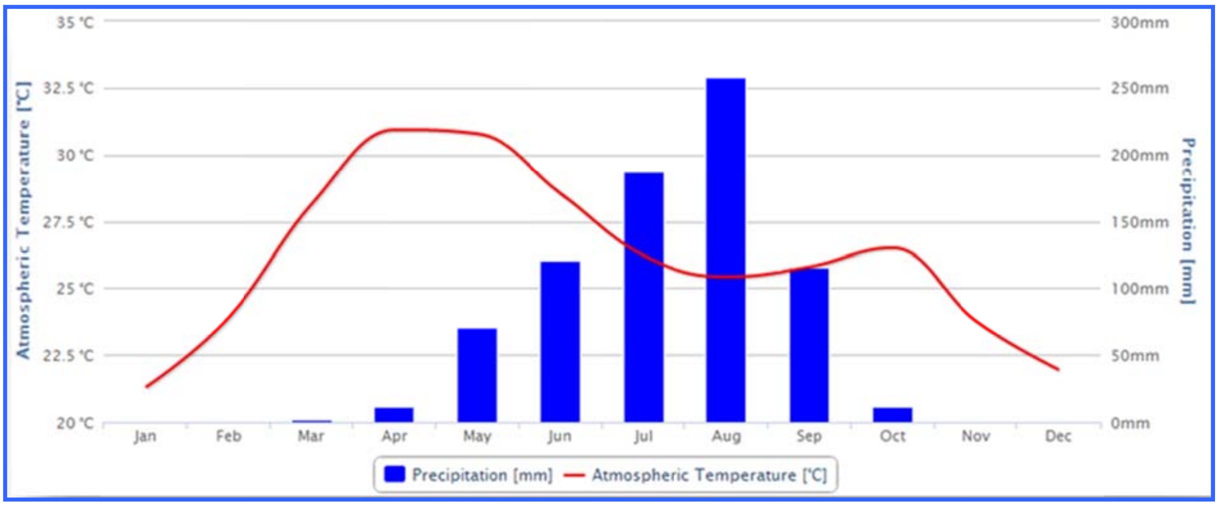



Figure 62: Climate diagram of Kano meteorological station (1961-1973)

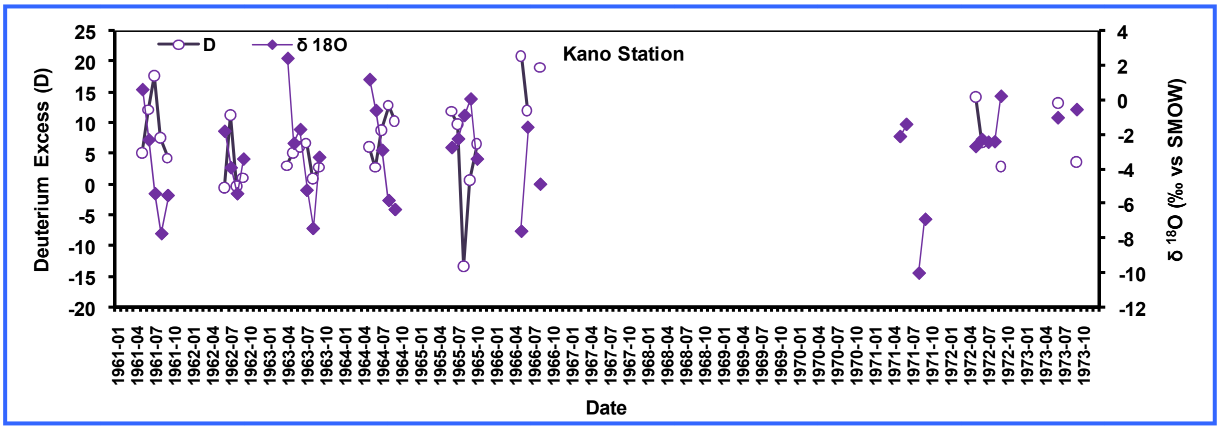



Figure 63: Monthly data of $^{18}O$ and d-excess in Kano meteorological station (1961-1973)

A variation in the altitudinal movements of the ITCZ from one year to cause large inter-annual variability in wet-season rainfall which means that suffers from recurring drought. The northern, desert region of Niger receives very scarce rainfall all year round. Annually, mean temperatures are similar across most of the country at 27-30°C and only differ substantially in the cooler mountainous regions of the north at 25-27°C. However, seasonal variations are large, and differ in their patterns for different parts of the country. The most northern parts experience the largest seasonal variations summer and winter temperatures are distinct at 27-35°C in summer (JAS) and 15-25°C in winter (JFM). In the south less seasonal variation in evident but the summer months (JAS) are the coolest of the year (23-27°C) due to the cooling effects of cloud and rainfall at this time of year, whilst the drier season (AMJ) is the warmest season (25-30°C). Niger is one of the hottest countries in the world. The thermal equator, which matches the hottest spots year-round on the planet based on the mean daily annual temperature, crosses the country. Most of Niger receives negligible rainfall and droughts are very frequent Late June to early December is the rainy season in the southernmost area. During this time, flooding of the Niger River is common, creating the Inner Niger Delta.

Sahelian rainfall is characterized by high variability on inter-annual and inter-decadal timescales, which can make long-term trends difficult to identify. A period of particularly high rainfall occurred in the early 1960s, whilst the early 80s were very dry, causing widespread dry in Mali and other Sahelian countries (Taupin and *al.,* 2002).

- **Isotope composition of groundwater and surface waters in Nigeria**

Stable isotopes $^{18}O$ and $^{2}H$ have been measured in all collected samples under the project RAF/7/011 from groundwater and surface water from Nigerian sector (Fig.64).

Position of the points representing the analyzed water samples of Nigeria on the $^{18}O/^{2}H$ diagram (Figure 64) show some variation of the isotopic compositions which may be related to the interference of several processes such as evaporation, paleoclimatic effect and actual recharge. Several observations may be made about the stable isotopes of the studied aquifers in relation to the modern rainfall.

-Points comprising CI, CT, Maastrichtian and Upper Paleocene aquifers which are more depleted than the weighted mean of local precipitation probably indicates that the groundwater have been recharged under climatic conditions which are cooler to those prevailing at present in the region (very low tritium contents ~0 TU, Fig. 65):

-Points showing mixture of water with stable isotope exhibiting signals that is between present day rainfall and palaeowater. This explains the plot of some data between depleted and relatively enriched stable isotope respectively interpreted as palaeowater and present day recharged water (Fig. 64).

-Points exhibiting enriched isotope contents collected from Rivers and Reservoirs indicate an evaporation process in open water bodies (tritium contents > 2.5 TU, Fig. 65).

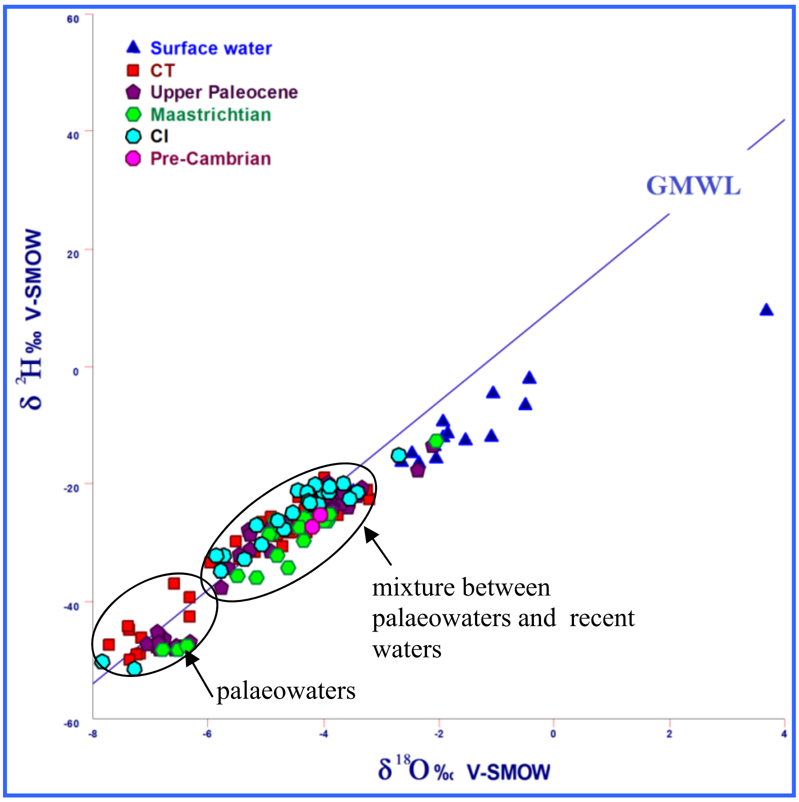



Figure 64: Relationship between $^{2}H$ and $^{18}O$ contents in water samples of the Nigeria basin.

**- Tritium**

Tritium data are available for the whole Nigeria samples. In surface water, the tritium contents vary between 2.1 and 5.6 TU. In groundwater tritium concentration vary between 0 and 6.7 TU. The samples of Pre-Cambrian show a low variation with significant tritium values ~2 TU consistent with a significant current recharge occurring in the outcropping part of the aquifer. Comparing to the Pre-Cambrian, all aquifer formations CI and CT, UP shows a higher variation in tritium indicated the presence of old and recent groundwater in the basin (Figs. 65, 66).

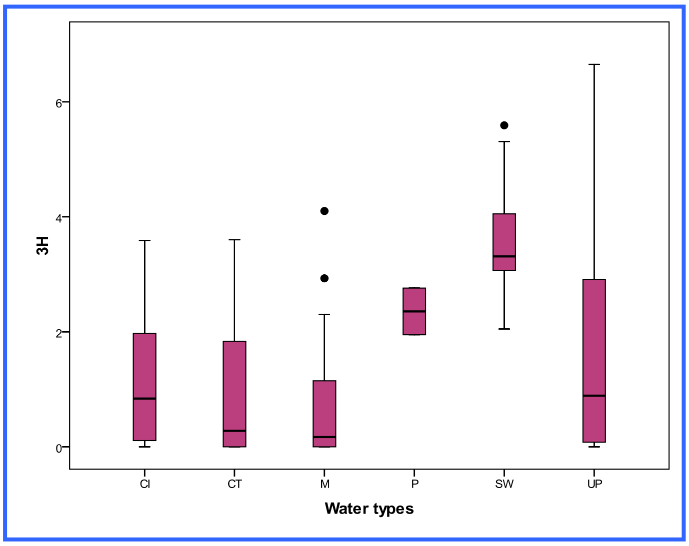



Figure 65: Variability and distribution of $^3H$ in the water samples of the Nigeria basin

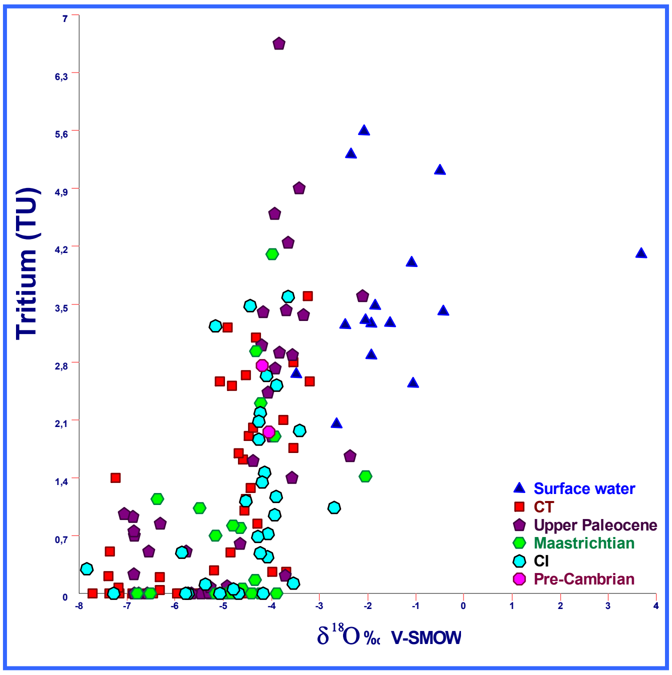



Figure 66: Plot of $^3H$ versus $^{18}O$ in water samples of the Nigeria basin

# 4.3. Geochemical data of the Kandi basin (Benin)

## 4.3.1. Hydrochemical study in the Kandi basin (Benin)

The Kandi basin, which is part of the transboundary Iullemeden sedimentary basin, belongs to the semiarid zone where people mostly depend on groundwater as their main source of water supply. The Kandi basin is limited in the north by the Niger River, in the south by the basement rocks, in the west by the Kandi regional fault and in the east by the republic of Nigeria. It covers an area of about 8700 km$^2$ which represents 7% of Benin's territory. The basin is flanked in the west and south by basement rocks. Within the IAEA-supported project RAF/7/011, a total of 165 samples were collected from this basin (Fig. 67).

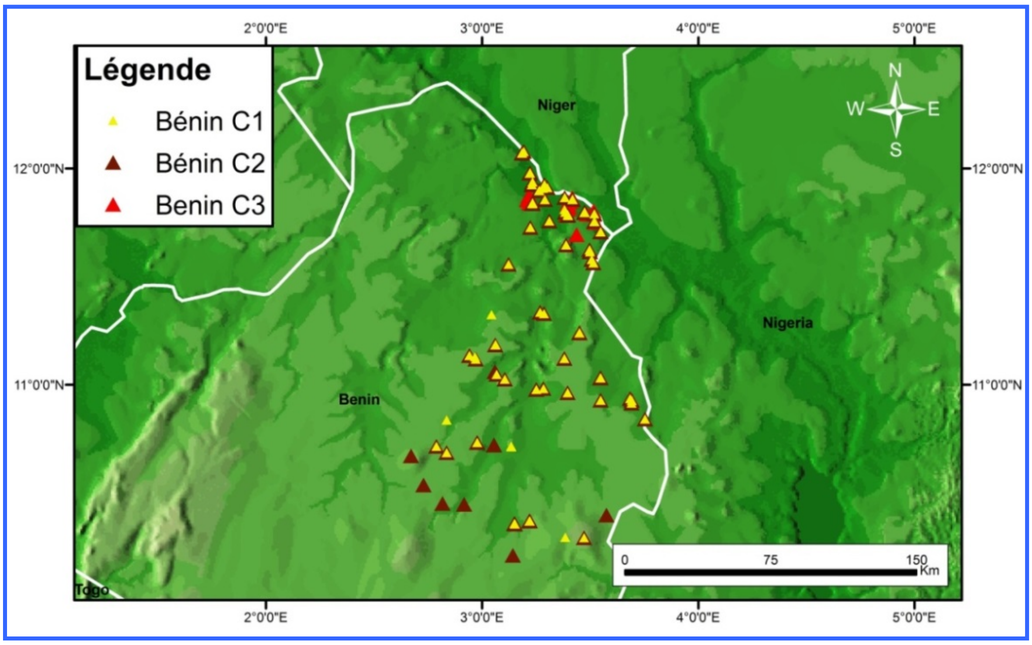



Figure 67: Location of sampling points within the Iullemeden basin (Kandi -Benin).

**- Electrical Conductivity**

The Electrical Conductivity varies from 12 to 1929 µS/cm (Fig. 68). Groundwater from the different geological formations shows differences in the EC. Higher EC values were observed in Quaternary aquifer (mean= 296 µS/cm) which present a big variability, while the lowest values were recorded in Ordovician-Silurian OS aquifer which is more homogenous (mean= 208 µS/cm).

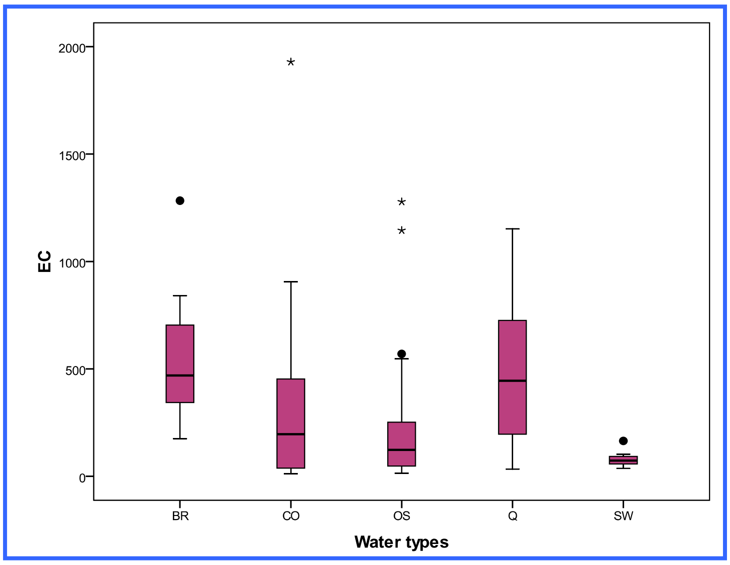


Figure 68: EC distribution in water samples of the Kandi basin.

**- Temperature**

The temperature varies from 23.1 to 34.4°C. Groundwater temperatures show smaller variation than surface water which traduce atmospheric temperature fluctuations in this zone (Fig. 69). For both surface and groundwater, the lower values are observed in the southern basin and the higher values are observed in the northern basin, in the vicinity of the Niger River (Kpegli et al., 2015). This indicates that groundwater temperature in the whole basin is influenced by the surface air temperatures as the surface air temperature gradient increases from the south to the north in the basin (LeBarbé and al., 1993).

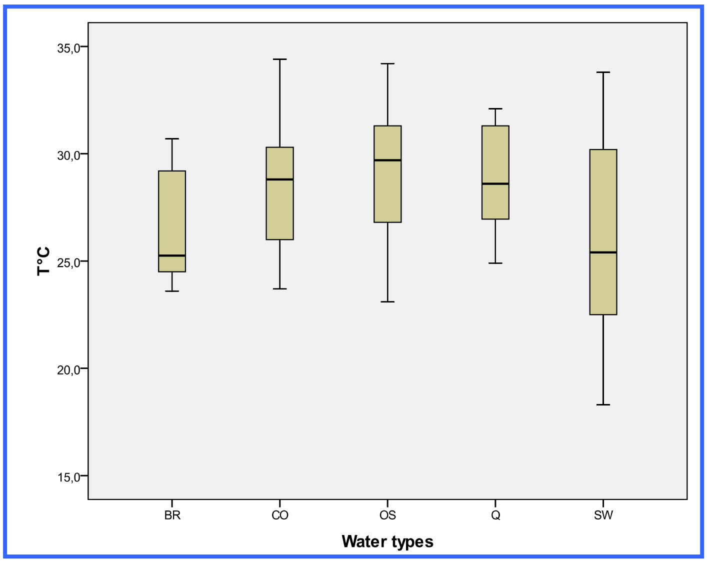



Figure 69: Temperature distribution in water samples of the Kandi basin.

**- pH**

The pH values vary from 4.5 to 8.1 (Fig. 70). The pH of surface water could be classified in three groups: a first group of pH values ranging from 5.7 to 6.1 characterizing the Sota River; a second group of pH values ranging from 6.9 to 7.3, with low values characterizing the Niger River; and a pH value of 7.8 characterizing Alibori River. The high pH variability observed in groundwater samples (from 4.5 to 7.9) traduce combinations effects of different factors surface water-groundwater interaction, groundwater depth, resident time in the flow system, recharge.

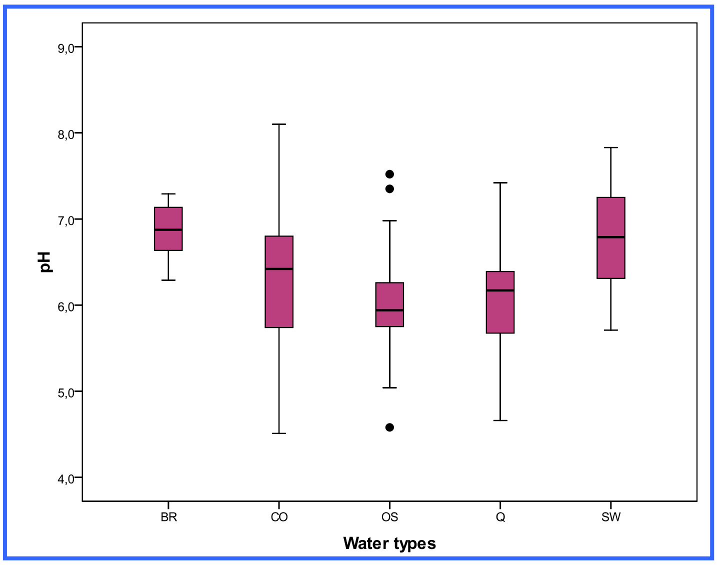



Figure 70: pH distribution in water samples of the Kandi basin.

**-TDS**

The Total Dissolved Salts (TDS) displays heterogeneous distributions. It varies between 10.8 and 2160 mg/l. This indicates that the basin is characterized by significant heterogeneities and the TDS values are affected by different geochemical processes. However, relatively low values of TDS (TDS < 400 mg/l) characterize the Terminal Ordovician to Silurian aquifer. Higher observed values come from the Cambro-Ordovician aquifer, Quaternary aquifer and the basement rocks aquifer that underlie the basin (Fig. 71). Both lower and higher values are unrelated to the geographical position.

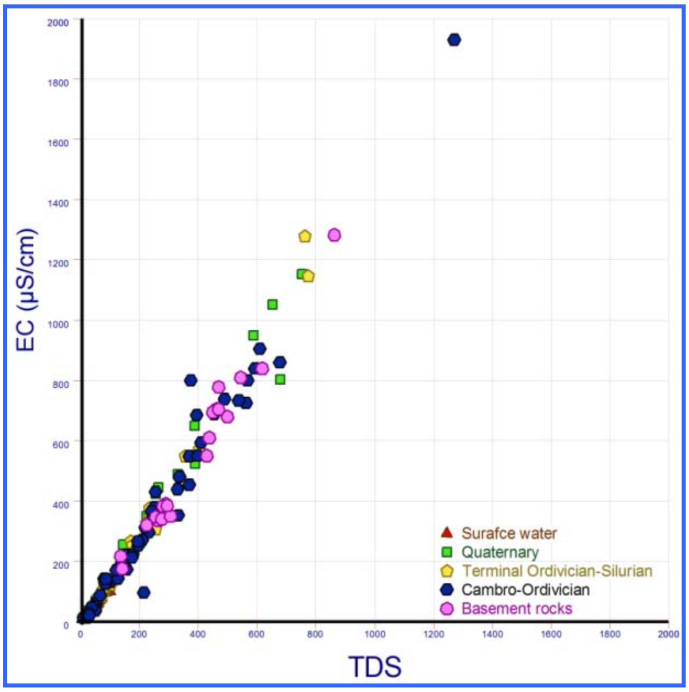



Figure 71: EC versus TDS in water samples of the Kandi basin.

**- Cations**

Figures 72, 73, 74 and 75 clearly show that the concentrations of all cations present low levels in surface waters in consistence with TDS values. Calcium and magnesium show lower values in the Cambro-Ordivician CO and Ordovician-Silurian OS formations. The other groundwaters from Quaternary Q, and Basement-Rocks BR, have high levels with significant variability (Figs. 72, 73).

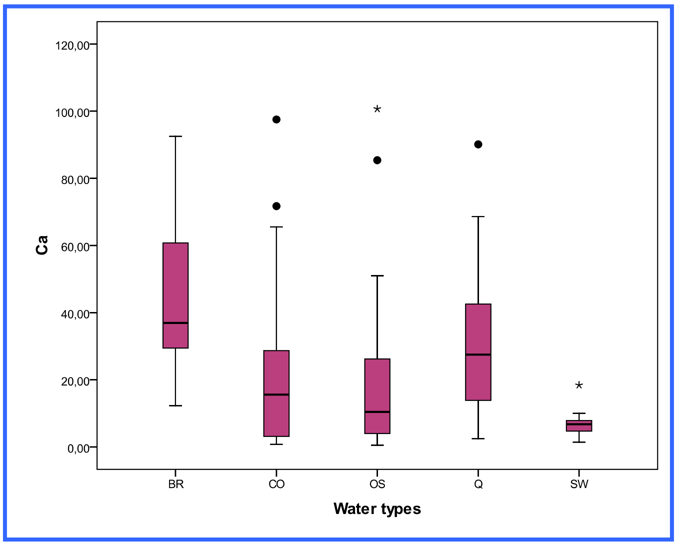



Figure 72: Variability and distribution of Ca in the water samples of the Kandi basin.

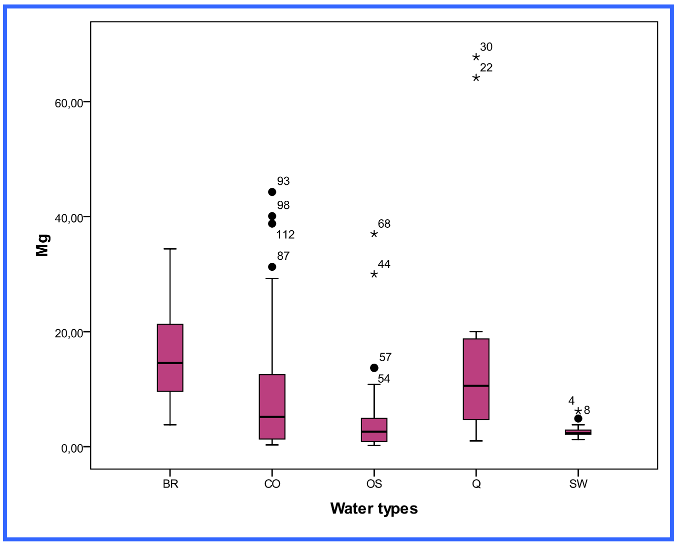



Figure 73: Variability and distribution of Mg in the water samples of the Kandi basin.

Sodium and potassium reveal mainly lower contents in Cambro-Ordivician and Ordivician-Silurian aquifers with higher variability aquifers and elevated content in Quaternary shallow aquifer and Basement-Rocks (Figs. 74, 75).

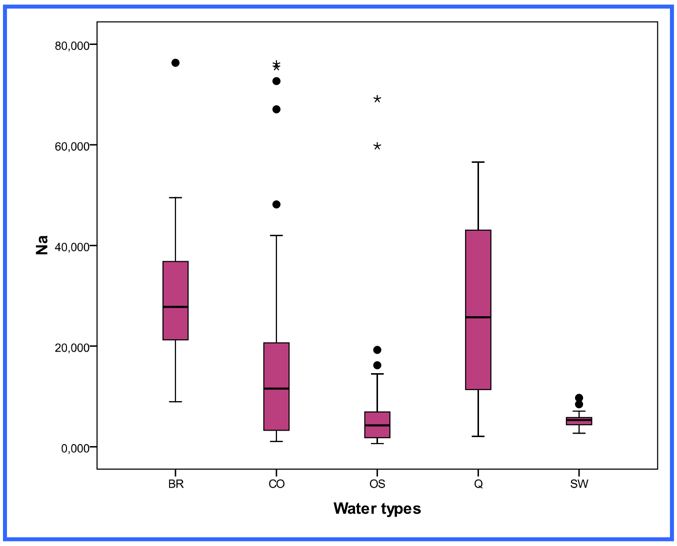



Figure 74: Variability and distribution of Na in the water samples of the Kandi basin.

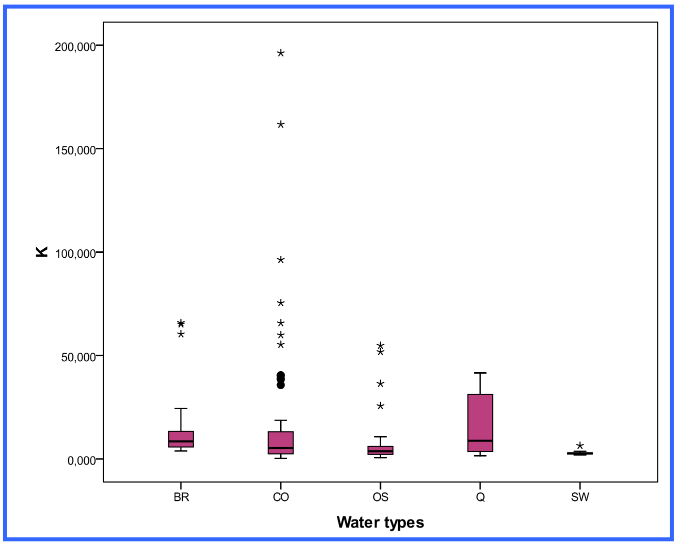



Figure 75: Variability and distribution of K in the water samples of the Kandi basin.

**- Anions**

Generally, the anions contents are very low in surface river waters (Figs. 76, 77, 78, 79). Bicarbonate concentrations (Fig. 76) range from 4 and 396.5 mg/l. OS ground waters show the lowest values in concordance with lower EC values. The CO and BR groundwater show higher values. According to geological data about these two aquifer formations in the study zone, it seems obvious that limestones and dolomite could contribute to water mineralization. Chloride contents (Fig. 77) show low values (< 20 mg/l) as natural level, as shown for OS ground waters. For BR and Q almost values show a higher level (30-210 mg/l).

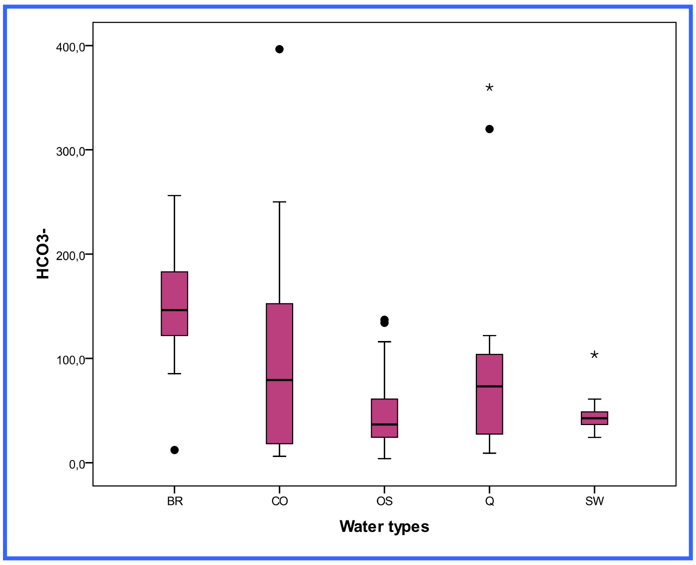



Figure 76: Variability and distribution of HCO3 in the water samples of the Kandi basin.

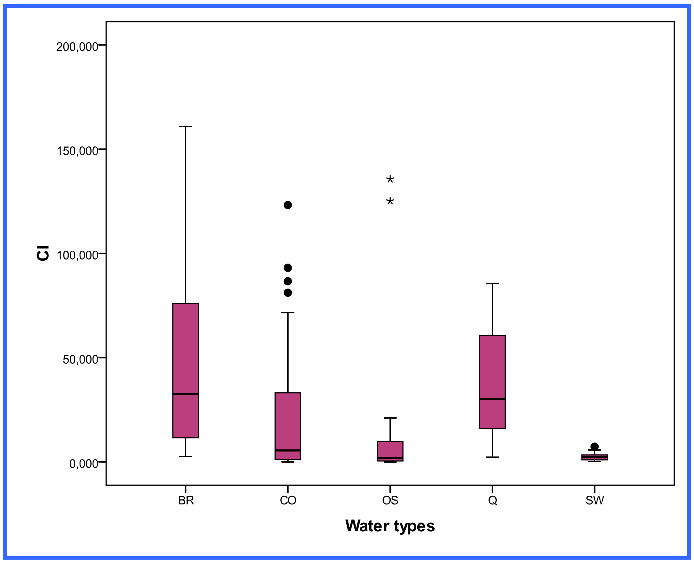



Figure 77: Variability and distribution of Cl in the water samples of the Kandi basin.

Sulfate contents (Fig. 78) show high levels for Quaternary ground waters which have the highest EC and low values (< 20 mg/l) in OS formation. In Quaternary shallow formation, sulfate concentrations reach 43.3 mg/l, and could be associated with a high content in sodium and calcium. It may be linked to evaporitic minerals locally (gypsum, thenardite or glauberite).

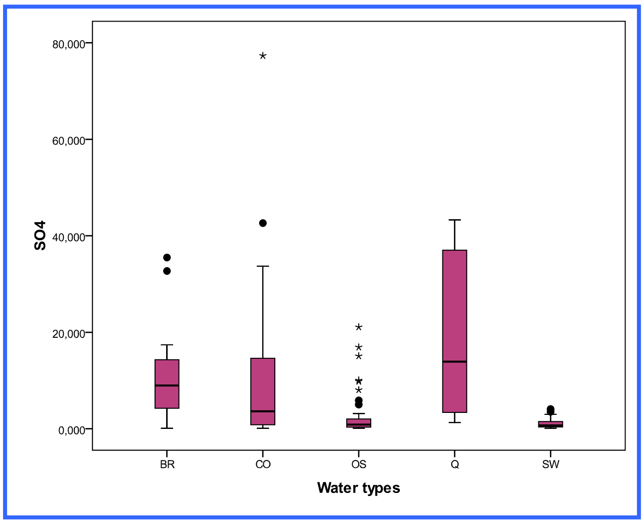



Figure 78: Variability and distribution of $SO_4$ in the water samples of the Kandi basin

**- Nitrate**

The nitrate contents in Kandi groundwater fluctuate between 0 and 765 mg/l. Some samples show high nitrate exceeding 50 mg/l (the World Health Organization, WHO) recommended maximum for drinking- water). These high nitrate concentrations were found at depths ranging between 1.4 and 76 m. The extreme nitrate concentrations were found at depths less than 20 m. These data may be related to natural conditions such the presence of the specific vegetation like acacias and termite or to an anthropogenic effect such extensive agricultural activities, manure (Figs. 79, 80). Potential influence of fertilizer is reflected in the agricultural areas where a vast of amount of N-fertilizers are used in the form of Urea (N), MTK (N, P, K rich fertilizer) and organic fertilizers. Over use of fertilizers may result in high concentration of nitrate in the farm lands.

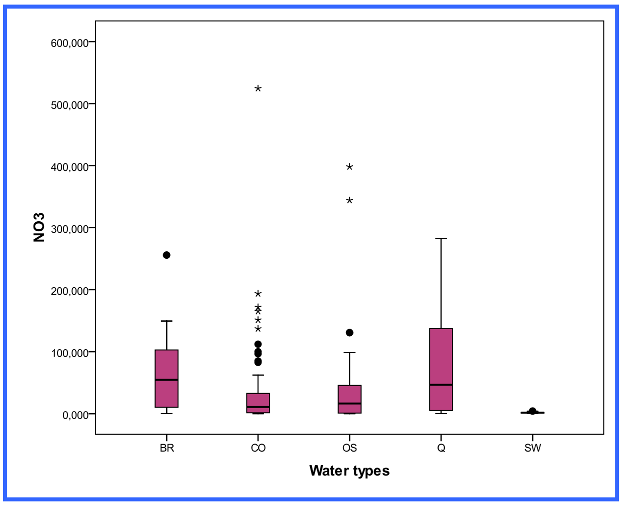



Figure 79: *Variability and distribution of $NO_3$ in the water samples of the Kandi basin.*

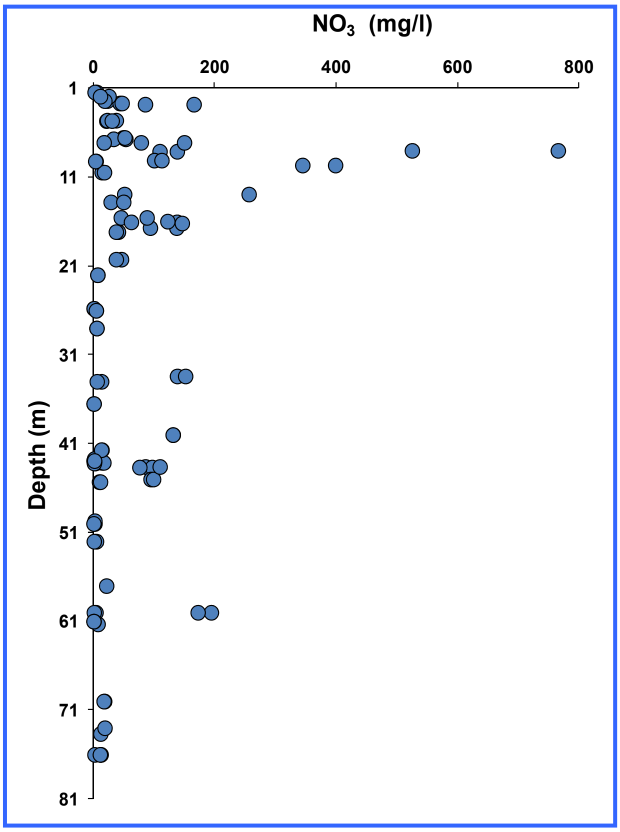



Figure 80: Distribution of nitrate contents with depth in groundwater of the Kandi basin

**-Hydrochemical Facies**

Chemical compositions of the analyzed water samples were plotted on the Piper trilinear equivalence diagrams shown in Figure 81. Concentration of nitrate was taking into account when plotting this diagram because of its relative abundance in some water samples.

Fig. 81 shows that Kandi basin is characterized by low proportions of sulfate ions but there is a clear gradation from $HCO_3$ to Cl-$NO_3$. All surface waters exhibit a unique water type of Ca-$HCO_3$ except sample BK60 which displays a Mg-$HCO_3$ water type (Fig. 82). Groundwater in the basin exhibits heterogeneity in water type. Four groundwater types are clearly identifiable (Fig. 81):

$HCO_3$-Na which are mainly Cambro-Ordovician groundwater, Cl-Na which are from the three aquifers, $HCO_3$-Ca which are mainly Terminal Ordovician to Silurian groundwater, and Cl-Ca which are from the three aquifers. The other groundwater samples from all aquifers are characterized by a mixed ionic water type. This is an indication of a variety of factors governing the groundwater geochemistry in this basin.

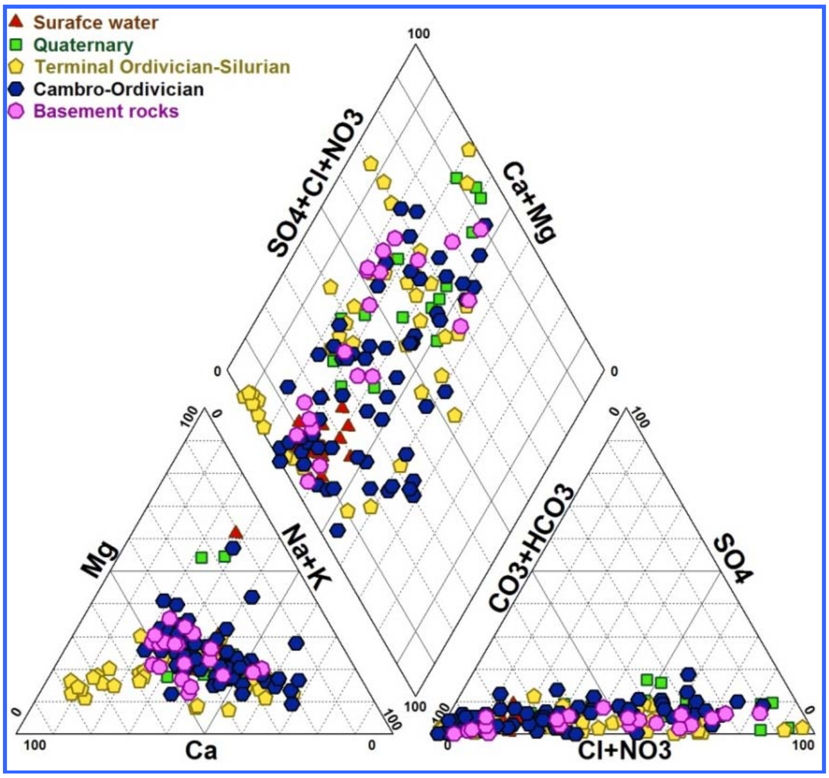
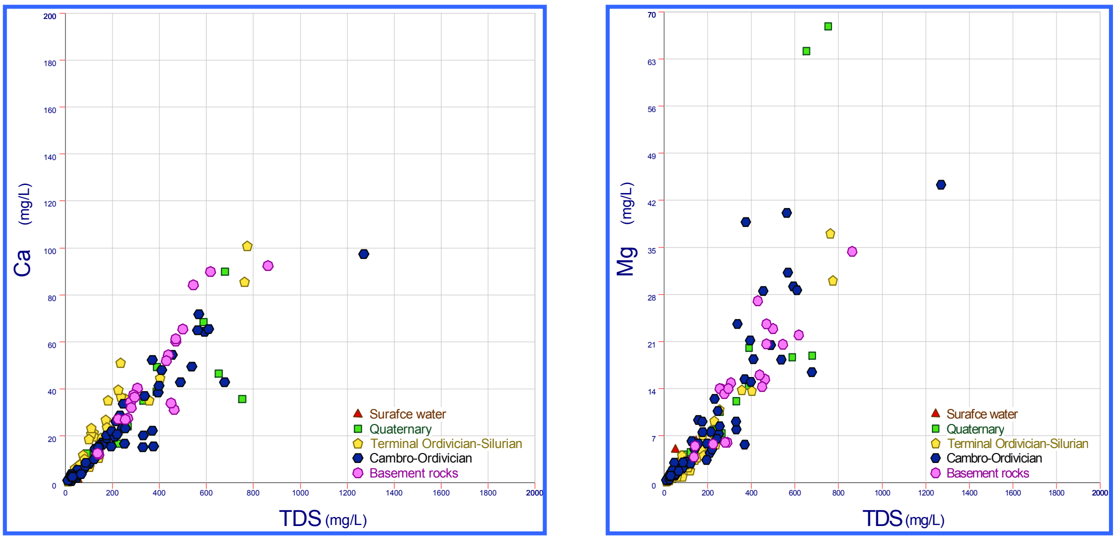



Figure 81: Piper diagram of the water samples of the Kandi basin.

**-Origin of major ions and mineralization processes**

In order to highlight the different mechanisms contributing to water mineralization in Kandi basin, the relationships between major elements and total dissolved solutes (TDS) were investigated (Figs. 82, 83). The Ca, Na, Mg, K, Cl, $HCO_3$, $SO_4$ and $NO_3$ concentrations show systematic increases with TDS. These positive correlations indicate that the mentioned ions contribute significantly to the groundwater mineralization.



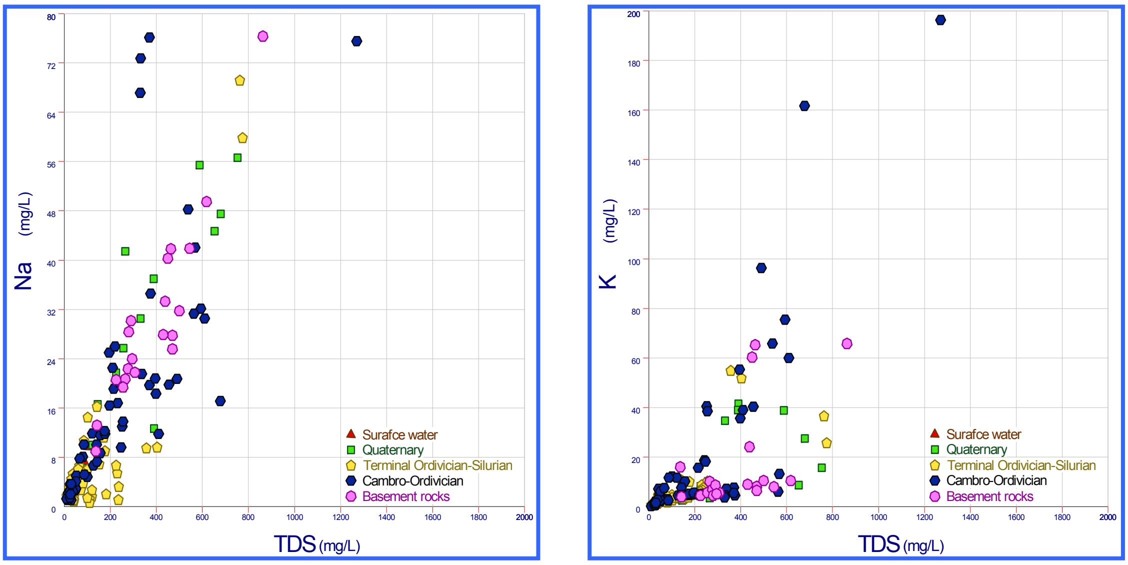



Figure 82: Relationships between TDS and major elements (cations)

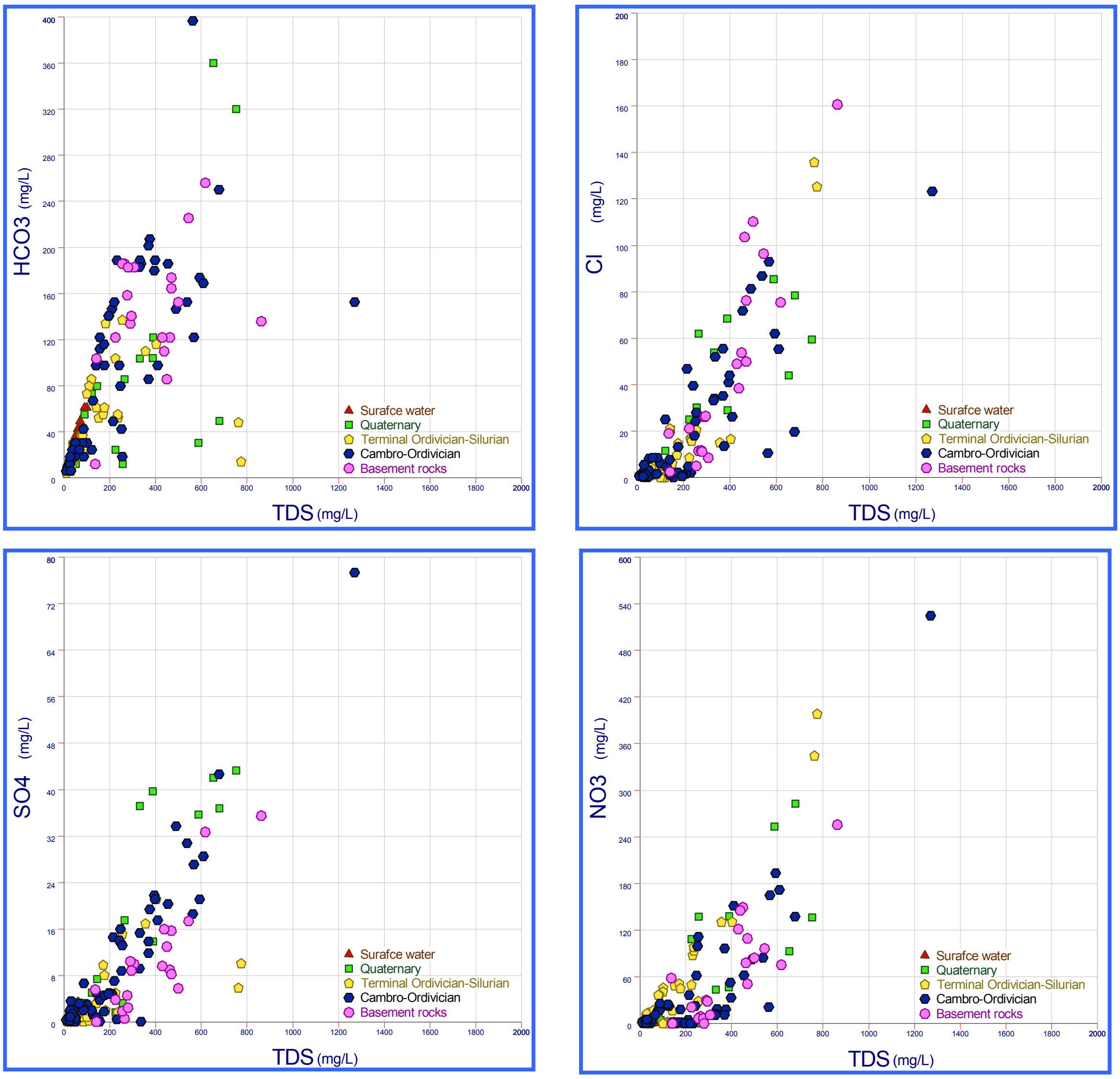



Figure 83: Relationships between TDS and major elements (anions)

In order to determine the origins of referred ions and the processes that control their concentration, several bivariate diagrams were plotted. These diagrams were plotted taking into account the most abundant minerals (Calcite and Aragonite: $CaCO_3$, Dolomite: $CaMg(CO_3)_2$, Magnesite: $MgCO_3$) and evaporites (Halite: NaCl, Gypsum: $CaSO_4$, $2H_2O$, anhydrite: $CaSO_4$, mirabilite: $Na_2SO_4$) generally existing in sedimentary deposits. However, gypsum, anhydrite, and mirabilite dissolution in the case of Iullemeden basin in Benin should be excluded as a result of insignificant values of sulfate ions.

The Ca versus $HCO_3$ diagram (Fig. 84) shows that some groundwater samples, basically from the Quaternary and Terminal Ordovician to Silurian aquifers, plot perfectly cluster along the calcite or aragonite dissolution line. This indicates that the dissolution of calcite and aragonite participates in part to the presence of these ions in the Quaternary and Terminal Ordovician to Silurian aquifers (Fig. 84). Dissolution of calcite and aragonite is confirmed through the parabolic proportional relationship in the plots of Ca and $HCO_3$ versus saturation indices of waters with respect to referred minerals (Fig. 85).

However, the other points that do not plot along the 1:1 line indicate that the Ca and $HCO_3$ in the basin are attributable to other additional sources.

The Na versus Cl relationship (Fig. 84) shows a parallel enrichment in both ions for the Quaternary aquifer and demonstrates that these points cluster along the halite dissolution line for that aquifer. The presence of sodium and chloride ions in the Quaternary aquifer could be related to halite dissolution (Fig. 85). The participation of chloride to the mineralization is weak compared to the nitrate shown on the Piper diagram. So, a great part of chloride comes from an anthropogenic input as nitrate pollution.

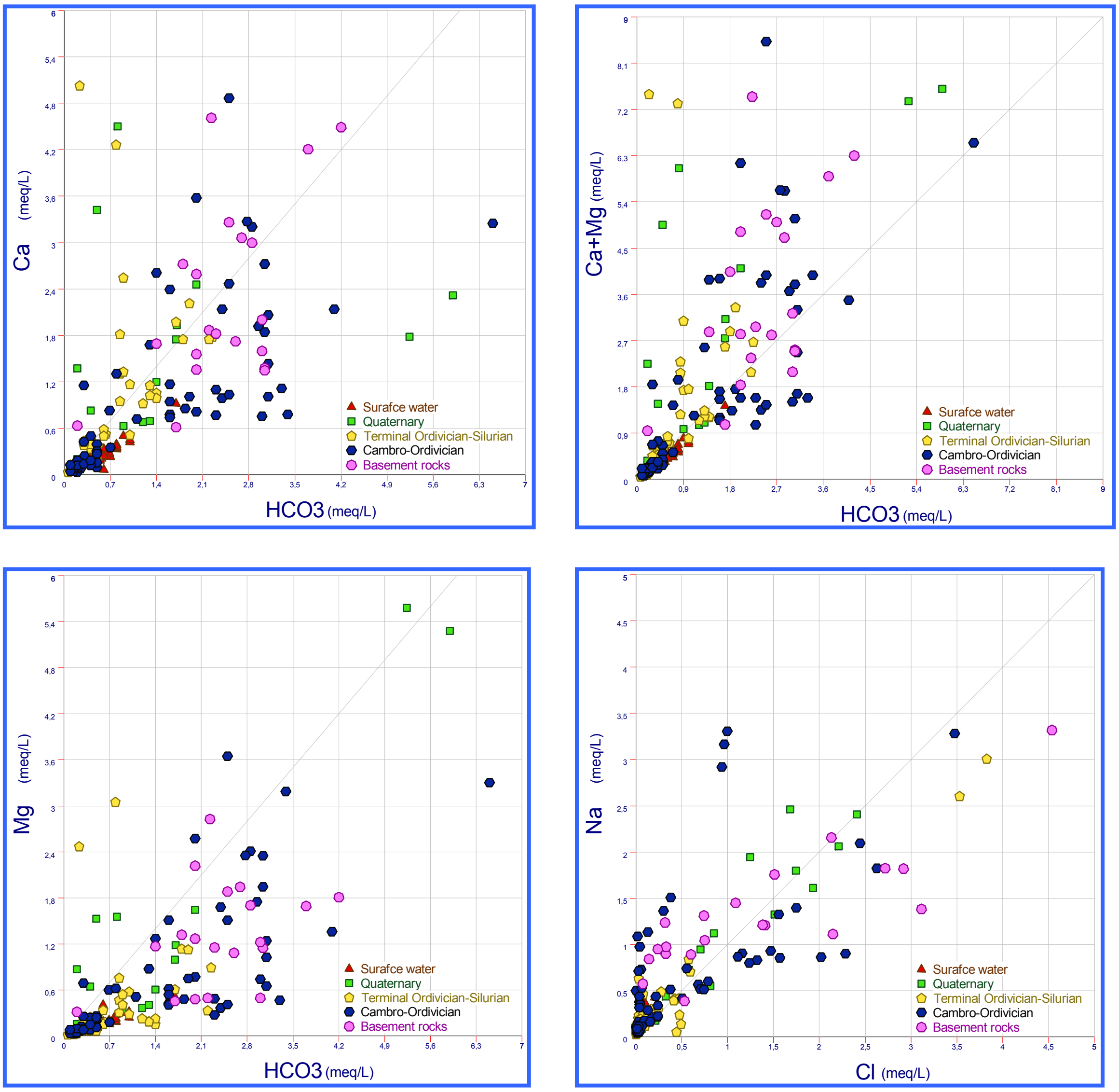



Figure 84: Relationships between major elements of water of the Kandi basin

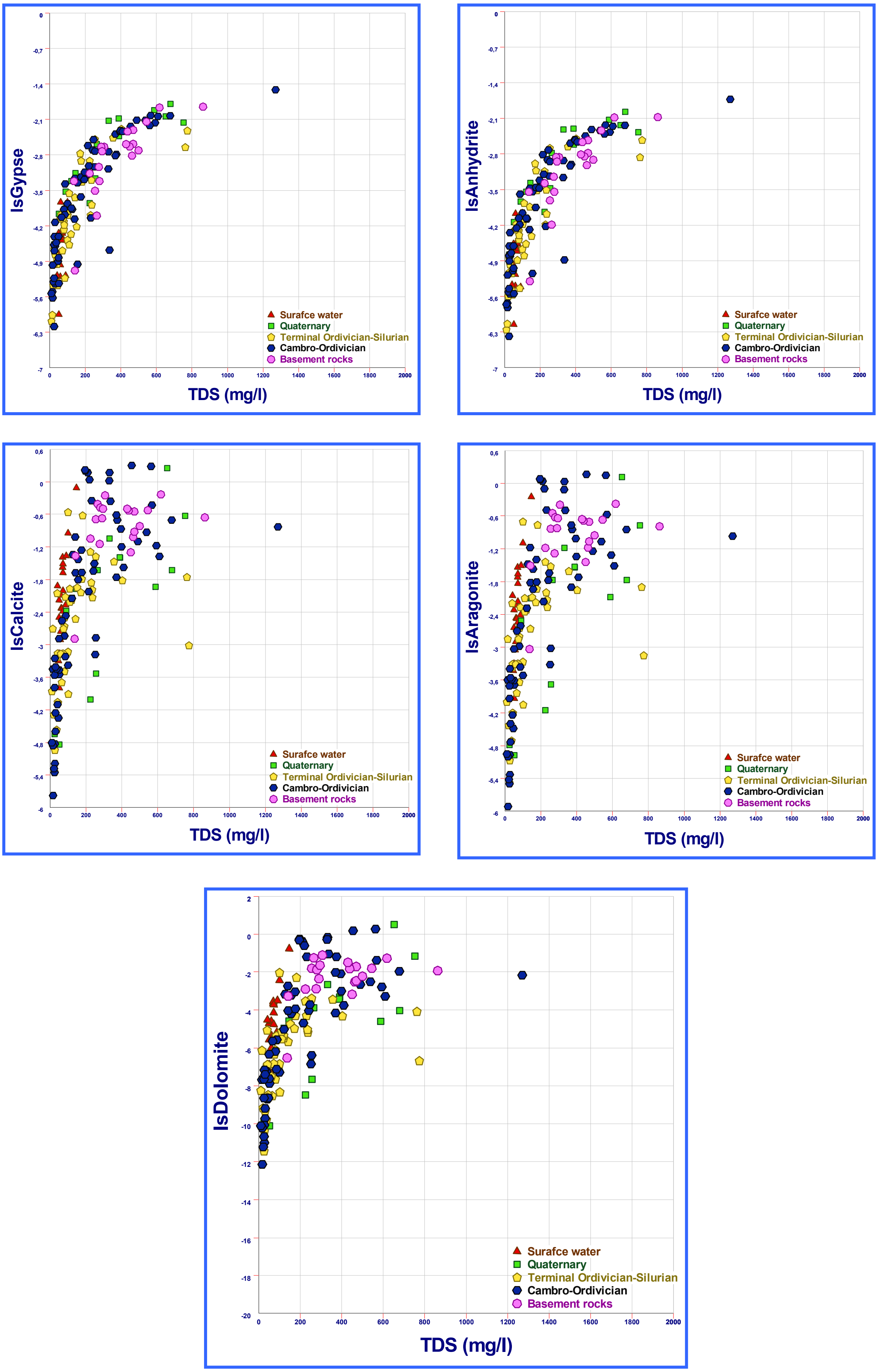



Figure 85: Relationships between saturation indices and TDS in waters of the Kandi basin

## 4.3.2. Isotope study of Kandi basin (Benin)

- **Isotope composition of surface and groundwater**

All groundwater and surface water samples from Kandi basin have been analyzed for stable isotopes. The range of values in the whole aquifers of Kandi is between -6.5 and -0.9 ‰ for oxygen 18 and -43.4 ‰ and -10.3 ‰ for deuterium (Figs. 86, 87). The variability of the analyzed groundwater samples is low traducing homogeneity of isotopic composition except some outliers which present either enriched or depleted values.

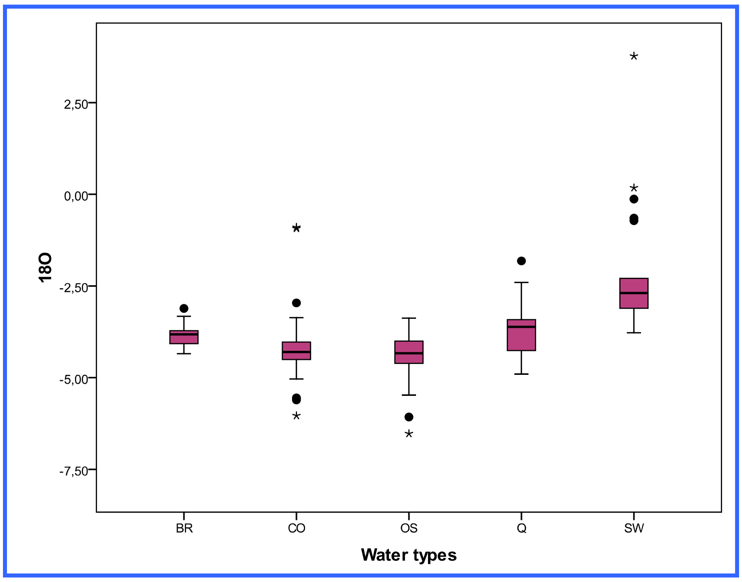



Figure 86: Variability and distribution of $\delta^{18}O$ in the analyzed water samples of the Kandi basin.

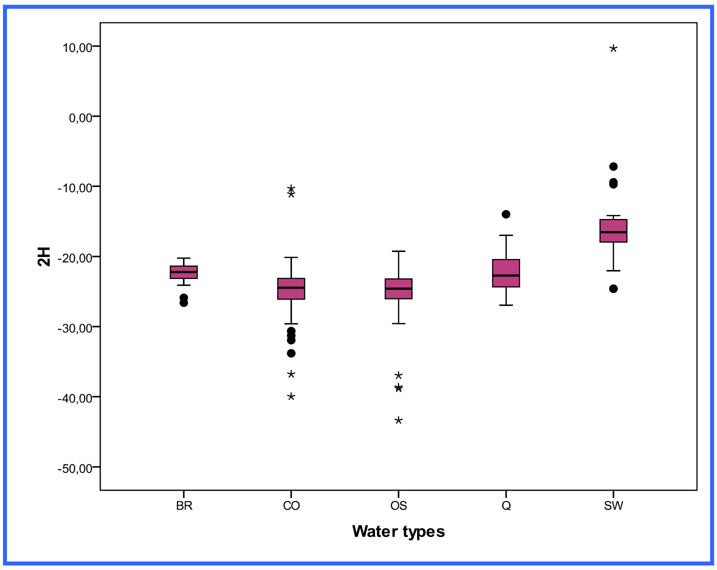



Figure 87: Variability and distribution of $\delta^{2}H$ in the analyzed water samples of the Kandi basin.

Figures 88 and 89 show that surface waters are enriched in stable isotopes. Enriched values indicate the evaporation effect, as these surface waters points cluster along the evaporation line.

Groundwater in the basin display large range of variation. Most groundwater from the Cambro-Ordovician aquifer and Terminal Ordovician to Silurian aquifer fall around the GWML (Global Water Meteoric Line) reported by Craig (1961). This indicates that they originated from modern precipitation infiltration. In addition, the fact that these two aquifers are characterized by the same signature range of $^{2}$H and $^{18}$O is a sign of water exchange (mixing) between these two aquifers in some areas. However, the unique sample from the Cambro-Ordovician aquifer that is highly enriched in stable isotopes and falls on the evaporation line (Fig. 88) is a result of a direct recharge of the Cambro-Ordovician aquifer by the Alibori river in that area. This sample point is located in the northwestern Kandi basin, in the vicinity of Alibori River, where existing micro faults contribute to this direct recharge.

The points on Fig. 88 representing the Quaternary aquifer cluster along the evaporation line. This means that the surface waters contribute to the recharge of the Quaternary aquifer and this aquifer is under the evaporation effect. In some areas the points representing the Quaternary aquifer display similar signatures with those of the Terminal Ordovician to Silurian groundwater. This reveals a mixing process between the Quaternary and the Terminal Ordovician to Silurian aquifers in these areas (Madekali, Ganrou, and Malanville). Groundwater from southern surrounding basement rocks contribute to the recharge of the Cambro-Ordovician and Terminal Ordovician to Silurian aquifers in the basin, as suggested by the potentiometric map.

Reason for concern is the groundwater quality on water points in the vicinity of settlements because of contamination by human activities as shown for the village of Dogué. Nitrate concentrations achieved in many places already alerting levels (> 50 mg/l) (Fig. 89).

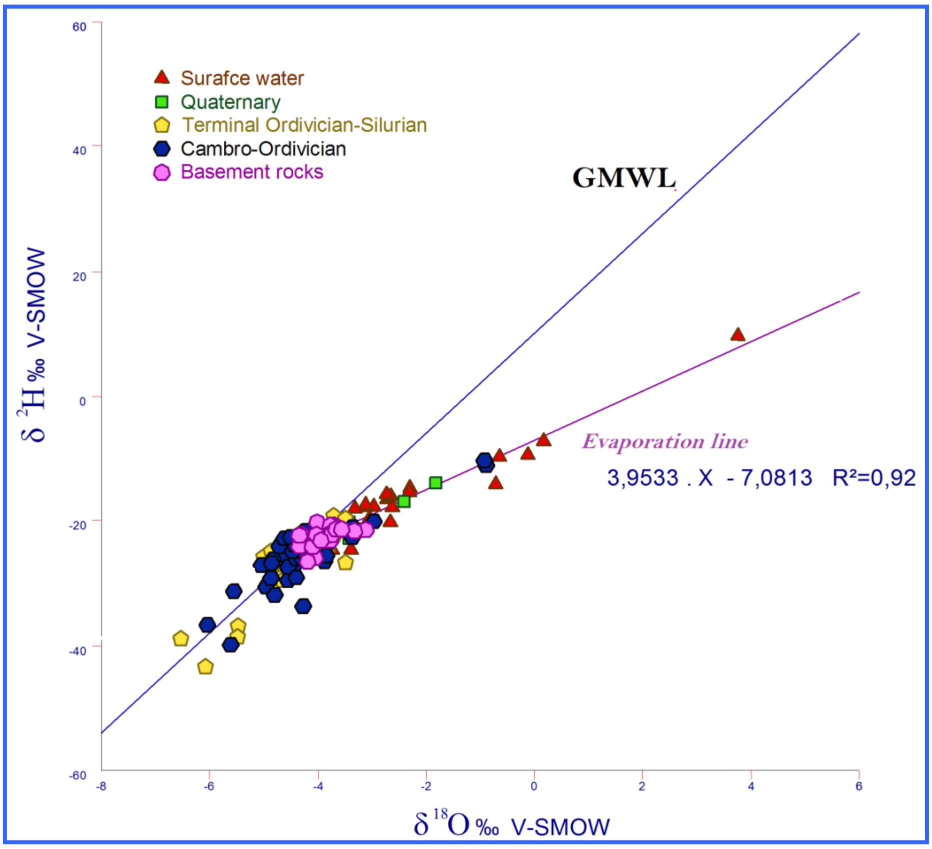



Figure 88: Plot of $^{2}H$ versus $^{18}O$ of the analyzed water samples of the Kandi basin.

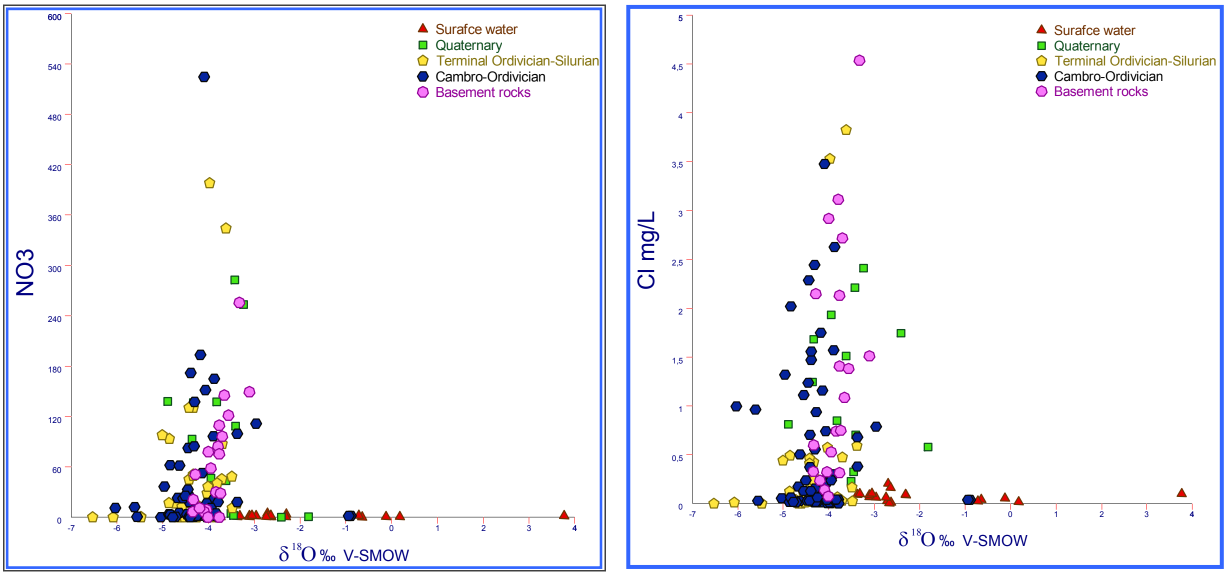



Figure 89: Plots of chloride versus $^{18}O$ and nitrate versus $^{18}O$ of the water samples.

**Tritium**

Tritium content of surface water samples vary between 0.6 and 4.5 TU. Those of groundwater range from 0 to 5.1 TU. More than 80 % of water samples in Kandi basin are enriched in tritium. Some few water samples display low values of tritium, less than 0.5 TU. Such low tritium values are an indication of the presence of old groundwater or old-recent mixed groundwater in the Kandi basin system (Figs. 90, 91). As most samples are characterized by values greater than 0.5 TU (Tritium Unit), it means that most waters are post-nuclear recharged waters, i.e. groundwater recharged after the period of 1960 (Clark and Fritz, 1997). High tritium values such 4.5 TU are known as groundwater recharged around 2000 to 2005. These high values of tritium are found almost everywhere in the basin. This means that direct infiltration of precipitation at almost all the surface of Kandi basin contributes to the groundwater recharge. Surface waters are generally enriched in stable isotopes. This is a clear indication that they are evaporated, which is normal in such a semi-arid environment. However, two surface samples points located in the northern basin tend to behave as old waters. These samples are the most depleted in both $^{18}O$ and $^{2}H$ among all measured surface water samples. This indicates that these sample points are probably areas where relatively old groundwater discharges into Sôta River.

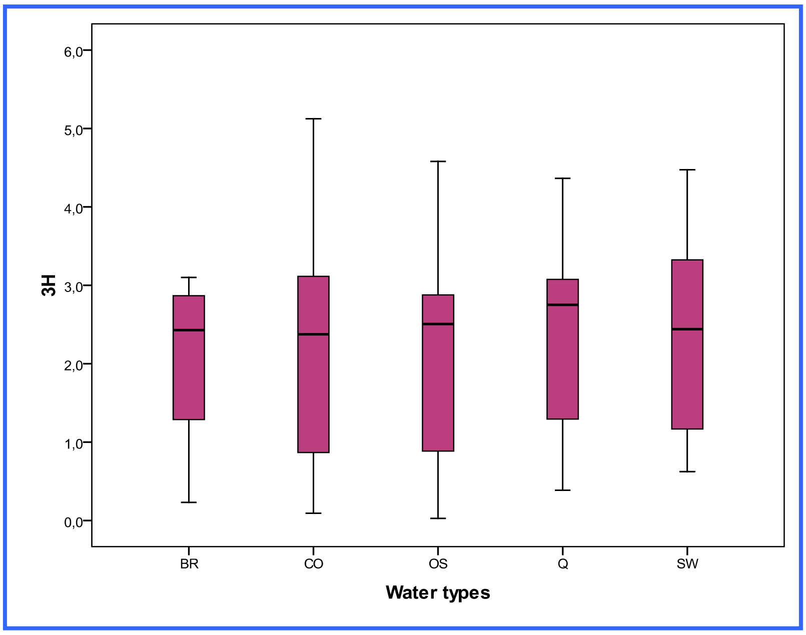



Figure 90: Variability and distribution of $^{3}H$ in the water samples of the Kandi basin.

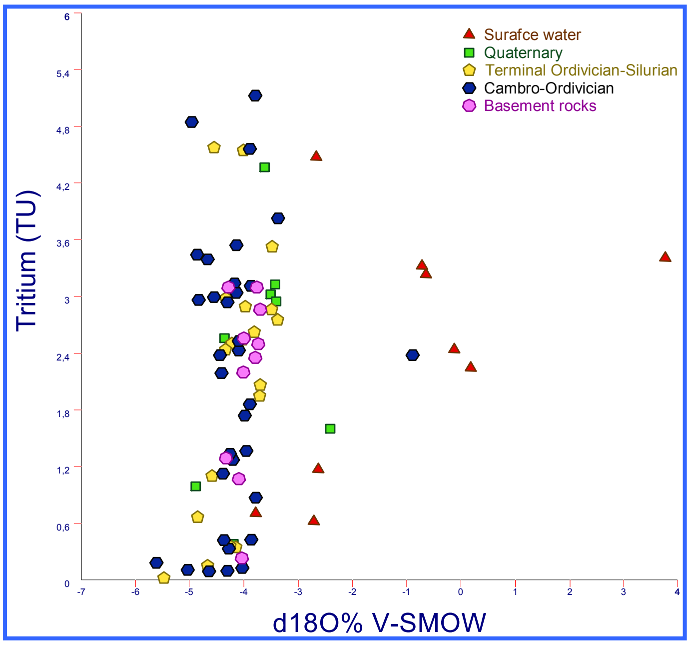



Figure 91: Plot of $^{3}H$ versus $^{18}O$ of the analyzed water samples of the Kandi basin

**Carbon-14**

The $^{14}C$ and $^{13}C$ analysis were measured only on 8 samples collected during the second campaign (Fig. 92). The $^{14}C$ concentration of groundwater samples ranges from 17 to 103 pmc (percent of modern carbon). Relatively high $^{14}C$ activities observed in groundwater samples suggest a recent groundwater recharge. By contrast, low $^{14}C$ activities in groundwater samples suggest a relatively old groundwater recharge.

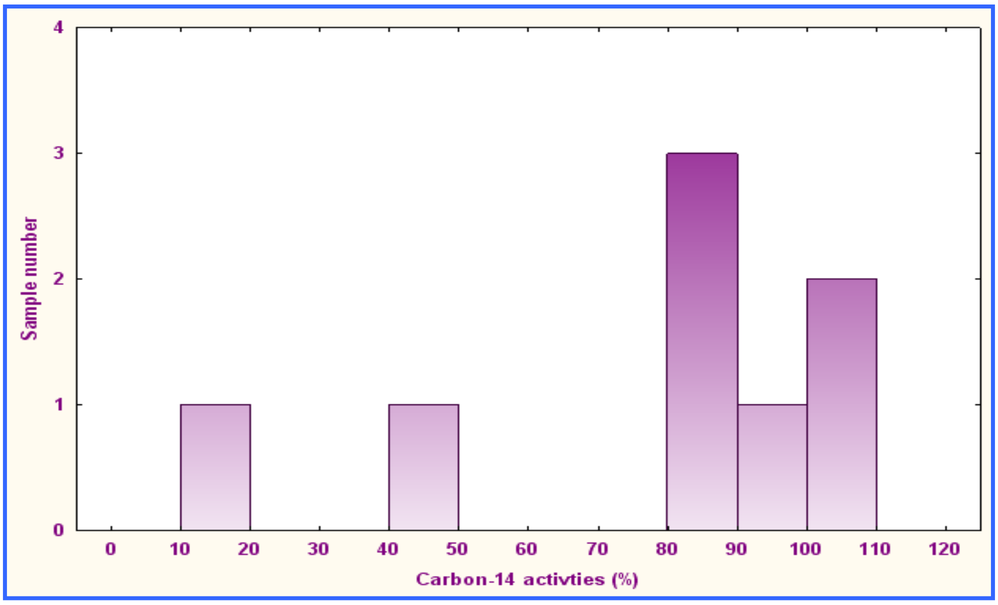



Figure 92: Frequency distribution of $^{14}C$ in the analyzed water samples of the Kandi basin

Figure 93 shows that these groundwaters are classified into two distinct groups. Group 1 represents groundwater that is relatively recent with carbon-14 activities ranging from 80 to 103 pmc. Group 2 represents relatively old groundwater with carbon-14 activities ranging between 16 and 50 pmc. An important remark is that recent groundwater is found basically in the southern basin and the relatively old groundwater is found in the northern basin around Sakaoun and Garoutedji townships. This quite logical organization of groundwater age pointed out by isotopic techniques confirms the groundwater flow pattern early indicated by the potentiometric map in the Kandi basin.

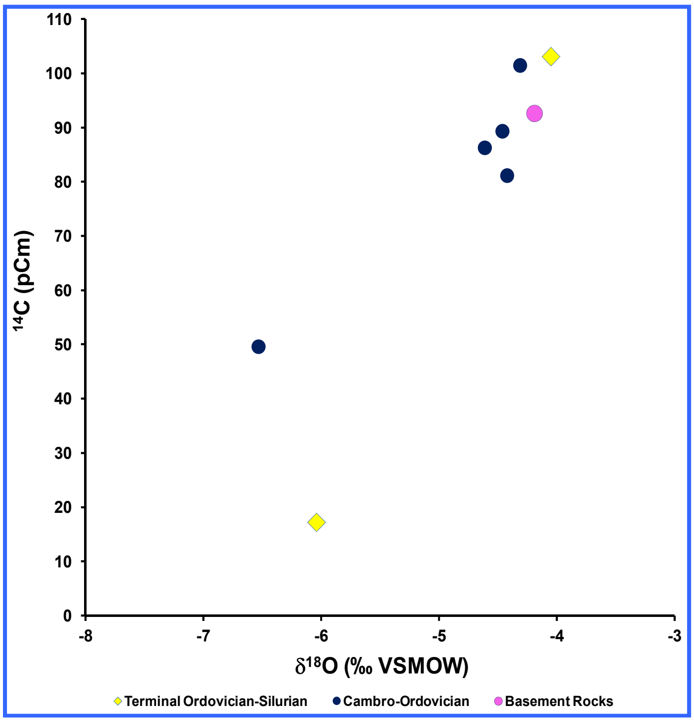



Figure 93: Relationship between $^{14}C$ and $^{18}O$ in groundwater samples of the Kandi basin

# 4.4. Geochemical data of the Iullemeden Aquifer System

The geochemical data of the Iullemeden transboundary basin were collected from several sampling campaigns that were carried out intermittently in Niger, Nigeria and Benin. Owing to field security problems in Mali and Algerian territories, the water sampling points were not visited by the experts. A total of 471 samples were collected from the Iullemeden basin.

## 4.4.1. Hydrochemical study in the Iullemeden Aquifer System

### -Groundwater salinity

The values of the EC measured on wells and boreholes range from 10 and 3860 µS/cm. Those of rivers vary between 10 and 490 µS/cm.

More than 75% of water samples present TDS contents less than 400 mg/l (Fig. 94). Few outliers and extreme value are characterized by high TDS value which could exceed 1g/l. These high salinities are local and observed mainly in the Upper Paleocene Aquifer (UP), CI and CT aquifer. These points are situated in different part of the whole basin (Fig.95)

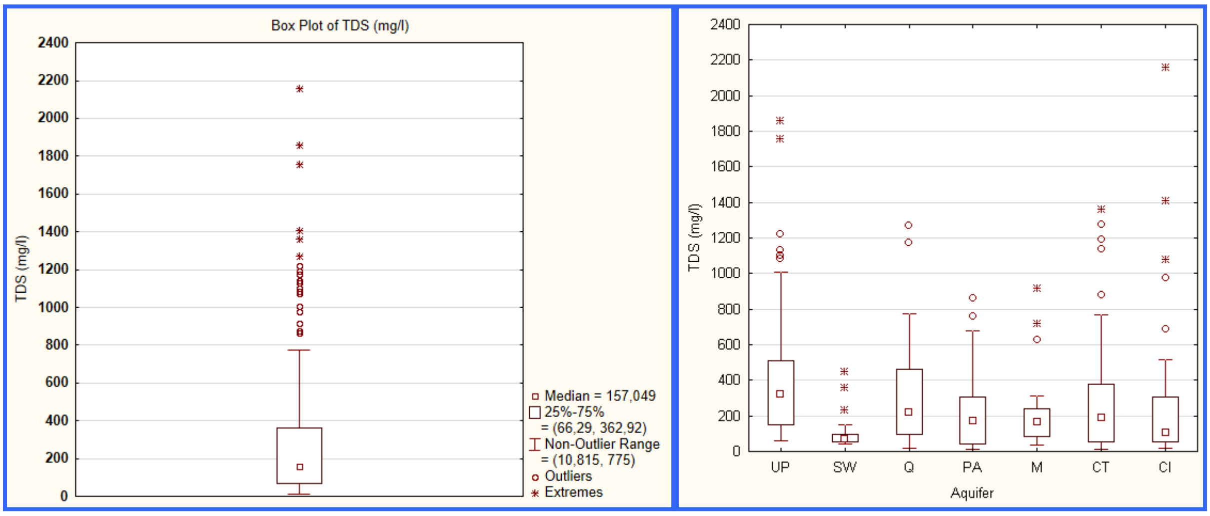



Figure 94: Distribution and variability of TDS values in waters samples of the Iullemeden Aquifer System

There are no spatial pattern observed in different aquifers, it seems obvious that the variability of TDS and chemical parameters depends on local conditions especially the variety of mineralogy, water depth, recharge structure and the contamination process.

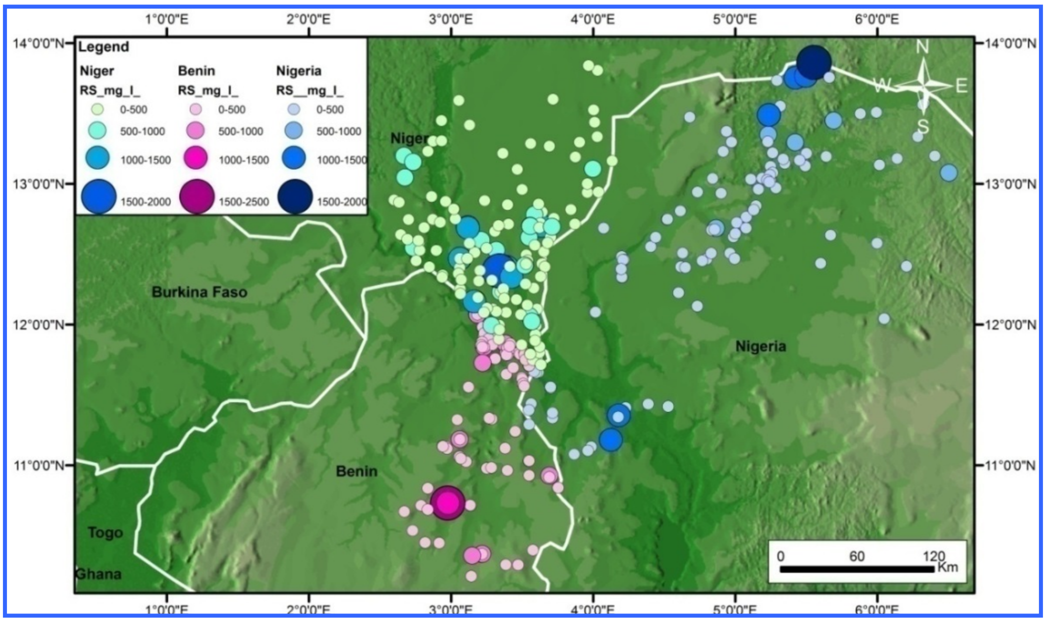



Figure 95: *Spatial distribution map of TDS values in the Iullemeden Aquifer System*

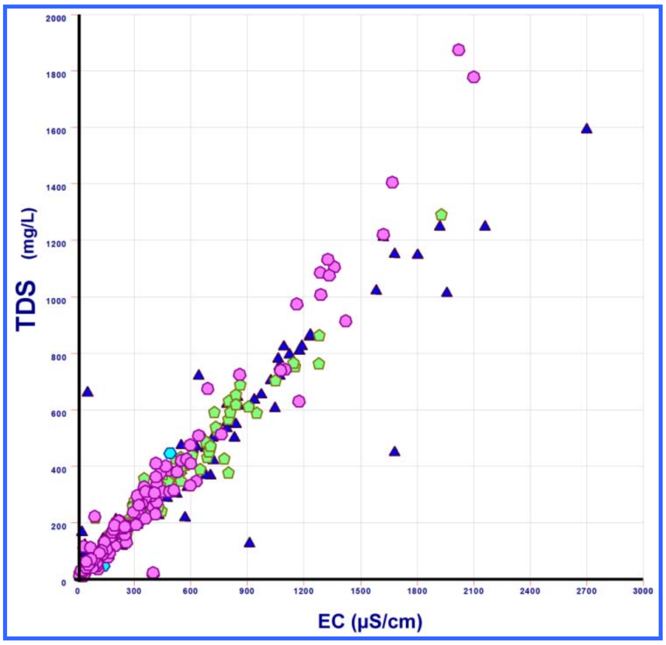



Figure 96: EC versus TDS in sampling points within the Iullemeden Aquifer System

## - Geochemical facies of groundwater

The chemical composition of the Iullemeden aquifer system groundwater is characterized by low contents of cations with 95% below 40 mg/l with dominance of calcium and sodium which show a high variability (Fig.97). Despite the fact that surface water samples are collected from different rivers in the basin, they are the most homogeneous with the lowest content in cations which could be linked to the chemical fluctuations of rain water quality.CI and CT aquifer show low and homogenous contents in Ca, Mg and K but more variable and

higher Na concentrations. The anions contents are low but very variable in particular sulfate which could exceed 1200 mg/l in some outliers (Fig.98) in the Upper Paleocene aquifer. The bicarbonate constitutes the major anions with high variability on all aquifer groundwater.
Chloride contents are low and more homogenous. About 80% of samples exhibit nitrate contents < 50 mg/l. However, some groundwater samples collected mainly in shallow quaternary aquifer (Q) and Paleozoic (PA) and Upper Paleocene aquifer (UP) show local pollution by nitrates placed mainly in Niger and Benin. This contamination could be related to specific vegetation like acacias and termite which are nitrogen-fixing trees, or anthropogenic activities related to agricultural and domestic practices.

The chemical composition of the analyzed samples was plotted on the Piper trilinear equivalence diagrams shown in Figure 99. Several water types could be identified:

- Ca-Mg-$HCO_3$; Na-K-Cl; Ca- Cl - $SO_4$ and Na-K-$HCO_3$.

The large spatial variability of hydrochemical facies observed in the analyzed water samples could be related to physical and chemical weathering reaction of silicate minerals.

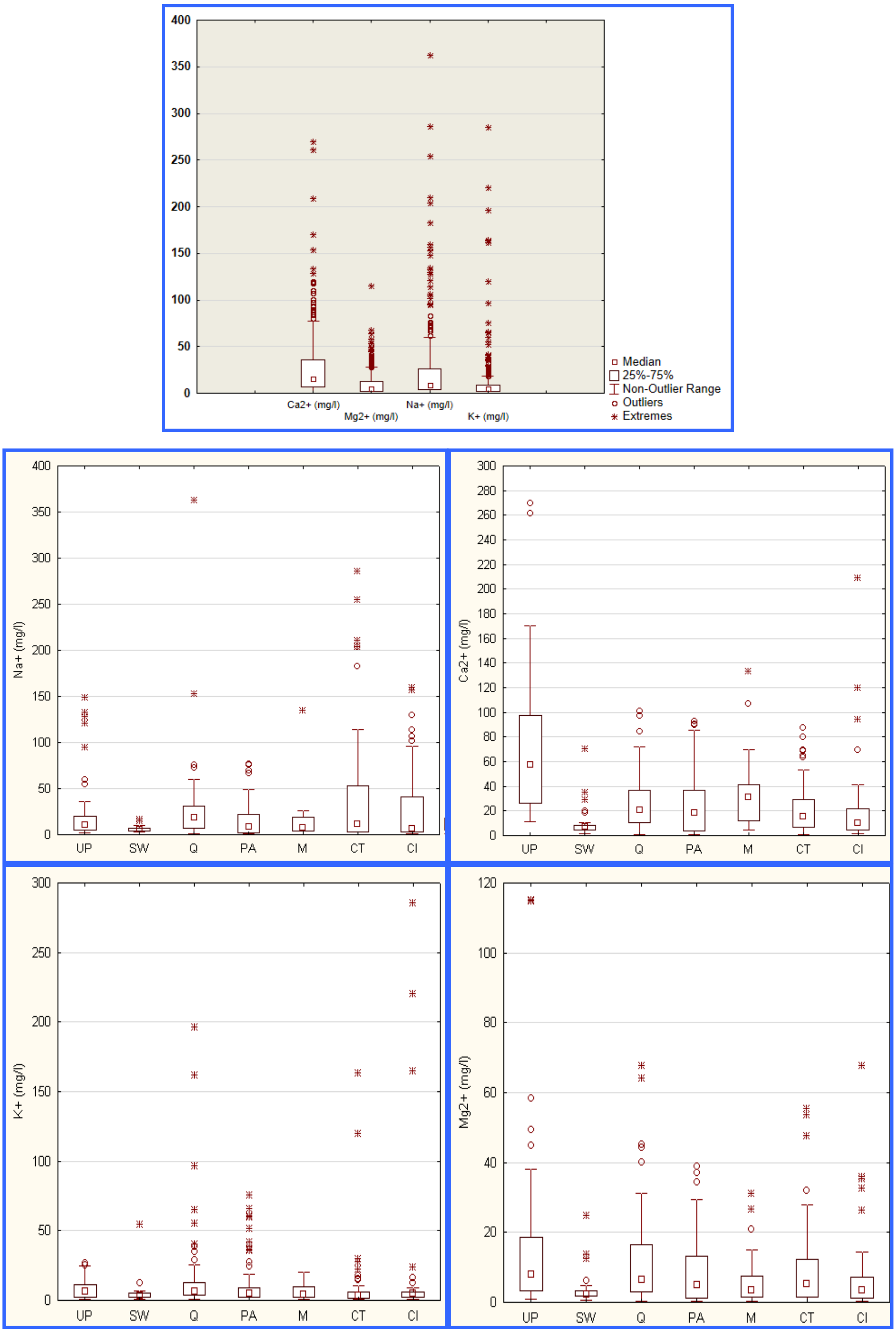



Figure 97: Distribution and variability of major cations in water samples of the Iullemeden Aquifer System

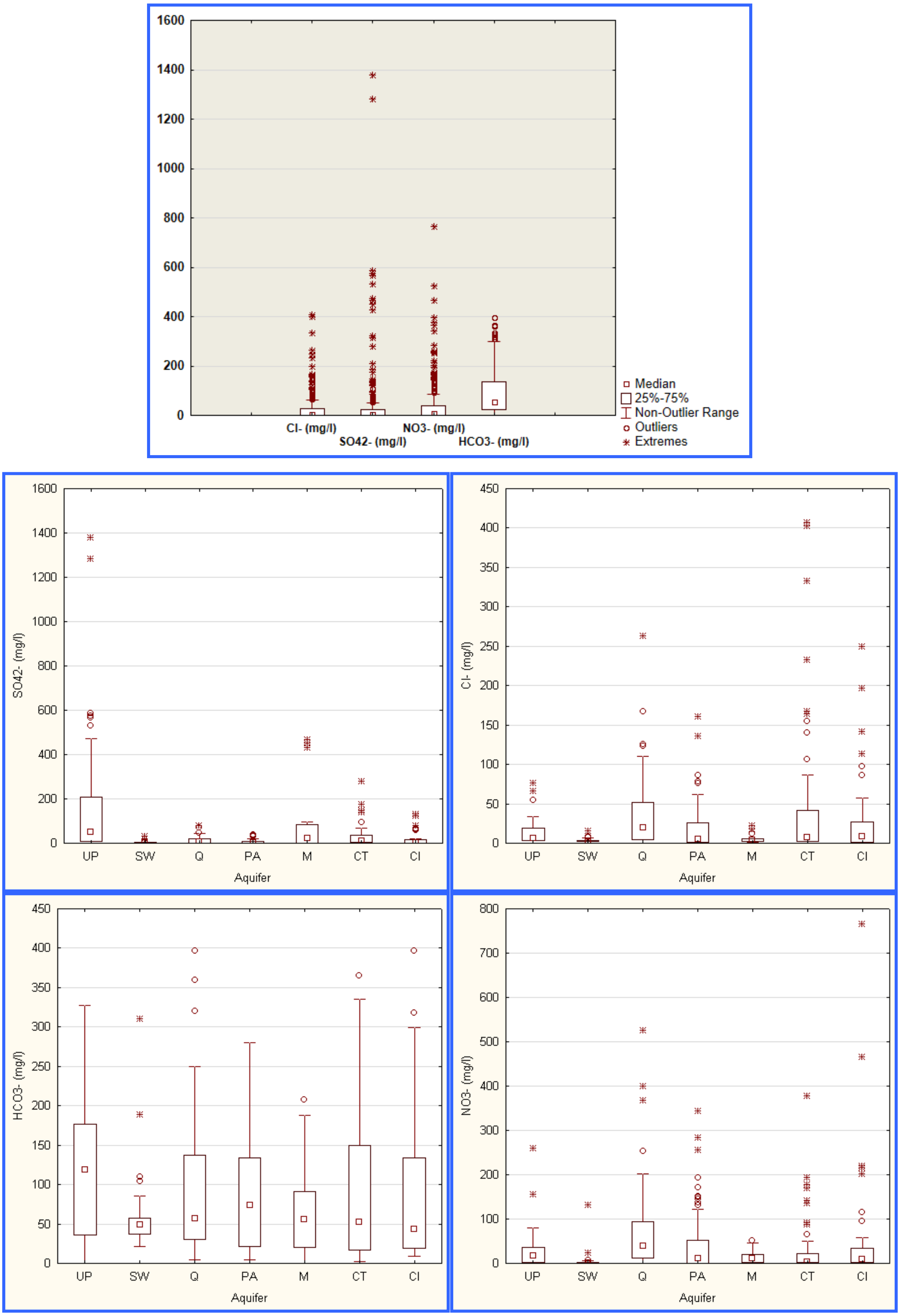



Figure 98: Statistic and variability of major anions in the Iullemeden Aquifer System

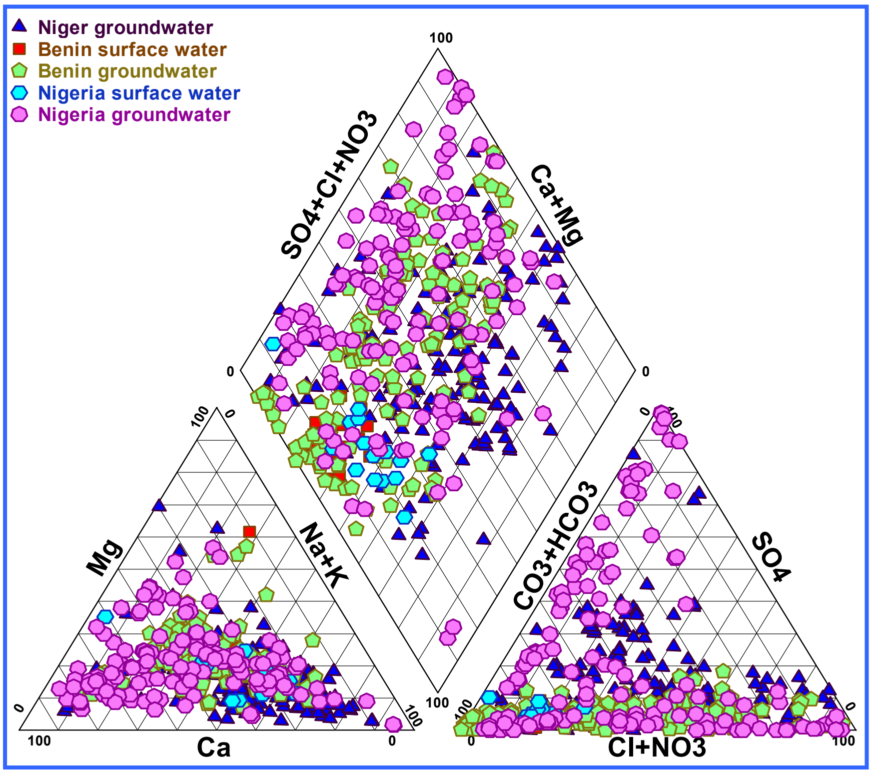



Figure 99: Piper diagram of the water samples collected in the Iullemeden Aquifer System

## - Origins of major ions and mineralization processes

The bivariate diagrams represented by major ionic compositions of waters from repeatedly sampled wells were plotted in Fig. 100. These data show that the chemistry of the groundwater samples in the Iullemeden basin appears to be dominantly controlled by the dissolution of minerals in the catchment's host lithologies.

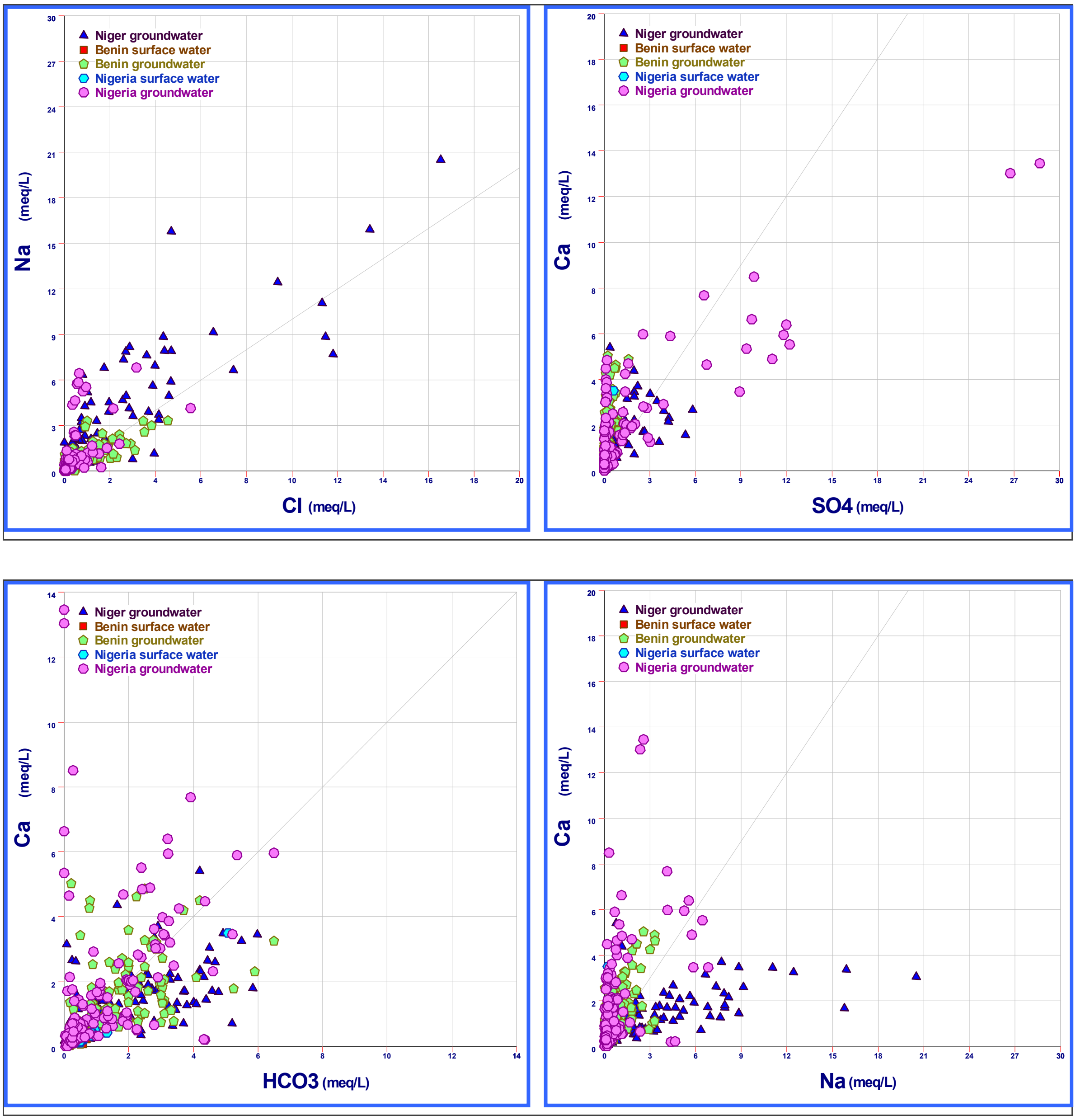



Figure 100: Relationships between major elements in waters of the Iullemeden Aquifer System

## 4.4.2. Isotope study in the Iullemeden transboundary basin

The stables isotopes results show that 65% of the Iullemeden groundwater are characterized by $\delta^{18}O$ ranging from -5‰ to -3‰ and $\delta^{2}H$ between -30 to -20‰ which reflect the stable isotopes contents of rain water in arid and semi-arid regions (Figs. 101, 102).

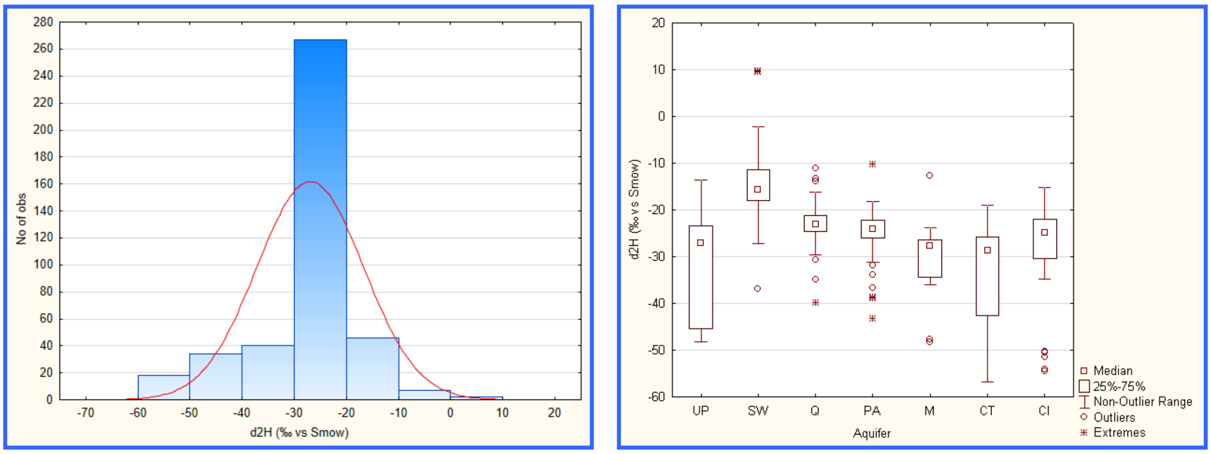



Figure 101: Distribution of deuterium contents in water samples of the Iullemeden Aquifer System

The depleted deuterium and oxygen-18 values are recorded in CI, CT and the Upper Paleocene aquifers in some points which present about 10% of the total collected samples. This indicates that the proportions of paleo groundwater in IAS groundwater are lower comparing to the recent contribution by rain or surface water.

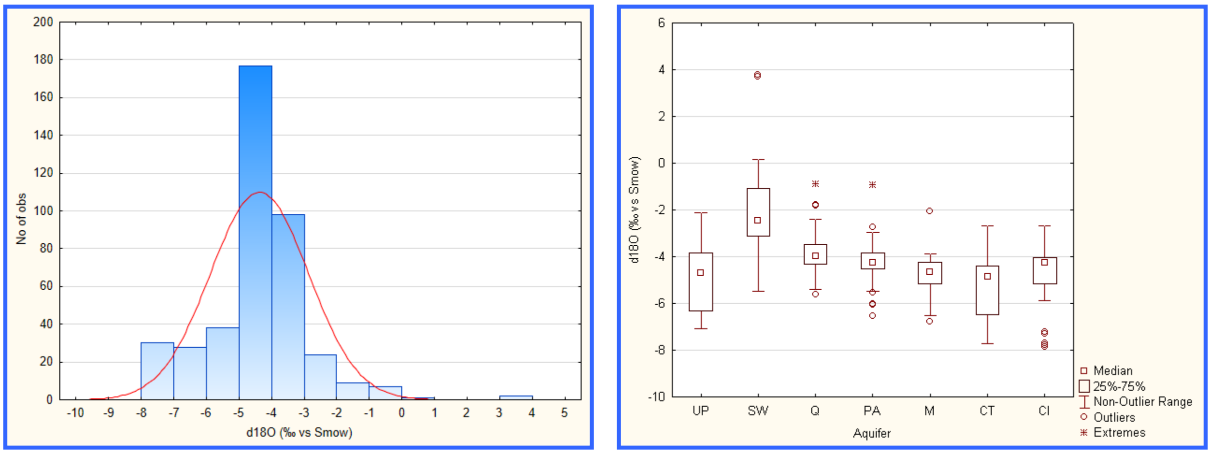



Figure 102: Distribution of oxygen-18 contents in water samples of the Iullemeden Aquifer System

Results from the whole investigated Iullemeden region are shown in Fig. 103 in relation to the Global Meteoric Water Line (GMWL) ($\delta^2H = 8 \times \delta^{18}O + 10$) (Craig, 1961). Generally, there are three groups in the isotopic data, which indicates the variations likelihood in the rainfall input sources over time: (i) isotopically depleted water which is different from the isotopic composition of present-day precipitation. Therefore, the studied aquifers (especially from Niger and Nigeria) contain paleowaters that were recharged in the past and have not been coupled to the present-day hydrological cycle (ii) enriched water highlighting the significance of the surface river water input in the evolution of the observed isotopic composition of the sampled waters of the study area; and (iii) Mixture of water with stable isotope exhibiting signals that is between present day rainfall and paleowater. This explains the plot of some data between depleted and relatively enriched stable isotope.

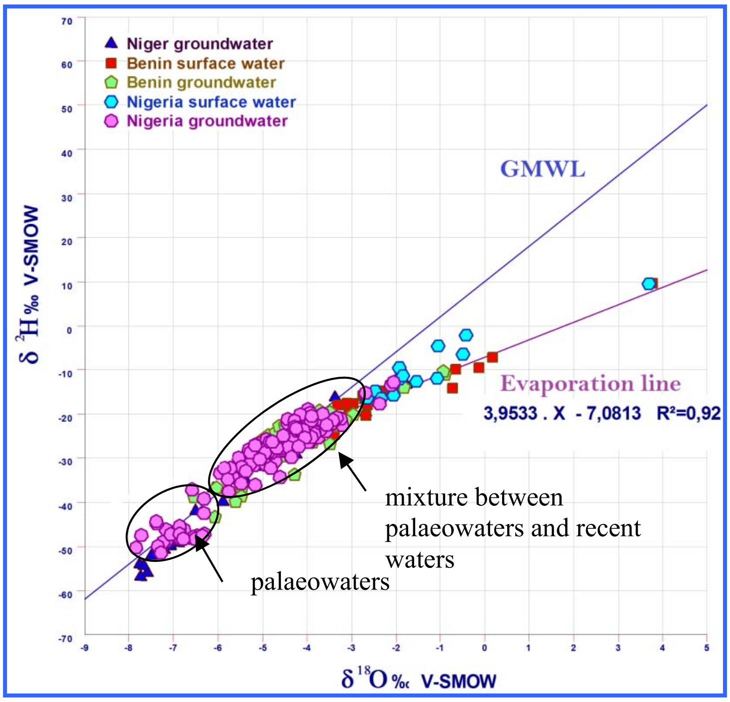



Figure 103: Plot of $\delta^2H$ versus $\delta^{18}O$ of the water samples in the Iullemeden Aquifer System

A plot of the $\delta^{18}O$ and EC was made in order to confirm the mineralization mechanisms in the studied basin (Fig. 104). According to available data, two main processes contributing to groundwater salinization could be identified: minerals dissolution and evaporation processes:

-The first process reveals a dissolution effect where the samples isotopic compositions ($\delta^{18}O$) show no change according to the increasing EC values. This pattern supports strongly the hypothesis that the salinity of these groundwaters is mainly governed by a dissolution process as highlighted previously by the hydrochemical analyses.

-The second process illustrates an evaporation effect. In this case, the isotopic contents of the sampled water are relatively correlative with EC values (Fig. 104).

In the Iullemeden basin, the majority of samples show significant tritium contents. More than 65% of the water samples have tritium contents higher than one unit. In contrast, only 33% of the water samples have tritium contents lower than one unit. In the tritium/ oxygen-18 relationship (Fig. 105), two recharge periods are highlighted in the investigated groundwater. Waters with $^3$H contents < 1 TU indicate a pre–nuclear recharge (pre- 1960). Waters with $^3$H contents > 1 TU clearly suggest the occurrence of post-nuclear recharge (1960 - 1980 periods) or contemporaneous recharge probably during the last two or three decades.

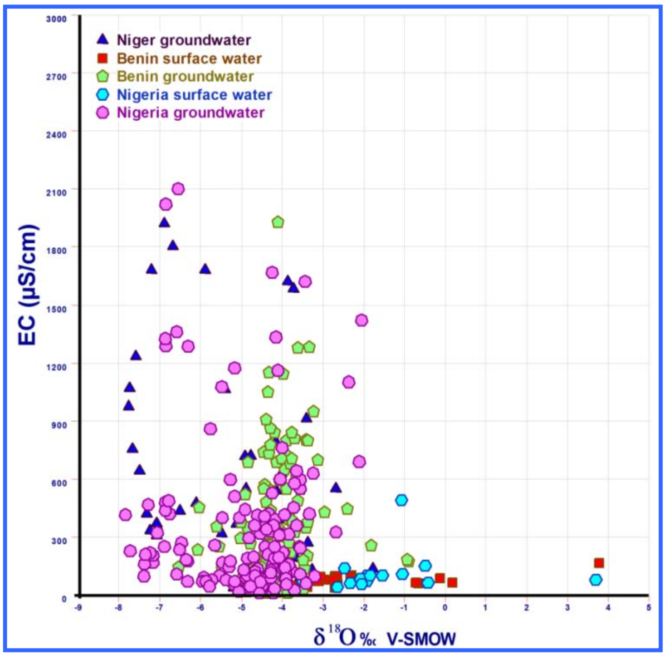



Figure 104: EC versus oxygen-18 of water samples in the Iullemeden Aquifer System

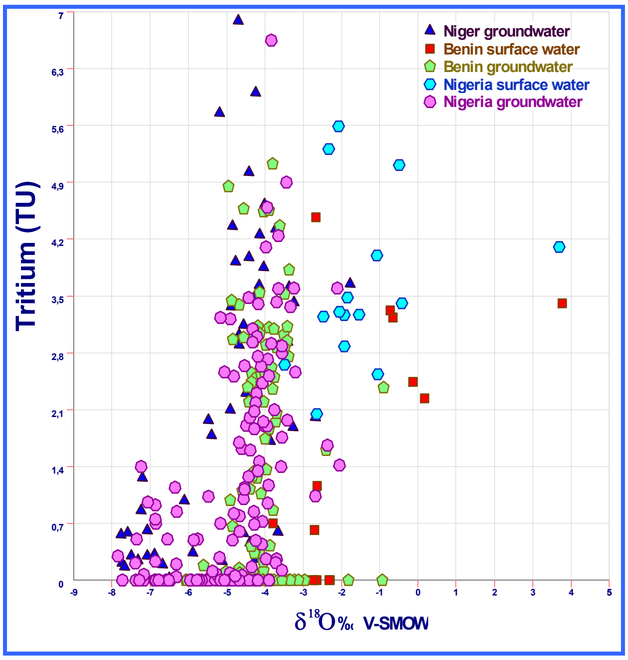



Figure 105: $^3$H versus oxygen-18 of the water samples in the Iullemeden Aquifer System

### 4.4.3. Statistical study in the Iullemeden transboundary basin

Multivariate statistical analyses by Principal Component Analysis (PCA) combined with conventional hydrochemical and isotopic methods were applied to identify the main geochemical process controlling groundwater quality in the Iullemeden Aquifer System. The total number of factor generated from a typical factor analysis indicates the total number of possible sources of variation in the data. Factors are ranked in order of merit. The first factor or component has the highest eigen-vector sum and represents the most important sources of variation in the data. The last factor is the least important process contributing to the chemical variation. Fig 106 shows the eigenvalues representing factors and the proportion of total sample variance explained by the factors. Eigenvalues of 1.0 or greater are considered significant (Kim and Mueller, 1987). The first factor F1 with 45.52% expressed variance, is the most important of all followed by factors F2, F3 and F4 with respectively 17.12%, 13.88% and 7.41% of variance expressed. The four factors account for 83.93% of total variance. These factors variance exceed 70% and they are sufficient to explain the mechanisms controlling groundwater chemistry. In this report, the factorial design F1-F2 is analyzed to underline the general trend of groundwater chemistry.

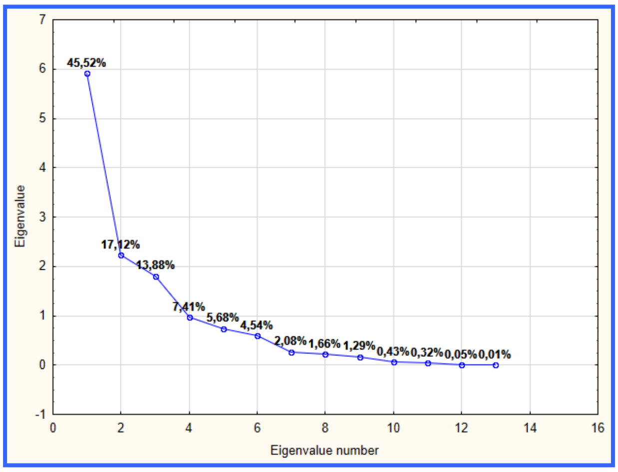



Figure 106: Total variance of Factors in the Iullemeden aquifer system

The factor F1 that contributes to 45.52% of the total variance of the system characterization is determined in positive part by $Cl^-$, $Na^+$, EC, TDS, $Mg^{2+}$, $Ca^{2+}$, $SO_4^{2-}$ and $Cl^-$ variables (Fig.107). The proximity of Ca2+ and Mg2+, also Na+, Cl- and $SO_4^{2-}$ witnessed a good correlation between these variables and TDS. The group of variables expresses water natural mineralization thus the degree of rock weathering and in other way, the residence time of water and the water-rock interaction. In fact, the variables like $Mg^{2+}$ and $Ca^{2+}$ coming in general from rock weathering and silicates minerals hydrolysis. In spite, the group of $K^+$ and

$NO_3^-$ variables corresponds to anthropogenic mineralization and may characterize an evolution in surface water or in shallow aquifer. The factor F1 represents the groundwater evolution and the importance of water-rock interaction processes. It emphasizes that groundwater with a higher residence time has higher values in calcium, and magnesium, as related to the lithology of the aquifer. Factor F1 represents therefore the phenomenon of mineralization-water residence time. Factor 2, explaining 17.2% of the total variance has strong negative loading on $\delta^{18}O$ and $\delta^{2}H$. This factor characterizes an enriched isotopic composition and expresses therefore the evaporation process in the negative part.

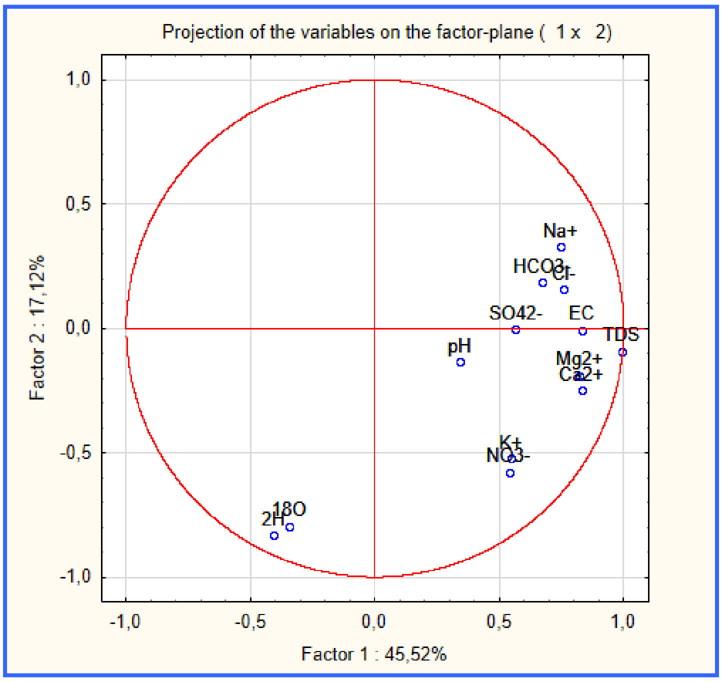



Figure 107: Correlation circle of variables in the F1-F2 plane of the Iullemeden Aquifer System

In the projection of water samples on the plan F1-F2: several groups are identified (Fig.108) as follow:

- Group 1: it represents groundwater samples that are characterized by high salinity linked to water-rock interaction and mineral dissolution.
- Group 2: it is composed by paleo groundwater with relatively high salinity.
- Group 3: it represents shallow or surface fresh water affected by evaporation process.
- Group 4: It contains groundwater samples characterized by high salinity and affected by nitrate pollution.

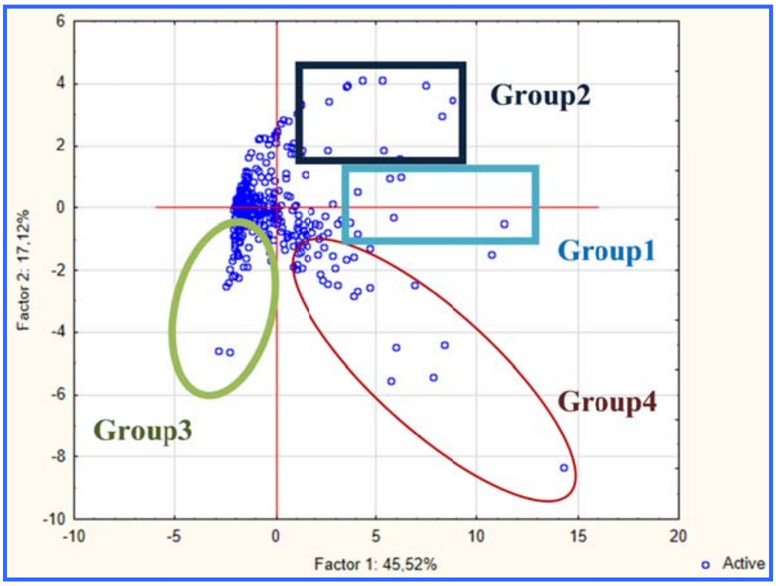



Figure 108: PCA of water samples of the Iullemeden Aquifer System

# 5. CONCLUSIONS

The Iullemeden Aquifer System (IAS) shared between Algeria, Mali, Niger, Nigeria and Benin constitutes the main perennial resource of drinking water and a strategic resource for sustainable development of the concerned countries in the Sahel region. Only three countries (Niger, Nigeria and Benin) are involved under this project and carried out several sampling campaigns. In the case of Algeria and Mali due to field security problems, it was impossible to investigate the lateral continuity of the IAS in these regions.

This report constitutes a preliminary synthesis of this shared basin. It's based on geological and hydrogeological information available in some synthesis studies (OSS, 2008, 2011).
The Iullemeden basin consists of sedimentary formations that range from the Cambrian-Ordovician to Tertiary and Quaternary. The main shared aquifers are the Continental Intercalaire aquifer (CI), the Continental Terminal (CT) and the Quaternary. The CI is the largest multilayered aquifer system logged in the sedimentary series of Cretaceous. It is unconfined at its borders and confined at the center and the western part of Mali.

The Continental Terminal is contained in the Tertiary continental sediments constituted by alternating sand and clay with frequent rapid lateral and vertical changes of the facies. The CT aquifer is a multi-layer aquifer system in Niger including the CT1 (confined), the CT2 (semi-confined) and the CT3 (unconfined). In Mali and Nigeria it is constituted by one aquifer. The Quaternary is unconfined logged in alluvium deposits and exploited in all countries. However, the Pre Cambrian aquifer (fractured basement and Cambro-Ordovician aquifer) is composed essentially of conglomerates, breaches and fluvial sandstones and well exploited in Benin.

The geochemistry and isotope hydrology of surface water and groundwater in the Iullemeden basin have provided useful insights into their origin, mineralization processes and recharge mechanisms. Chemical data showed low salinities with significant variations in hydrochemical facies of the analyzed water samples. The geochemical evolution of the studied groundwater is dominated by the physical and chemical weathering reaction of derived mostly from host lithological formation. Generally, IAS groundwater presents nitrate contents < 50 mg/l. However, few groundwater samples, with shallow depth, illustrate local pollution by nitrates placed mainly in Niger and Benin. This local nitrate contamination is

detected in different aquifers and do not show any specific spatial evolution. This pollution could be linked to anthropogenic activities related to agricultural and domestic practices.
The stable isotope signatures reveal that some groundwater samples of Iullemeden basin, in particular CI, CT and upper Paleocene aquifer have palaeo water signature probably recharged during periods that are wetter and climates that are cooler.

The shallower units are recharged presently, with water that shows stable isotope signal of present day rainwater and significant tritium contents. The isotopic approach underlined the interchange phenomenon between aquifers in the basin, palaeo waters, direct recharge of aquifers by surface waters in some areas, and recharge of aquifers by modern precipitation, which influence the groundwater geochemistry in the basin.

Multivariate statistical analysis indicated several factors that are controlling the groundwater quality traducing the complexity and the interference of several geochemical processes. In this report only the two first factors were analysed. The first express the phenomenon of mineralization-water which is enhanced with longer residence time and the second represent the evaporation process affecting surface and shallowest groundwater. The anthropogenic effect is highlighted and contributes effectively to groundwater mineralization.

The resources in the studied aquifers of the Iullemeden basin represent a significant reserve of good quality water which needs to be properly managed as high quality resources and as part of integrated plans for the basin's future supplies. The scientific results of this study have important implications for groundwater management in the Iullemeden basin under this Development Strategy and can be used as a base for construction in future groundwater flow models. Hence, a strategy to implement the groundwater recharge, in a major way need to be launched with concerted efforts by various Governmental and Non–Governmental Agencies and Public at large to build up the water table and make the groundwater resource, a reliable and sustainable source for supplementing water supply needs of the dwellers.

## Recommendations

In view of the obtained results, a special focus should be given to:

- Monitor and assess the risk of salinization and pollution by certain heavy metals, such as lead, chromium cadmium, arsenic, copper, mercury already measured in some sectors in Nigeria (Anka and Bukkuyun and Zamfara) and Niger.

- Enhance the local capacities for sampling and analysis for $^{15}N$ and $^{34}S$ to further confirm sources of groundwater quality contamination.

- Sampling additional rainfall and surface water (better assess of interactions) in order to integrate all these data in the overall interpretation.

- Conduct additional sampling for $^{14}C$ and $^{13}C$ analysis for better identification of recharge periods.

The results obtained should help water authorities:

- To develop a Strategic Action Program (SAP) to establish legal, policy and institutional framework for management and rational use of IAS

- To develop a numerical groundwater flow models of IAS in order to define scenarios for the sustainable management of water resources.

Furthermore, the implementation of the Strategic Action Program (SAP) needs:

- Strengthen collaboration between the participating countries and the partner organizations involved in management of shared groundwater resources.

- Joint actions in data interpretation to promote inter-basin/inter-aquifer collaboration in order to harmonise strategies and promote exchange of experiences between countries.

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# ACRONYMS

**BR:** Basement-Rocks

**CH:** Continental Hamadian

**CI:** Continental Intercalaire

**CIH:** Continental Intercalaire Hamadian

**HPILC:** High Performance Ion Liquid Chromatography

**CNESTEN:** National Center for Nuclear Sciences and Technologies, Morocco

**CO:** Cambro-Ordivician

**CT:** Continental Terminal

**EC:** Electrical Conductivity

**GMWL:** Global Meteoric Water Line

**IAEA:** International Atomic Energy Agency

**GEF:** Global Environmental Facility

**OSS:** Sahara and Sahel Observatory

**IAS:** Iullemeden Aquifer System

**LMWL:** Local Meteoric Water Line

**M:** Maastrichtian

**OS:** Ordovician-Silurian

**P:** Pre-Cambrian

**PA:** Paleozoic

**PCA:** Principal Component Analysis

**PDB:** Dee Belemnite Standard

**Q:** Quaternary

**SAP:** Strategic Action Plan

**TDS:** Total dissolved Salts

**TU:** Tritium Unit

**UP:** Upper Paleocene

**VSMOW:** Vienna–Standard Mean Oceanic Water

**WHO:** Word Health Organization

# ANNEXES

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Niger Basin (Campaign 1)

| N° | Echantillon | LAT | LON | localités | Aquifère | Profondeur d'échantillonnage (N.S) | Date de prélèvement | Conductivité µs/cm | Température | pH | TDS_mg/l | Ca_mg/l | Mg_mg/l | Na_mg/l | K_mg/l | Cl_mg/l | $SO_4$_mg/l | $NO_3$_mg/l | $CO_3$_mg/l | $HCO_3$_mg/l | $\delta^{18}O$ (‰ vs Smow) | $\delta^{2}H$ (‰ vs Smow) | $^{3}H$ (TU) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | NERDOS9 | 03°31'46'' | 12°29'39'' | Angoal Dokal | Quaternaire | 3,22 | 14/03/2013 | 270 | 28,6 | 6,9 | 197 | 20,56 | 5,45 | 20,39 | 9,62 | 19,94 | 20,45 | 45,29 | 0 | 50 | -3,36 | -16,26 | 3,61 |
| 18 | NERDOS18 | 03°20'55'' | 12°13'56'' | Kawara Gohé | Quaternaire | 7,5 | 14/03/2013 | 1064 | 30,8 | 6,1 | 771 | 63,11 | 13,80 | 152,58 | 8,20 | 263,07 | 71,99 | 201,70 | 0 | 5 | -5,39 | -34,87 | 1,79 |
| 28 | NERDOS28 | 03°36'20'' | 11°45'40'' | Pinke Polé | Quaternaire | 3,45 | 15/03/2013 | 912 | 30,3 | 6,7 | 124 | 14,78 | 4,64 | 10,94 | 6,24 | 11,80 | 5,60 | 37,37 | 0 | 33 | -3,41 | -23,04 | 2,94 |
| 29 | NERDOS29 | 03°34'32'' | 11°44'56'' | Gokou | Quaternaire | 21,08 | 15/03/2013 | 133 | 31,7 | 6,2 | 89,965 | 11,119 | 2,658 | 7,933 | 6,721 | 6,828 | 4,48 | 1,499 | 0 | 55 | -3,27 | -20,92 | 1,88 |
| 30 | NERDOS30 | 03°33'27'' | 11°47'23'' | Gatawani Kaina | Quaternaire | 4,5 | 15/03/2013 | 190 | 30,8 | 6,1 | 139,958 | 15,025 | 3,889 | 19,274 | 6,71 | 17,455 | 3,259 | 54,983 | 0 | 30 | -3,64 | -24,34 | 2,88 |
| 33 | NERDOS33 | 03°16'21'' | 12°01'02'' | Momboye Tounga | Quaternaire | 2,37 | 16/03/2013 | 629 | 30,6 | 7,2 | 429 | 27,47 | 16,495 | 75,475 | 28,625 | 50,405 | 47,84 | 85,84 | 0 | 135 | -4,01 | -23,51 | 4,63 |
| 36 | NERDOS36 | 03°13'50'' | 12°05'07'' | Albarkaize | Quaternaire | 3,66 | 16/03/2013 | 135 | 31,3 | 6,5 | 131,216 | 21,474 | 4,511 | 8,814 | 4,563 | 7,264 | 3,132 | 34,682 | 0 | 58 | -1,77 | -13,23 | 3,65 |
| 37 | NERDOS37 | 03°09'45'' | 12°09'55'' | Ouna | Quaternaire | 6,4 | 16/03/2013 | 1619 | 31,1 | 8,5 | 1175,658 | 33,32 | 6,47 | 362,68 | 2,18 | 166,68 | 28,94 | 366,52 | 60 | 183 | -3,85 | -21,70 | 1,72 |
| 44 | NERDOS44 | 02°56'31'' | 12°20'29'' | Bombodji djerma | Quaternaire | 5,68 | 17/03/2013 | 364 | 31,1 | 7 | 293,825 | 29,866 | 15,836 | 21,57 | 22,98 | 27,818 | 14,988 | 98,686 | 0 | 75 | -4,27 | -26,46 | 3,49 |
| 45 | NERDOS45 | 02°50'46'' | 12°24'33'' | Boumba | Quaternaire | 6,2 | 17/03/2013 | 84 | 33 | 7 | 82,1049 | 7,709 | 2,744 | 7,508 | 3,725 | 2,841 | 2,783 | 14,193 | 0 | 41 | -3,24 | -21,00 | 3,42 |
| 47 | NERDOS47 | 02°44'08'' | 12°32'43'' | Bossia | Quaternaire | 6,55 | 17/03/2013 | 717 | 30,3 | 8 | 494,78 | 42,425 | 45,105 | 12,59 | 12,73 | 39,745 | 10,24 | 121,82 | 0 | 215 | -4,90 | -26,85 | 2,10 |
| 14 | NERDOS14 | 03°31'14'' | 12°25'12'' | Guéza Bissala | CT1 | 23,17 | 14/03/2013 | 792 | 31,6 | 6 | 548 | 53,48 | 15,58 | 104,60 | 3,42 | 41,89 | 278,87 | 42,72 | 0 | 15 | -4,15 | -24,78 | 3,64 |
| 15 | NERDOS15 | 03°26'04'' | 12°22'41'' | Bellawa | CT1 |  | 14/03/2013 | 1234 | 31,6 | 8 | 879 | 52,20 | 15,71 | 210,12 | 3,78 | 232,34 | 62,93 | 4,00 | 0 | 285 | -7,59 | -55,91 | 0,59 |
| 2 | NERDOS2 | 03°03'42'' | 12°28'08'' | Noma Koara | CT2 | 33,4 | 13/03/2013 | 1803 | 33,4 | 7,2 | 1273 | 69,76 | 53,64 | 203,61 | 15,42 | 407,25 | 94,89 | 2,22 | 0 | 300 | -6,67 | -47,75 | 0,19 |
| 3 | NERDOS3 | 03°33'27'' | 12°41'59'' | Zabori | CT2 | 20,1 | 13/03/2013 | 1068 | 35,8 | 7,95 | 769 | 34,27 | 12,39 | 182,25 | 6,34 | 166,71 | 69,58 | 0,51 | 0 | 280 | -7,74 | -56,79 | 0,21 |
| 4 | NERDOS4 | 03°37'56'' | 12°42'03'' | Angoal Dangné | CT2 | 7,43 | 13/03/2013 | 1581 | 30,5 | 6,6 | 1139 | 87,47 | 31,89 | 26,72 | 163,36 | 139,73 | 93,09 | 377,30 | 0 | 100 | -3,72 | -22,52 | 4,32 |
| 6 | NERDOS6 | 03°38'26'' | 12°47'57'' | Kara kara | CT2 | 16,4 | 13/03/2013 | 419 | 33,6 | 8,5 | 313 | 12,96 | 9,12 | 73,99 | 4,40 | 26,75 | 4,35 | 4,68 | 0 | 205 | -7,32 | -50,79 | 0,25 |
| 19 | NERDOS19 | 03°20'55'' | 12°13'56'' | Adiga lele | CT2 | 32,5 | 14/03/2013 | 20 | 31 | 5,5 | 16 | 2,31 | 0,72 | 1,259 | 0,52 | 1,26 | 0,80 | 0,10 | 0 | 11 | -4,56 | -25,79 | 0,58 |
| 27 | NERDOS27 | 03°37'15'' | 11°48'01'' | Tounouga | CT2 | 21,3 | 15/03/2013 | 367 | 34,2 | 7,2 | 253,825 | 28,2 | 4,004 | 48,072 | 8,576 | 41,578 | 22,426 | 1,988 | 30 | 61 | -5,12 | -32,10 | 0,23 |
| 34 | NERDOS34 | 03°23'14 | 12°05'08'' | Bouma | CT2 | 34,9 | 16/03/2013 | 478 | 31,6 | 5,8 | 301 | 25,485 | 18,36 | 22,455 | 10,78 | 1,59 | 174,735 | 0 | 0 | 35 | -6,12 | -36,89 | 0,98 |
| 42 | NERDOS42 | 03°06'59'' | 12°41'30'' | Tokoye bangou | CT2 | 17,21 | 17/03/2013 | 1921 | 32,2 | 7,5 | 1359,852 | 69,15 | 47,69 | 254,12 | 14,49 | 401,73 | 94,73 | 0 | 0 | 365 | -6,88 | -49,15 | 0,32 |
| 11 | NERDOS11 | 03°38'24'' | 12°25'56'' | Angoual Daoura | CT2-CT3 | 26,15 | 14/03/2013 | 97 | 31,2 | 5,8 | 90 | 8,44 | 2,12 | 8,29 | 1,24 | 2,82 | 2,42 | 27,95 | 0 | 30 | -4,24 | -23,27 | 6,00 |
| 12 | NERDOS12 | 03°39'33'' | 12°24'37'' | Doli | CT2-CT3 | 0,3 | 14/03/2013 | 306 | 32,6 | 7,9 | 206 | 10,34 | 6,58 | 44,34 | 3,52 | 13,37 | 1,15 | 0,15 | 0 | 145 | -7,08 | -49,73 | 0,61 |
| 13 | NERDOS13 | 03°37'45'' | 12°20'26'' | Toranké | CT2-CT3 | 9,64 | 14/03/2013 | 372 | 33 | 7,9 | 255 | 15,92 | 7,57 | 56,95 | 3,00 | 20,38 | 8,38 | 0,62 | 0 | 170 | -7,08 | -49,89 | 0,30 |
| 16 | NERDOS16 | 03°23'33'' | 12°24'33'' | Béla1 | CT2-CT3 | 20,1 | 14/03/2013 | 1679 | 32,9 | 7,6 | 1190 | 65,06 | 17,99 | 286,02 | 15,49 | 332,52 | 94,64 | 2,78 | 0 | 335 | -7,20 | -50,71 | 1,26 |
| 1 | NERDOS1 | 03°18'30'' | 12°39'43'' | Barazé Gorou | CT3 | 23,42 | 13/03/2013 | 36 | 31,7 | 6 | 54 | 4,64 | 0,85 | 6,58 | 2,87 | 11,13 | 1,47 | 5,42 | 0 | 17 | -4,25 | -29,20 | 0,26 |
| 7 | NERDOS7 | 03°35'15'' | 12°46'53'' | Angoal Doua | CT3 | 23,1 | 13/03/2013 | 640 | 33,2 | 8,05 | 721 | 29,01 | 8,16 | 203,86 | 0,50 | 154,60 | 56,30 | 0,60 | 0 | 268,4 | -7,50 | -52,17 | 0,30 |
| 10 | NERDOS10 | 03°39'09'' | 12°31'02'' | Balifolo 2 | CT3 | 26,9 | 14/03/2013 | 107 | 31,5 | 5,5 | 97 | 9,22 | 3,94 | 5,38 | 2,98 | 7,52 | 3,05 | 26,48 | 0 | 30 | -4,84 | -26,28 | 4,36 |
| 17 | NERDOS17 | 03°18'16'' | 12°28'33'' | Régie Faréye | CT3 |  | 14/03/2013 | 1679 | 32,9 | 7,6 | 415 | 35,64 | 14,86 | 83,31 | 5,22 | 106,87 | 36,58 | 0,16 | 0 | 165 | -5,89 | -39,88 | 0,34 |
| 22 | NERDOS22 | 03°34'23 | 12°05'57'' | Malamkadi | CT3 | 13,37 | 15/03/2013 | 145 | 29,1 | 6,8 | 135 | 27,76 | 1,15 | 2,22 | 1,658 | 1,38 | 2,28 | 6,61 | 0 | 85 | -4,67 | -26,82 | 3,02 |
| 23 | NERDOS23 | 03°36'16 | 12°06'33'' | Faska | CT3 | 33,53 | 15/03/2013 | 436 | 32 | 6,9 | 301 | 28,50 | 11,01 | 45,76 | 3,625 | 28,52 | 39,81 | 2,00 | 0 | 150 | -6,50 | -42,03 | 0,02 |
| 24 | NERDOS24 | 03°32'11'' | 12°08'18'' | Dankouna | CT3 | 4 | 15/03/2013 | 550 | 30 | 6 | 381 | 52,70 | 18,54 | 14,68 | 29,855 | 45,66 | 26,05 | 176,32 | 0 | 22 | -4,89 | -27,25 | 3,37 |
| 31 | NERDOS31 | 03°20'09 | 11°53'45'' | Tara | CT3 | 15 | 16/03/2013 | 168 | 32,8 | 5,8 | 151,52 | 15,515 | 4,294 | 6,088 | 15,217 | 8,09 | 3,952 | 40,762 | 0 | 55 | -4,69 | -25,75 | 6,89 |
| 32 | NERDOS32 | 03°20'20 | 11°59'41'' | Tanda | CT3 | 21,08 | 16/03/2013 | 72 | 32,6 | 6 | 66,29 | 7,934 | 1,44 | 7,908 | 2,784 | 2,058 | 7,729 | 5,291 | 0 | 35 | -4,42 | -24,37 | 5,02 |
| 35 | NERDOS35 | 03°17'42 | 12°06'37'' | Sia | CT3 | 4,3 | 16/03/2013 | 76 | 34,5 | 5,5 | 70,078 | 5,944 | 1,619 | 6,397 | 3,696 | 5,268 | 1,473 | 16,821 | 0 | 25 | -4,42 | -23,09 | 3,97 |
| 38 | NERDOS38 | 03°03'52'' | 12°13'05'' | Koulou | CT3 | 4,16 | 16/03/2013 | 539 | 30,5 | 7,25 | 385 | 27,005 | 27,79 | 53,005 | 3,4 | 18,635 | 11,755 | 6,45 | 60 | 213,5 | -4,13 | -23,57 | 4,25 |
| 39 | NERDOS39 | 03°03'37 | 12°24'13'' | Sambera Zeno | CT3 | 14,62 | 16/03/2013 | 320 | 32,2 | 5,9 | 210,469 | 13,88 | 3,708 | 44,724 | 1,364 | 68,754 | 7,534 | 1,194 | 0 | 52 | -5,48 | -32,16 | 1,97 |
| 40 | NERDOS40 | 03°06'45'' | 12°28'07'' | Kobti Tanda | CT3 | 17,21 | 16/03/2013 | 390 | 34,8 | 6,5 | 273,845 | 15,49 | 5,325 | 62,29 | 2,15 | 24,09 | 6,09 | 142,13 | 0 | 35 | -4,04 | -26,33 | 3,85 |
| 41 | NERDOS41 | 03°12'49'' | 12°35'59'' | Marigouna | CT3 | 69,92 | 17/03/2013 | 51 | 31,2 | 5,5 | 651,122 | 44,11 | 16,64 | 53,03 | 119,88 | 87,015 | 50,27 | 134,255 | 0 | 155 | -3,66 | -24,28 | 0,59 |
| 43 | NERDOS43 | 03°03'42'' | 12°28'08'' | Bani Kané Issa | CT3 | 16,05 | 17/03/2013 | 721 | 31,2 | 6 | 457,64 | 25,93 | 4,99 | 114,065 | 1,16 | 163,29 | 34,775 | 14,93 | 0 | 61 | -4,76 | -29,29 | 3,92 |
| 46 | NERDOS46 | 02°45'17'' | 12°27'18'' | Brigambou | CT3 |  | 17/03/2013 | 550 | 33 | 7,5 | 455,455 | 27,25 | 55,38 | 30,2 | 3,045 | 3,61 | 29,455 | 20,055 | 60 | 244 | -2,67 | -19,69 | 2,00 |
| 48 | NERDOS48 | 02°46'25'' | 12°35'01'' | Sakala Gonga | CT3 | 38,18 | 17/03/2013 | 36 | 30,8 | 6 | 43,68 | 7,006 | 1,204 | 1,412 | 1,15 | 5,946 | 2,503 | 3,367 | 0 | 18 | -5,19 | -29,53 | 5,75 |
| 49 | NERDOS49 | 02°35'57'' | 12°53'04'' | Bouringa Béri | CT3 | 3,6 | 17/03/2013 | 170 | 33,5 | 7 | 151,52 | 12,744 | 5,568 | 14,532 | 1,334 | 8,514 | 23,336 | 17,767 | 0 | 55 | -4,67 | -27,64 | 2,89 |
| 50 | NERDOS50 | 02°51'44'' | 12°54'35'' | Fabidji | CT3 | 29,86 | 17/03/2013 | 19 | 32,2 | 6 | 26,205 | 4,412 | 1,052 | 2,131 | 0,487 | 1,702 | 0,889 | 2,799 | 0 | 15,5 | -4,55 | -26,86 | 3,14 |
| 5 | NERDOS5 | 03°43'22'' | 12°45'14'' | Yéldou | CH |  | 13/03/2013 | 335 | 35,2 | 7,8 | 233 | 7,13 | 7,18 | 49,12 | 5,33 | 16,17 | 3,10 | 4,07 | 0 | 145 | -7,23 | -50,51 | 0,86 |
| 8 | NERDOS8 | 03°32'58'' | 12°37'07'' | Dioundiou | CH |  | 13/03/2013 | 975 | 34 | 8,5 | 688 | 26,40 | 8,49 | 159,45 | 2,80 | 140,99 | 64,12 | 0,78 | 0 | 250 | -7,76 | -54,11 | 0,56 |
| 20 | NERDOS20 | 03°35'52 | 11°59'25'' | Bengou | CI | 11,07 | 15/03/2013 | 108 | 35,8 | 6 | 98 | 16,34 | 2,64 | 2,40 | 0,537 | 1,53 | 17,81 | 0,21 | 0 | 48 | -4,40 | -25,11 | 0,47 |
| 21 | NERDOS21 | 03°33'10 | 12°03'31'' | Bana | CI | 7,82 | 15/03/2013 | 752 | 34,1 | 8 | 518 | 41,45 | 10,06 | 113,67 | 5,54 | 97,04 | 59,99 | 2,96 | 0 | 200 | -7,68 | -54,44 | 0,17 |
| 25 | NERDOS25 | 03°34'55'' | 12°15'33'' | Yélou | CH | 11,7 | 15/03/2013 | 134 | 33,9 | 5,5 | 97 | 7,32 | 4,63 | 8,06 | 3,896 | 4,88 | 21,74 | 19,90 | 0 | 22 | -4,49 | -26,51 | 2,30 |
| 26 | NERDOS26 | 03°35'24'' | 11°53'06'' | Sabon Birni | CI | 18,2 | 15/03/2013 | 41 | 31,6 | 5,6 | 52 | 4,43 | 0,97 | 6,79 | 1,943 | 1,74 | 0,79 | 13,80 | 0 | 25 | -4,00 | -26,31 | 1,35 |

| N° | Echantillon | LAT | LON | Localité | AQUIFERE | Profondeur d'échantillonnage (N.S) | Date de prélèvement | Conductivité µs/cm | Température | pH | TDS_mg/l | Ca_mg/l | Mg_mg/l | Na_mg/l | K_mg/l | Cl_mg/l | $SO_4$_mg/l | $NO_3$_mg/l | $HCO_3$_mg/l | $SiO_2$ | $\delta^{18}O$ (‰ vs Smow) | $\delta^{2}H$ (‰ vs Smow) | $^{3}H$ (TU) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | NERDOSO 50 | 12,55 | 2,74 | Bossia | Quaternaire | 9,4 | 2014/01/31 | 1231,0 | 27,1 | 7,5 | 856,7 | 108,2 | 64,5 | 18,5 | 16,3 | 106,0 | 17,3 | 269,7 | 256,2 | 22,8 | -24,4 | -4,4 | 2,4 |
| 42 | NERDOSO 52 | 12,45 | 2,75 | Brigambou | Quaternaire | | 2014/01/31 | 601,0 | 30,0 | 6,2 | 433,7 | 33,6 | 47,3 | 0,0 | 1,8 | 3,8 | 34,5 | 20,9 | 292,0 | 25,7 | -16,0 | -2,0 | |
| 43 | NERDOSO 54 | 12,87 | 2,96 | Kankandi | Quaternaire | 4,0 | 2014/01/31 | 433,0 | 32,1 | 6,1 | 226,1 | 13,7 | 7,2 | 35,1 | 15,3 | 46,2 | 24,8 | 71,9 | 12,2 | 26,8 | -20,9 | -3,4 | 5,7 |
| 46 | NERDOSO 22 | 11,99 | 3,29 | Barifo Kambou | Quaternaire | 3,56 | 2014/01/26 | 1024 | 27,4 | 7,2 | 703 | 47,25 | 29,75 | 89,60 | 19,70 | 131,50 | 40,25 | 88,65 | 256 | 46,42 | -18,8 | -3,0 | 3,3 |
| 33 | NERDOSO 4 | 12,48 | 3,30 | Régie farrey | CT2 | | 2014/01/22 | 612,0 | 31,0 | 6,5 | 460,1 | 34,2 | 13,5 | 94,8 | 7,0 | 101,1 | 35,3 | 1,3 | 173,0 | 7,4 | -39,5 | -6,1 | 0,7 |
| 34 | NERDOSO 5 | 12,53 | 3,32 | Farrey | CT2 | 33,2 | 2014/01/22 | 1048,0 | 29,7 | 6,9 | 605,6 | 34,2 | 17,8 | 107,4 | 6,7 | 91,5 | 122,5 | 0,5 | 225,0 | 12,3 | -44,4 | -6,5 | 0,7 |
| 35 | NERDOSO 7 | 12,70 | 3,56 | Zabori | CT2 | 19,6 | 2014/01/23 | 1071,0 | 31,0 | 8,1 | 721,4 | 29,0 | 8,2 | 203,9 | 0,5 | 154,6 | 56,3 | 0,6 | 268,4 | 4,6 | -53,3 | -7,2 | |
| 36 | NERDOSO 31 | 12,69 | 3,12 | Tokoye Bangou | CT2 | 40,2 | 2014/01/27 | 1957,0 | 31,2 | 6,8 | 1013,2 | 74,3 | 46,7 | 176,6 | 13,1 | 418,7 | 106,0 | 1,0 | 176,9 | 7,5 | -49,9 | -6,7 | 0,7 |
| 37 | NERDOSO 40 | 12,38 | 3,34 | Bela 2 | CT2 | | 2014/01/29 | 2700,0 | 31,1 | 7,5 | 1593,2 | 61,0 | 22,9 | 471,2 | 9,2 | 585,5 | 167,7 | 1,2 | 274,5 | 4,9 | -57,4 | -7,7 | 0,7 |
| 48 | NERDOSO 37 | 12,18 | 3,46 | Malgorou | CT2 | | 2014/01/28 | 272 | 33,8 | 6 | 206 | 11,57 | 3,36 | 47,11 | 1,82 | 14,80 | 40,44 | 1,84 | 85 | 8,58 | -40,3 | -5,8 | 0,1 |
| 49 | NERDOSO 39 | 12,34 | 3,42 | Kawara Gohé | CT2 | | 2014/01/29 | 2160 | 31 | 6,9 | 1248 | 67,50 | 12,80 | 365,46 | 9,50 | 475,60 | 145,40 | 0,70 | 170,8 | 6,71 | -49,6 | -7,3 | 0 |
| 10 | NERDOSO 18 | 11,71 | 3,63 | Dolé | CT2-CT3 | | 2014/01/25 | 385,0 | 31,2 | 7,0 | 259,4 | 16,4 | 3,1 | 53,5 | 8,3 | 31,8 | 26,2 | 0,2 | 120,0 | 17,6 | -28,7 | -4,5 | 1,0 |
| 19 | NERDOSO 29 | 12,36 | 3,05 | Sambera Alfa | CT2-CT3 | 15,1 | 2014/01/27 | 705,0 | 31,0 | 6,5 | 368,4 | 23,2 | 5,3 | 85,5 | 4,7 | 147,4 | 35,0 | 40,3 | 27,0 | 5,3 | -28,0 | -4,4 | 2,9 |
| 24 | NERDOSO 35 | 12,31 | 3,29 | Maikada | CT2-CT3 | | 2014/01/28 | 300,0 | 30,7 | 5,5 | 232,8 | 32,9 | 4,5 | 30,0 | 1,3 | 63,8 | 20,8 | 0,2 | 79,3 | 5,5 | -37,1 | -5,3 | 0,7 |
| 25 | NERDOSO 36 | 12,25 | 3,37 | Adiga Kaboye | CT2-CT3 | 17,1 | 2014/01/28 | 113,0 | 32,3 | 5,7 | 73,2 | 4,6 | 1,7 | 11,3 | 2,5 | 3,8 | 3,2 | 39,4 | 6,7 | 9,5 | -29,7 | -4,7 | 6,1 |
| 1 | NERDOSO 1 | 12,71 | 3,40 | Mamane Dey | CT3 | 21,7 | 2014/01/22 | 65,0 | 31,6 | 5,5 | 51,6 | 4,4 | 0,7 | 10,0 | 1,3 | 8,3 | 0,9 | 9,2 | 17,0 | 6,0 | -30,6 | -5,1 | 0,8 |
| 2 | NERDOSO 2 | 12,70 | 3,33 | Gabikoy Dey | CT3 | 41,7 | 2014/01/22 | 37,0 | 31,1 | 5,4 | 89,6 | 15,7 | 1,9 | 5,4 | 1,0 | 4,2 | 0,3 | 1,2 | 60,0 | 6,0 | -31,4 | -5,0 | 1,2 |
| 3 | NERDOSO 3 | 12,54 | 3,25 | Guitodo | CT3 | 69,0 | 2014/01/22 | 48,0 | 31,2 | 6,0 | 47,1 | 8,5 | 0,7 | 2,6 | 0,8 | 2,5 | 0,7 | 1,0 | 30,5 | 7,8 | -28,6 | -4,9 | 0,8 |
| 4 | NERDOSO 10 | 12,62 | 3,70 | Koukadou | CT3 | 38,2 | 2014/01/23 | 27,0 | 30,7 | 5,8 | 24,6 | 2,2 | 0,9 | 2,7 | 1,2 | 1,5 | 0,1 | 3,7 | 12,2 | 6,5 | -28,0 | -4,8 | 0,9 |
| 5 | NERDOSO 11 | 12,45 | 3,54 | Rouwan Chama | CT3 | 4,3 | 2014/01/24 | 448,0 | 29,1 | 6,2 | 314,7 | 25,7 | 8,4 | 34,0 | 35,8 | 39,3 | 17,9 | 107,0 | 46,5 | 12,7 | -17,4 | -3,0 | 2,6 |
| 6 | NERDOSO 13 | 12,29 | 3,52 | Dangnakou | CT3 | 3,7 | 2014/01/24 | 679,0 | 32,6 | 6,9 | 463,4 | 24,9 | 9,2 | 89,9 | 4,1 | 68,8 | 68,3 | 0,6 | 197,5 | 6,8 | -49,3 | -6,9 | 0,7 |
| 7 | NERDOSO 14 | 12,18 | 3,37 | Banikoubay | CT3 | 6,6 | 2014/01/24 | 188,0 | 29,0 | 6,0 | 133,9 | 13,0 | 2,5 | 21,8 | 2,1 | 10,3 | 14,6 | 51,6 | 18,0 | 12,8 | -27,2 | -4,5 | 1,6 |
| 8 | NERDOSO 16 | 11,93 | 3,59 | Goro Kondo | CT3 | 3,4 | 2014/01/25 | 144,0 | 29,3 | 6,1 | 134,2 | 18,0 | 2,2 | 14,5 | 2,6 | 10,0 | 9,1 | 4,6 | 73,2 | 4,5 | -28,7 | -4,6 | 0,9 |
| 9 | NERDOSO 17 | 11,84 | 3,62 | Gamzaki | CT3 | 3,2 | 2014/01/25 | 165,0 | 29,6 | 6,4 | 119,8 | 10,3 | 4,9 | 11,5 | 9,8 | 11,4 | 7,1 | 36,7 | 28,0 | 9,4 | -26,2 | -4,6 | 3,3 |
| 11 | NERDOSO 19 | 11,79 | 3,56 | Gatawani | CT3 | 4,3 | 2014/01/25 | 235,0 | 28,4 | 6,1 | 117,3 | 13,8 | 4,2 | 11,0 | 8,2 | 22,2 | 5,7 | 15,7 | 36,6 | 26,7 | -21,5 | -3,1 | 2,8 |
| 12 | NERDOSO 20 | 11,86 | 3,50 | Kessa | CT3 | 3,9 | 2014/01/25 | 121,0 | 28,2 | 6,2 | 70,8 | 5,6 | 1,2 | 11,9 | 3,1 | 13,9 | 6,3 | 4,5 | 24,4 | 10,9 | -25,8 | -3,9 | 2,2 |
| 13 | NERDOSO 21 | 11,96 | 3,34 | Koaga | CT3 | 23,3 | 2014/01/26 | 83,0 | 28,8 | 6,0 | 64,3 | 6,9 | 2,1 | 5,5 | 4,1 | 2,3 | 1,5 | 11,4 | 30,5 | 9,1 | -23,5 | -3,9 | 3,2 |
| 14 | NERDOSO 23 | 12,09 | 3,32 | Zaroumey Koara | CT3 | | 2014/01/26 | 292,0 | 31,0 | 7,1 | 274,0 | 41,0 | 3,9 | 18,3 | 19,5 | 15,8 | 29,2 | 6,1 | 140,3 | 21,9 | -27,8 | -4,7 | 0,8 |
| 15 | NERDOSO 24 | 12,12 | 3,25 | Chantier Maikassoua | CT3 | | 2014/01/26 | 135,0 | 32,8 | 6,0 | 97,6 | 8,2 | 3,2 | 8,4 | 5,9 | 8,9 | 2,7 | 29,8 | 30,6 | 32,0 | -25,1 | -4,1 | 2,1 |
| 16 | NERDOSO 25 | 12,19 | 3,19 | Tiakey Koara | CT3 | | 2014/01/26 | 59,0 | 30,0 | 6,2 | 62,2 | 5,3 | 0,8 | 7,8 | 2,6 | 3,3 | 0,8 | 11,1 | 30,5 | 14,9 | -28,2 | -4,1 | 0,8 |
| 17 | NERDOSO 26 | 12,25 | 3,06 | Bani Gorou | CT3 | | 2014/01/26 | 81,0 | 29,4 | 6,5 | 65,1 | 4,6 | 1,9 | 8,9 | 2,8 | 6,3 | 3,0 | 9,6 | 28,0 | 7,7 | -23,6 | -3,8 | 3,4 |
| 18 | NERDOSO 28 | 12,35 | 2,94 | Koumbougoni Koara | CT3 | 6,5 | 2014/01/27 | 174,0 | 29,9 | 6,4 | 124,4 | 14,8 | 4,6 | 10,9 | 6,2 | 11,8 | 5,6 | 37,4 | 33,0 | 7,3 | -25,1 | -4,0 | 3,3 |
| 20 | NERDOSO 30 | 12,51 | 3,17 | Loufari Koara | CT3 | 22,6 | 2014/01/27 | 296,0 | 30,0 | 6,5 | 196,3 | 11,2 | 3,3 | 46,6 | 3,9 | 44,6 | 6,0 | 56,6 | 24,0 | 7,1 | -29,0 | -4,6 | 2,1 |
| 21 | NERDOSO 32 | 12,58 | 3,13 | Dargol | CT3 | 47,5 | 2014/01/27 | 53,0 | 30,1 | 6,2 | 48,1 | 3,5 | 0,9 | 8,6 | 0,9 | 7,3 | 0,9 | 1,6 | 24,4 | 8,8 | -28,9 | -5,1 | 1,3 |
| 22 | NERDOSO 33 | 12,38 | 3,20 | Mayara koara | CT3 | 31,5 | 2014/01/28 | 105,0 | 30,8 | 5,6 | 65,0 | 3,5 | 1,7 | 11,7 | 0,8 | 1,9 | 3,1 | 41,1 | 1,2 | 6,8 | -24,6 | -4,3 | 4,8 |
| 23 | NERDOSO 34 | 12,31 | 3,19 | Fakara beri | CT3 | 48,0 | 2014/01/28 | 24,0 | 30,6 | 5,5 | 163,9 | 33,1 | 2,0 | 3,7 | 1,5 | 1,4 | 0,1 | 2,1 | 120,0 | 2,5 | -29,3 | -4,8 | 1,6 |
| 26 | NERDOSO 38 | 12,07 | 3,49 | Kagna Kagna | CT3 | 26,9 | 2014/01/29 | 57,0 | 31,2 | 6,0 | 92,0 | 19,6 | 1,0 | 1,8 | 0,9 | 1,1 | 5,5 | 1,2 | 61,0 | 7,7 | -27,2 | -4,6 | 1,1 |
| 27 | NERDOSO 42 | 12,75 | 3,03 | Haname Tombo | CT3 | 42,7 | 2014/01/29 | 45,0 | 29,6 | 6,0 | 45,9 | 4,1 | 0,8 | 5,2 | 1,9 | 2,4 | 0,9 | 6,2 | 24,4 | 5,5 | -25,7 | -4,4 | 1,3 |
| 28 | NERDOSO 45 | 12,53 | 2,90 | Saboula | CT3 | 5,7 | 2014/01/30 | 100,0 | 30,6 | 6,3 | 75,1 | 7,6 | 2,9 | 6,4 | 1,9 | 3,7 | 2,2 | 26,0 | 24,4 | 16,1 | -23,6 | -3,7 | 3,4 |
| 29 | NERDOSO 46 | 12,69 | 2,81 | Mallam Koara | CT3 | 16,4 | 2014/01/30 | 202,0 | 31,3 | 6,0 | 129,4 | 15,6 | 4,6 | 15,3 | 1,4 | 16,7 | 0,2 | 63,3 | 12,2 | 9,1 | -26,8 | -4,3 | 2,2 |
| 30 | NERDOSO 47 | 12,75 | 2,70 | Talwal | CT3 | 40,9 | 2014/01/30 | 85,0 | 31,7 | 5,6 | 67,4 | 8,2 | 2,2 | 6,2 | 1,3 | 3,2 | 0,1 | 31,2 | 15,0 | 3,2 | -25,5 | -4,1 | 3,1 |
| 31 | NERDOSO 51 | 12,53 | 2,78 | Kokorbé Bangou | CT3 | 36,4 | 2014/01/31 | 36,0 | 28,8 | 6,0 | 118,9 | 23,9 | 1,6 | 2,2 | 1,5 | 1,7 | 0,1 | 2,5 | 85,4 | 19,6 | -27,1 | -4,4 | 3,7 |
| 32 | NERDOSO 53 | 12,75 | 2,87 | Belandé | CT3 | 6,4 | 2014/01/31 | 202,0 | 29,4 | 6,0 | 210,9 | 28,2 | 3,7 | 20,3 | 2,6 | 8,7 | 0,2 | 74,0 | 73,2 | 26,2 | -22,7 | -3,4 | 3,5 |
| 44 | NERDOSO 12 | 12,42 | 3,52 | Gueza Bissala | CT3 | 21,72 | 2014/01/24 | 791 | 31,4 | 5,8 | 532 | 31,72 | 11,97 | 119,98 | 4,18 | 36,43 | 258,00 | 45,25 | 24,4 | 5,08 | -26,1 | -4,1 | 3,9 |
| 47 | NERDOSO 27 | 12,32 | 3,07 | Kayan Kaina | CT3 | 14,65 | 2014/01/27 | 678 | 31,3 | 6,6 | 368 | 34,45 | 9,35 | 77,30 | 4,35 | 146,73 | 27,57 | 56,52 | 12,2 | 5,5 | -30,7 | -4,9 | 1,8 |
| 50 | NERDOSO 41 | 12,82 | 3,02 | Gorou Yeno | CT3 | 26,48 | 2014/01/29 | 49 | 30,2 | 5,5 | 34 | 2,57 | 0,98 | 4,72 | 0,61 | 1,99 | 7,13 | 3,89 | 12,2 | 7,43 | -28,7 | -4,4 | 1,8 |
| 51 | NERDOSO 43 | 12,73 | 2,92 | Tour Tour Koara | CT3 | 2,12 | 2014/01/29 | 166 | 33,1 | 7 | 111 | 15,06 | 3,30 | 7,90 | 3,48 | 8,11 | 3,50 | 51,56 | 18,3 | 12,73 | -20,8 | -3,6 | 2,9 |
| 52 | NERDOSO 44 | 12,88 | 2,60 | Bouringa Béri | CT3 | 3,6 | 2014/01/30 | 162 | 31,6 | 6,5 | 98 | 9,63 | 4,28 | 13,89 | 1,52 | 10,45 | 24,99 | 15,30 | 18,3 | 12,86 | -23,6 | -3,9 | 2,6 |
| 53 | NERDOSO 48 | 12,64 | 2,65 | Koumbourfou | CT3 | 35,75 | 2014/01/30 | 60 | 32,4 | 5,8 | 76 | 7,61 | 4,77 | 2,57 | 2,24 | 1,15 | 1,62 | 0,92 | 54,9 | 6,42 | -31,3 | -5,1 | 0,3 |
| 54 | NERDOSO 49 | 12,61 | 2,69 | Zou Koara | CT3 | | 2014/01/30 | 102 | 32,2 | 6 | 82 | 11,68 | 2,86 | 1,76 | 2,43 | 0,96 | 0,80 | 12,23 | 48,8 | 8,37 | -25,5 | -4,3 | 2,3 |
| 38 | NERDOSO 6 | 12,62 | 3,55 | Dioundiou | CIH | | 2014/01/23 | 939,0 | 26,8 | 8,0 | 645,6 | 25,6 | 7,8 | 175,2 | 4,7 | 128,3 | 59,9 | 0,4 | 231,8 | 11,0 | -56,9 | -7,7 | 0,8 |
| 39 | NERDOSO 8 | 12,72 | 3,63 | Angoal Laboua | CIH | | 2014/01/23 | 459,0 | 31,7 | 8,0 | 358,8 | 14,4 | 6,1 | 79,8 | 5,0 | 26,8 | 0,5 | 0,5 | 225,7 | 6,9 | -51,4 | -7,5 | 0,7 |
| 40 | NERDOSO 9 | 12,70 | 3,71 | Kizamou | CIH | | 2014/01/23 | 833,0 | 32,7 | 7,9 | 499,9 | 22,6 | 7,5 | 104,5 | 4,6 | 70,0 | 77,5 | 3,2 | 210,0 | 4,0 | -56,8 | -7,7 | 1,0 |
| 45 | NERDOSO 15 | 12,02 | 3,57 | Hamdallaye Bengou | CIH | | 2014/01/24 | 840 | 31,1 | 6,6 | 548 | 44,29 | 7,25 | 129,75 | 3,81 | 137,52 | 66,13 | 0,17 | 158,6 | 5,5 | -53,1 | -7,4 | 0,1 |

# Field, hydrochemical and isotope data presented for the Niger Basin (Campaign 3)

| N° | Localité | Aquifère | LON | LAT | T°C | pH | CE | Ca_mg/l | Mg_mg/l | Na_mg/l | K_mg/l | Fe3 | Fe2 | $HCO_3$_mg/l | $SO_4$_mg/l | Cl_mg/l | $NO_3$_mg/l | NO2 | F | CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | Diki Koara tagui | Quaternaire | 3,13 | 13,42 | 32,2 | 6,5 | 137,0 | 5,6 | 1,0 | 19,4 | 3,6 | 0,0 | 0,0 | 39,0 | 18,0 | 2,0 | 11,0 | 0,0 | 0,4 | |
| 4 | Gagila 1 | CT2 | 4,01 | 13,44 | 32,2 | 6,0 | 80,0 | 5,6 | 2,2 | 6,0 | 1,4 | 0,0 | 0,0 | 6,1 | 1,0 | 0,0 | 40,9 | 0,1 | 0,5 | |
| 5 | Majarkola | CT2 | 4,03 | 13,81 | 31,0 | 6,4 | 329,0 | 22,4 | 4,9 | 32,0 | 4,9 | 0,0 | 0,0 | 68,3 | 27,0 | 12,0 | 52,8 | 0,3 | 0,4 | 0,0 |
| 6 | Tombo bouya | CT2 | 4,13 | 13,16 | 31,1 | 6,0 | 43,0 | 3,6 | 1,2 | 4,6 | 1,0 | 0,0 | 0,0 | 9,8 | 6,0 | 2,0 | 8,8 | 0,0 | 0,3 | 3,0 |
| 7 | Kore mairoua | CT2 | 3,90 | 13,30 | 32,6 | 6,4 | 146,0 | 4,8 | 2,9 | 17,8 | 3,1 | 0,2 | 0,1 | 50,0 | 12,0 | 3,0 | 5,7 | 0,0 | 0,4 | 0,0 |
| 8 | Kaini Kougoum | CT2 | 4,03 | 13,33 | 29,1 | 6,0 | 38,0 | 2,8 | 0,5 | 3,0 | 1,2 | 0,0 | 0,0 | 15,9 | 1,0 | 0,0 | 4,4 | 0,0 | 0,7 | 0,0 |
| 9 | Kola Gobirawa | CT2 | 3,87 | 13,19 | 32,4 | 6,9 | 313,0 | 44,0 | 3,9 | 19,8 | 1,4 | 0,0 | 0,0 | 126,9 | 12,0 | 20,0 | 24,6 | 0,1 | 0,1 | 4,0 |
| 11 | Malabawa | CT2 | 3,96 | 12,94 | 29,5 | 6,9 | 154,0 | 11,2 | 2,7 | 6,0 | 1,8 | 0,1 | 0,0 | 42,7 | 9,0 | 3,0 | 10,1 | 0,1 | 0,5 | 0,0 |
| 12 | Guidadam | CT2 | 4,04 | 12,94 | 29,5 | 6,1 | 90,0 | 7,2 | 1,9 | 8,3 | 1,3 | 0,2 | 0,1 | 29,3 | 9,0 | 2,0 | 9,2 | 0,0 | 0,4 | 0,0 |
| 15 | Sakoara peulh | CT2 | 3,87 | 12,71 | 32,4 | 6,5 | 105,0 | 8,0 | 1,0 | 9,5 | 1,1 | 0,1 | 0,0 | 31,7 | 2,0 | 6,0 | 10,1 | 0,0 | 0,4 | 0,0 |
| 16 | zabori | CT2 | 3,56 | 12,70 | 32,0 | 7,9 | 1096,0 | 36,0 | 12,6 | 182,3 | 6,3 | 0,1 | 0,0 | 356,2 | 71,0 | 156,0 | 2,2 | 0,0 | 0,1 | 0,0 |
| 17 | Garin Zabarmawa | CT2 | 3,68 | 12,58 | 31,1 | 6,9 | 117,0 | 14,0 | 5,6 | 2,1 | 1,0 | 0,0 | 0,0 | 43,9 | 2,0 | 8,0 | 13,2 | 0,0 | 0,2 | 0,0 |
| 18 | Gomboro | CT2 | 3,62 | 12,69 | 30,2 | 6,6 | 139,0 | 6,4 | 1,0 | 14,7 | 6,2 | 0,1 | 0,0 | 56,1 | 0,0 | 12,0 | 0,0 | 0,0 | 0,1 | 2,0 |
| 10 | Tibiri | CT2-3 | 4,00 | 13,11 | 29,6 | 7,7 | 793,0 | 14,4 | 2,4 | 146,1 | 11,5 | 0,0 | 0,0 | 317,2 | 96,0 | 28,0 | 3,1 | 0,0 | 0,1 | 0,0 |
| 1 | Garin zangui | CT3 | 3,97 | 13,84 | 32,5 | 6,3 | 220,0 | 13,6 | 4,6 | 18,0 | 4,0 | 0,0 | 0,0 | 79,3 | 10,0 | 12,0 | 3,5 | 0,0 | 0,3 | 1,0 |
| 2 | Noufawa | CT3 | 4,00 | 13,52 | 32,4 | 6,4 | 64,0 | 5,6 | 1,7 | 4,0 | 0,8 | 0,0 | 0,0 | 20,7 | 1,0 | 2,0 | 11,9 | 0,0 | 0,1 | 0,0 |
| 3 | Kodey | CT3 | 3,72 | 13,60 | 33,1 | 6,0 | 29,0 | 1,6 | 0,5 | 5,3 | 0,6 | 0,0 | 0,0 | 11,0 | 6,0 | 0,0 | 4,4 | 0,0 | 0,4 | 1,0 |
| 19 | Kizamou | CT3 | 3,71 | 12,69 | 33,7 | 7,8 | 848,0 | 34,4 | 9,0 | 156,3 | 7,2 | 0,1 | 0,0 | 226,9 | 128,0 | 62,0 | 19,8 | 0,0 | 0,4 | 0,0 |
| 20 | Garin Na Allay | CT3 | 3,41 | 12,41 | 29,6 | 7,0 | 581,0 | 33,2 | 3,6 | 57,0 | 5,6 | 0,0 | 0,0 | 136,6 | 33,0 | 51,0 | 4,8 | 0,0 | 0,5 | 0,0 |
| 21 | Gueza Bissala | CT3 | 3,53 | 12,43 | 30,1 | 8,0 | 526,0 | 32,0 | 4,9 | 48,0 | 5,6 | 0,1 | 0,0 | 145,2 | 0,0 | 63,0 | 4,4 | 0,0 | 0,4 | 0,0 |
| 22 | Hama Mara | CT3 | 3,59 | 12,56 | 30,0 | 5,5 | 71,0 | 4,4 | 1,2 | 5,0 | 1,2 | 0,0 | 0,0 | 25,6 | 2,0 | 1,0 | 7,5 | 0,0 | 0,4 | 0,0 |
| 23 | Dankouna | CT3 | 3,54 | 12,14 | 30,0 | 7,0 | 571,0 | 26,4 | 4,4 | 34,0 | 5,6 | 0,1 | 0,0 | 103,7 | 24,0 | 20,0 | | 0,0 | 0,0 | 2,0 |
| 24 | Gatawani | CT3 | 3,56 | 11,79 | 30,3 | 6,4 | 279,0 | 15,2 | 8,3 | 24,0 | 8,3 | 0,0 | 0,0 | 56,1 | 9,0 | 14,0 | 67,3 | 0,2 | 0,3 | 3,0 |
| 25 | Hamdallaye bengou | CT3 | 3,57 | 12,02 | 31,1 | 7,1 | 856,0 | 38,4 | 14,6 | 135,0 | 10,3 | 0,1 | 0,0 | 158,6 | 86,0 | 166,0 | 3,1 | 0,0 | 0,2 | 0,0 |
| 26 | Sabon Birni | CT3 | 3,59 | 11,89 | 30,2 | 6,1 | 38,0 | 3,2 | 1,0 | 4,0 | 1,1 | 0,0 | 0,0 | 8,5 | 10,0 | 1,0 | 5,3 | 0,0 | 0,4 | 1,0 |
| 27 | Albarkaizé | CT3 | 3,23 | 12,09 | 31,8 | 6,3 | 122,0 | 4,8 | 1,9 | 19,0 | 4,1 | 0,0 | 0,0 | 31,7 | 14,0 | 2,0 | 24,6 | 0,0 | 0,2 | 1,0 |
| 28 | Koulou | CT3 | 3,06 | 12,22 | 30,6 | 7,3 | 669,0 | 44,8 | 2,4 | 98,3 | 7,1 | 0,1 | 0,0 | 200,1 | 96,0 | 32,0 | 18,5 | 0,0 | 0,5 | 0,0 |
| 29 | Kopti Tanda | CT3 | 3,11 | 12,47 | 34,8 | 6,5 | 390,0 | 18,4 | 3,4 | 43,2 | 3,5 | 0,1 | 0,0 | 125,7 | 12,0 | 0,0 | 48,4 | 0,0 | 0,2 | 0,0 |
| 30 | Bombodji | CT3 | 2,94 | 12,34 | 31,1 | 7,0 | 364,0 | 16,8 | 7,3 | 43,1 | 7,1 | 0,1 | 0,0 | 117,1 | 43,0 | 12,0 | 30,8 | 0,0 | 0,2 | |
| 31 | Brigambou | CT3 | 2,75 | 12,45 | 33,0 | 7,5 | 550,0 | 38,4 | 3,9 | 47,2 | 8,6 | 0,0 | 0,0 | 142,7 | 51,0 | 23,0 | 39,6 | 0,0 | 0,1 | 3,0 |
| 32 | Saboula | CT3 | 2,89 | 12,53 | 31,8 | 6,6 | 103,0 | 4,8 | 1,9 | 11,3 | 2,3 | 0,0 | 0,0 | 28,1 | 16,0 | 3,0 | 8,8 | 0,0 | 0,1 | |
| 33 | Sakala Gonga | CT3 | 2,77 | 12,60 | 30,8 | 6,0 | 36,0 | 1,6 | 1,0 | 6,1 | 1,7 | 0,0 | 0,0 | 12,2 | 5,0 | 1,0 | 8,4 | 0,0 | 0,2 | |
| 34 | Fabidji | CT3 | 2,86 | 12,91 | 31,2 | 5,9 | 20,0 | 1,2 | 0,5 | 3,1 | 0,4 | 0,0 | 0,0 | 7,3 | 3,0 | 0,0 | 4,4 | 0,0 | 0,1 | |
| 35 | Gorou yéno | CT3 | 3,02 | 12,82 | 30,2 | 5,5 | 49,0 | 3,2 | 1,0 | 6,2 | 1,2 | 0,0 | 0,0 | 14,6 | 8,0 | 3,0 | 3,5 | 0,0 | 0,2 | |
| 36 | Tihoré | CT3 | 2,63 | 12,87 | 28,6 | 5,8 | 51,0 | 4,8 | 1,0 | 8,0 | 2,3 | 0,0 | 0,0 | 9,8 | 14,0 | 3,0 | 13,2 | 0,0 | 0,2 | |
| 37 | Mingui | CT3 | 2,68 | 13,05 | 31,1 | 7,1 | 1177,0 | 46,8 | 5,6 | 181,0 | 10,5 | 0,4 | 0,1 | 257,4 | 206,0 | 96,0 | 4,0 | 0,0 | 1,1 | |
| 38 | Kodjolé | CT3 | 2,67 | 13,20 | 29,6 | 7,6 | 1190,0 | 43,2 | 4,9 | 187,7 | 11,4 | 0,1 | 0,1 | 263,5 | 204,0 | 102,0 | 9,2 | 0,0 | 1,1 | |
| 39 | Kofo | CT3 | 2,73 | 13,16 | 30,0 | 7,3 | 1126,0 | 52,8 | 6,8 | 169,0 | 10,3 | 0,2 | 0,1 | 270,8 | 190,0 | 92,0 | 2,6 | 0,0 | 1,1 | |
| 40 | Sirignere peulh | CT3 | 2,87 | 13,30 | 30,5 | 6,3 | 68,0 | 4,8 | 0,5 | 8,3 | 2,8 | 0,1 | 0,0 | 22,0 | 12,0 | 0,0 | 5,3 | 0,0 | 0,1 | |
| 41 | Zagoré | CT3 | 2,84 | 13,23 | 30,3 | 6,1 | 40,0 | 3,2 | 1,0 | 4,8 | 1,1 | 2,7 | 1,4 | 14,6 | 9,0 | 1,0 | 2,2 | 0,0 | 0,1 | |
| 42 | Oude Seybou | CT3 | 2,93 | 13,30 | 30,6 | 6,9 | 148,0 | 16,0 | 0,7 | 19,7 | 1,4 | 0,1 | 0,0 | 40,3 | 32,0 | 6,0 | 11,0 | 0,0 | 0,4 | |
| 43 | Boulaga Zarma | CT3 | 3,05 | 13,59 | 30,7 | 5,5 | 156,0 | 12,8 | 1,0 | 17,8 | 3,8 | 0,1 | 0,0 | 26,8 | 8,0 | 2,0 | 62,4 | 0,0 | 0,3 | |
| 44 | Safa Dougoumi | CT3 | 2,93 | 13,45 | 30,7 | 6,5 | 104,0 | 9,6 | 1,5 | 14,1 | 3,1 | 0,1 | 0,0 | 28,1 | 21,0 | 4,0 | 13,2 | 0,0 | 0,2 | |
| 46 | Bangou Fada Rouzou | CT3 | 3,56 | 13,29 | 29,8 | 5,6 | 40,0 | 2,4 | 1,2 | 5,9 | 0,3 | 0,0 | 0,0 | 12,2 | 7,0 | 0,0 | 10,1 | 0,0 | 0,3 | |
| 47 | Ko Beri | CT3 | 3,36 | 13,22 | 29,2 | 5,9 | 29,0 | 1,6 | 0,2 | 6,1 | 0,2 | 0,0 | 0,0 | 11,0 | 6,0 | 0,0 | 3,5 | 0,0 | 0,2 | |
| 48 | Goroubankassam | CT3 | 3,47 | 13,10 | 32,2 | 5,8 | 36,0 | 4,0 | 0,5 | 4,3 | 0,3 | 0,0 | 0,0 | 17,1 | 4,0 | 0,0 | 3,5 | 0,0 | 0,2 | |
| 49 | Kargui Bangou | CT3 | 3,50 | 12,96 | 30,9 | 5,6 | 51,0 | 3,2 | 2,9 | 7,3 | 0,7 | 0,1 | 0,0 | 24,4 | 6,0 | 0,0 | 10,6 | 0,0 | 0,2 | |
| 50 | Sakadamna | CT3 | 3,69 | 13,27 | 31,7 | 6,7 | 130,0 | 5,6 | 1,5 | 14,3 | 2,1 | 1,0 | 0,0 | 36,6 | 18,0 | 2,0 | 8,8 | 0,0 | 0,3 | |
| 51 | Bourgami Peulh | CT3 | 3,62 | 12,86 | 28,8 | 5,7 | 13,0 | 0,8 | 0,2 | 1,5 | 0,2 | 0,0 | 0,0 | 6,1 | 0,0 | 0,0 | 1,3 | 0,0 | 0,5 | |
| 52 | Garbey Tombo | CT3 | 3,24 | 12,88 | 31,8 | 6,3 | 27,0 | 2,4 | 0,5 | 5,1 | 0,8 | 0,0 | 0,0 | 7,3 | 4,0 | 0,0 | 11,0 | 0,0 | 0,2 | |
| 53 | Mamaga | CT3 | 3,40 | 12,85 | 28,3 | 8,0 | 163,0 | 11,2 | 1,0 | 14,3 | 2,1 | 0,1 | 0,1 | 37,8 | 22,0 | 4,0 | 6,6 | 0,0 | 0,2 | |
| 13 | Angoal Bozari | CIH | 3,84 | 12,82 | 28,3 | 6,3 | 76,0 | 9,6 | 0,5 | 8,0 | 4,7 | 0,1 | 0,0 | 22,0 | 14,0 | 4,0 | 10,6 | 0,0 | 0,3 | 0,0 |
| 14 | Angoal toudou | CIH | 3,96 | 13,00 | 32,1 | 5,8 | 44,0 | 4,0 | 1,0 | 5,1 | 1,0 | 0,0 | 0,0 | 14,6 | 6,0 | 3,0 | 3,5 | 0,0 | 0,2 | 0,0 |

## Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Nigeria Basin (Campaign 1)

| Site | Sample_Code | Aquifer | Aquifer 2 | Latitude | Longitude | Altitude | Type | Sampling_Date | EC (µs/cm) | Temp | pH | $Ca^{2+}$ (mg/l) | $Mg^{2+}$ (mg/l) | $Na^{+}$ (mg/l) | $K^{+}$ (mg/l) | $Cl^{-}$ (mg/l) | $SO_4^{2-}$ (mg/l) | $HCO_3^{-}$ (mg/l) | $NO_3^{-}$ (mg/l) | Li | B | Si | Fe | $NH_4$ | F | PO4 | Chem_Lab | $^{18}O$ | $^{2}H$ | SI_Lab | $^{3}H$ | $^{3}H$_ERR | $^{3}H$_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gwandu | NIR-IAS-36 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,51 | 4,63 | 272 | GWB | 2013-07-26 | 11 | 33,0 | 4,4 | 0,54 | 0,15 | 1,97 | 0,54 | 0,54 | 0,65 | 5,61 | 1,49 | 3,623 | 9,759 | 9,097 | 0,0036 | 0,32 | <LQ | 0,69 | CNESTEN | -4,22 | -27,32 | CNESTEN | -0,16 | 0,17 | CNESTEN |
| Kalgo(Police Barrack) | NIR-IAS-39 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,33 | 4,20 | 212 | GWB | 2013-07-26 | 30 | 32,0 | 5,4 | 0,4 | 0,15 | 1,24 | 1,7 | 0,46 | 2,56 | 3,39 | 1,09 | 4,24 | 4,978 | 14,79 | 0,15 | 0,27 | <LQ | " | CNESTEN | -4,53 | -26,8 | CNESTEN | 1,15 | 0,18 | CNESTEN |
| Birnin Kebbi | NIR-IAS-40 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,46 | 4,21 | 245 | GWB | 2013-07-26 | 270 | 32,0 | 6,3 | 17,67 | 11,02 | 8,83 | 5,9 | 4,68 | 18,69 | 118,97 | 2,61 | -0,727 | 11,08 | <LD | <LD | 0,34 | 0,7 | " | CNESTEN | -6,46 | -47,55 | CNESTEN | -0,32 | 0,14 | CNESTEN |
| Goru(Birnin Kebbi) | NIR-IAS-41 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,39 | 4,20 | 217 | GWB | 2013-07-27 | 98 | 29,7 | 5,4 | 3,37 | 1,25 | 6,32 | 2,83 | 1,49 | ND | 7,32 | 32,99 | 3,445 | <LD | 9,021 | 0,296 | 0,35 | <LQ | " | CNESTEN | -3,2 | -22,59 | CNESTEN | 2,56 | 0,2 | CNESTEN |
| Dageri(Primary School) | NIR-IAS-43 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,55 | 4,40 | 222,3 | GWB | 2013-07-27 | 120 | 32,0 | 5,9 | 7 | 2,71 | 2,73 | 5,63 | 3,66 | 0,06 | 1,95 | 49,84 | 21,86 | 6,169 | 12,05 | 0,3955 | 0,25 | 0,08 | " | CNESTEN | -3,75 | -25,35 | CNESTEN | 2,1 | 0,18 | CNESTEN |
| Alwasa(Police Outpost) | NIR-IAS-44 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,62 | 4,44 | 221 | GWB | 2013-07-27 | 80 | 31,0 | 5,6 | 4,1 | 1,79 | 2,79 | 2,76 | 0,83 | 6,77 | 24,16 | 0,96 | 19,61 | 23,63 | 8,785 | 3,099 | 0,26 | 0,29 | 0,53 | CNESTEN | -4,71 | -30,65 | CNESTEN | -0,05 | 0,15 | CNESTEN |
| Karama Damba | NIR-IAS-38 | Gundummi-illo | Late Cretaceous(Upper Jurrassic) CI | 11,43 | 4,39 | 206 | GWD | 2013-07-26 | 60 | 31,1 | 4,8 | 3,53 | 0,83 | 3,68 | 2,22 | 0,92 | 0,18 | 10,98 | 17,04 | 4,585 | 2,036 | 11,38 | 0,6297 | 0,31 | 0,07 | " | CNESTEN | -3,41 | -21,38 | CNESTEN | 1,97 | 0,18 | CNESTEN |
| Tangaza | NIR-IAS-04 | Gwandu | Tertiary(Eocene-Miocene)CT | 13,37 | 4,94 | 255 | GWB | 2013-07-23 | 400 | 32,7 | 4,6 | 1,35 | 0,53 | 0,8 | 1,7 | 0,37 | 3,98 | 7,32 | 0,2 | 6,282 | 2,584 | 5 | 0,0289 | 0,34 | 0,12 | " | CNESTEN | -5,46 | -32,85 | CNESTEN | -0,25 | 0,12 | CNESTEN |
| Balle | NIR-IAS-05 | Gwandu | Tertiary(Eocene-Miocene)CT | 13,47 | 4,68 | 228 | GWB | 2013-07-23 | 170 | 32,6 | 6,2 | 6,54 | 9,93 | 3,98 | 5,04 | 2,93 | 16,47 | 61,01 | 1,12 | 0,385 | 21,28 | 8,562 | 2,749 | 0,34 | 0,22 | 0,57 | CNESTEN | -7,16 | -46,23 | CNESTEN | -0,42 | 0,14 | CNESTEN |
| Tumbulla | NIR-IAS-08 | Rima Group | Creteceous(Maestrichtien) | 13,19 | 5,64 | 279 | GWD | 2013-07-24 | 100 | 31,0 | 5,4 | 7,09 | 0,48 | 10,44 | 2,37 | 2,31 | 0,98 | 30,99 | 19,66 | 13,32 | 0,655 | 9,887 | 0,3089 | 0,24 | 0,07 | ND | CNESTEN | -4,86 | -28,32 | CNESTEN | 0,02 | 0,14 | CNESTEN |
| Gundumi | NIR-IAS-09 | Gundumi-illo | Late Cretaceous(Upper Jurrassic) CI | 13,13 | 6,01 | 294 | GWB | 2013-07-24 | 80 | 31,1 | 4,9 | 2,79 | 0,92 | 5,93 | 2,35 | 3,54 | 0,51 | 20,26 | 9,2 | 10,65 | 3,644 | 9,079 | 0,013 | 0,31 | 0,08 | " | CNESTEN | -5,37 | -32,87 | CNESTEN | 0,11 | 0,16 | CNESTEN |
| Gidan Sale | NIR-IAS-10 | Gundumi-illo | Late Cretaceous(Upper Jurrassic) CI | 13,18 | 6,14 | 332,2 | GWB | 2013-07-24 | 80 | 32,2 | 5,5 | 2,26 | 0,69 | 4,41 | 3,01 | 0,95 | 0,29 | 17,81 | 10,29 | 5,544 | 8,516 | 10,11 | 0,3168 | 0,28 | 0,1 | " | CNESTEN | -5,73 | -32,28 | CNESTEN | -0,05 | 0,13 | CNESTEN |
| Isa(Close to Izala Monsque) | NIR-IAS-13 | Gundumi-illo | Late Cretaceous(Upper Jurrassic) CI | 13,20 | 6,40 | 316 | GWB | 2013-07-24 | 360 | 31,7 | 5,7 | 17,93 | 7,75 | 23,2 | 6,01 | 26,81 | 6,4 | 75,65 | 49,76 | 1,372 | 6,637 | 17,57 | 0,0192 | 0,39 | 0,23 | " | CNESTEN | -3,65 | -19,96 | CNESTEN | 3,59 | 0,23 | CNESTEN |
| Sabon Birni (Rima River) | NIR-IAS-15 | Surface Water | Surface Water | 13,57 | 6,33 | 305 | SRI | 2013-07-24 | 140 | 32,0 | 7,0 | 2,39 | 0,91 | 4,55 | 4,01 | 1,72 | 1,85 | 21,96 | 6,52 | 10,54 | 0,644 | 20,34 | 7,498 | 0,32 | 0,4 | " | CNESTEN | -2,47 | -14,84 | CNESTEN | 3,25 | 0,19 | CNESTEN |
| Goronyo Dam | NIR-IAS-18 | Reservoir | Reservoir | 13,50 | 5,88 | 287 | SRE | 2013-07-24 | 70 | 29,0 | 6,6 | 4,29 | 1,52 | 6,45 | 4,93 | 2,17 | 2,07 | 37,09 | 7,06 | 10,55 | 6,019 | 35,45 | 12,41 | 0,29 | 0,43 | " | CNESTEN | -1,93 | -9,49 | CNESTEN | 2,88 | 0,21 | CNESTEN |
| Rima River(along Illela-Sokoto Rd) | NIR-IAS-27 | Surface Water | Surface Water | 13,12 | 5,25 | 242 | SRI | 2013-07-25 | 100 | 29,7 | 6,7 | 10,38 | 2,93 | 6,82 | 5,03 | 3,87 | 2,32 | 57,35 | 4,73 | 8,684 | 4,38 | 26,89 | 9,291 | 0,22 | 0,47 | " | CNESTEN | -1,54 | -12,6 | CNESTEN | 3,27 | 0,23 | CNESTEN |
| River Sokoto (along Illela-Sokoto Rd | NIR-IAS-28 | Surface Water | Surface Water | 13,08 | 5,26 | 247 | SRI | 2013-07-25 | 70 | 30,2 | 7,2 | 7,29 | 2,14 | 4,7 | 4,65 | 2,32 | 2,07 | 42,95 | 5,95 | 10 | 4,99 | 35,02 | 11,11 | 0,27 | 0,31 | " | CNESTEN | -3,49 | -21,3 | CNESTEN | 2,65 | 0,2 | CNESTEN |
| Birnin Kebbi(Water board intake point | NIR-IAS-42 | Rima River | Rima River | 12,48 | 4,20 | 198 | SRI | 2013-07-27 | 110 | 28,0 | 6,1 | 10,03 | 3,06 | 6,26 | 5,85 | 6,39 | 4 | 58,33 | 2,2 | 8,746 | 6,019 | 25,13 | 7,971 | 0,27 | 0,37 | " | CNESTEN | -1,05 | -4,62 | CNESTEN | 2,54 | 0,2 | CNESTEN |
| Argungu(River Zamfara) | NIR-IAS-46 | Surface Water | Surface Water | 12,75 | 4,52 | 209 | SRI | 2013-07-27 | 100 | 29,0 | 6,6 | 6,74 | 2,06 | 6,59 | 6,25 | 4,43 | 2,66 | 53,69 | 2,82 | 9,382 | 4,347 | 28,94 | 9,941 | 0,28 | 0,4 | " | CNESTEN | -1,93 | -12,12 | CNESTEN | 3,26 | 0,21 | CNESTEN |
| Goronyo Town | NIR-IAS-20 | Rima Group | Creteceous(Maestrichtien) | 13,44 | 5,67 | 281 | GWB | 2013-07-24 | 237 | 32,6 | 6,8 | 13,09 | 3,39 | 19,23 | 9,14 | 3,06 | 22,43 | 88,34 | 1,47 | 1,356 | 1,875 | <LD | <LD | 0,31 | 0,21 | 1,06 | CNESTEN | -6,51 | -48,26 | CNESTEN | -0,01 | 0,16 | CNESTEN |
| Marnona | NIR-IAS-21 | Sokoto group | Tertiary (Upper Paleocene) | 13,22 | 5,50 | 350 | GWD | 2013-07-24 | 140 | 29,8 | 6,9 | 16,96 | 2,73 | 4,82 | 5,42 | 6,23 | 3,44 | 42,71 | 30,63 | 1,769 | 8,23 | 4,509 | 0,1191 | 0,31 | 0,5 | ND | CNESTEN | -3,92 | -19,84 | CNESTEN | 2,72 | 0,21 | CNESTEN |
| Wurno(Adarawa) BH 2 | NIR-IAS-22 | Rima Group | Creteceous(Maestrichtien) | 13,29 | 5,43 | 277,4 | GWB | 2013-07-25 | 412 | 31,0 | 6,2 | 37,45 | 7,26 | 6,98 | 9,91 | 3,28 | 83,81 | 68,33 | 11,59 | 13,11 | 96,35 | 6,248 | 0,0015 | 0,39 | 0,92 | " | CNESTEN | -4,61 | -34,3 | CNESTEN | 0,06 | 0,15 | CNESTEN |
| Wurno(Kofar Rimi) | NIR-IAS-23 | Rima Group | Creteceous(Maestrichtien) | 13,28 | 5,42 | 282 | GWB | 2013-07-25 | 489 | 32,2 | 6,9 | 40,93 | 10,99 | 19,75 | 9,53 | 5,21 | 98,1 | 123,24 | 2,05 | 0,28 | 2,865 | 0,78 | <LD | 0,61 | 0,33 | " | CNESTEN | -6,78 | -48,31 | CNESTEN | -0,06 | 0,15 | CNESTEN |
| Wurno(Kan wuri) | NIR-IAS-24 | Rima Group | Creteceous(Maestrichtien) | 13,29 | 5,42 | 271 | GWB | 2013-07-25 | 1172 | 32,6 | 5,7 | 107,16 | 26,49 | 22,37 | 11,74 | 11,55 | 450,67 | 0 | ND | 0,642 | 7,729 | 0,824 | 0,1516 | 5,65 | 0,7 | " | CNESTEN | -5,16 | -36 | CNESTEN | -0,27 | 0,15 | CNESTEN |
| Kandam(Nursery) | NIR-IAS-25 | Sokoto group | Tertiary (Upper Paleocene) | 13,14 | 5,35 | 307 | GWB | 2013-07-25 | 421 | 36,3 | 7,1 | 38,15 | 10,09 | 9,53 | 9,1 | 3,54 | 75,83 | 124,46 | 1,7 | 2,961 | 26,41 | 6,979 | <LD | 0,41 | 0,43 | " | CNESTEN | -6,76 | -46,28 | CNESTEN | -0,08 | 0,15 | CNESTEN |
| Wamakko(FMWA) | NIR-IAS-29 | Sokoto group | Tertiary (Upper Paleocene) | 13,03 | 5,11 | 262 | GWB | 2013-07-25 | 597 | 32,2 | 5,7 | 58,45 | 16,65 | 3,64 | 5,24 | 2,29 | 186,53 | 55,89 | 3,26 | 3,672 | 2,281 | 0,67 | 0,0264 | 0,39 | 0,38 | " | CNESTEN | -5,27 | -31,22 | CNESTEN | -0,37 | 0,13 | CNESTEN |
| Kalambaina | NIR-IAS-30 | Sokoto group | Tertiary (Upper Paleocene) | 13,04 | 5,19 | 285 | GWB | 2013-07-25 | 596 | 31,4 | 6,7 | 77,47 | 6,62 | 35,56 | 4,46 | 66,19 | 7,1 | 197,67 | 80,04 | 0,135 | 0,336 | 1,374 | <LD | 0,5 | 0,27 | " | CNESTEN | -3,56 | -21,69 | CNESTEN | 2,89 | 0,21 | CNESTEN |
| Rundi | NIR-IAS-31 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,93 | 4,90 | 270 | GWD | 2013-07-25 | 136 | 31,0 | 5,9 | 11,56 | 2,14 | 7,62 | 2,2 | 2,46 | 1,23 | 23,18 | 44,16 | 5,711 | <LD | 3,134 | 0,0278 | 0,24 | <LQ | " | CNESTEN | -4,6 | -28,37 | CNESTEN | 1,62 | 0,17 | CNESTEN |
| Bodinga | NIR-IAS-32 | Sokoto group | Tertiary (Upper Paleocene) | 12,84 | 5,15 | 297 | GWB | 2013-07-26 | 200 | 32,6 | 5,2 | 16,22 | 2,81 | 9,67 | 2,35 | 1,02 | 40,77 | 18,3 | 25,36 | 1,473 | 0,548 | <LD | <LD | 0,29 | 0,08 | " | CNESTEN | -4,7 | -27,11 | CNESTEN | -0,28 | 0,16 | CNESTEN |
| Lambar Mazuru | NIR-IAS-33 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,76 | 5,08 | 318,5 | GWB | 2013-07-26 | 37 | 31,4 | 5,3 | 0,95 | 0,59 | 1,56 | 2 | 0,56 | 0,1 | 4,88 | 8,72 | 4,807 | 1,623 | 8,522 | 0,1026 | 0,3 | 0,08 | " | CNESTEN | -4,82 | -28,92 | CNESTEN | 2,51 | 0,2 | CNESTEN |
| Yabo(Torankawa) | NIR-IAS-34 | Gwandu | Tertiary(Eocene-Miocene)CT | 12,72 | 5,01 | 299 | GWB | 2013-07-26 | 50 | 30,9 | 5,3 | 2,21 | 0,93 | 4,84 | 1,53 | 2,29 | 2,05 | 7,32 | 13,1 | 2,879 | 0,55 | 11,55 | 0,0219 | 0,28 | <LQ | " | CNESTEN | -4,48 | -26,76 | CNESTEN | 1,91 | 0,17 | CNESTEN |
| Shagari | NIR-IAS-35 | Rima group | Creteceous(Maestrichtien) | 12,62 | 4,99 | 278 | GWB | 2013-07-26 | 153 | 32,0 | 5,2 | 17,8 | 1,32 | 4,43 | 2,19 | 4,9 | 1,89 | 20,74 | 51,48 | 0,012 | 5,638 | 6,711 | 0,0042 | 0,25 | 0,09 | " | CNESTEN | -4,24 | -27,16 | CNESTEN | -0,21 | 0,17 | CNESTEN |
| Sokoto Town(Sokoto South) | NIR-IAS-47 | Sokoto group | Tertiary (Upper Paleocene) | 13,02 | 5,25 | 304 | GWB | 2013-07-27 | 420 | 31,8 | 6,8 | 64,12 | 5,33 | 5,42 | 2,01 | 8,73 | 8,46 | 200,11 | 44,92 | 1,477 | 4,246 | 16,21 | 0,0006 | 0,36 | 0,3 | " | CNESTEN | -3,33 | -20,75 | CNESTEN | 3,37 | 0,19 | CNESTEN |
| Sabongari-Sokoto | NIR-IAS-48 | Sokoto group | Tertiary (Upper Paleocene) | 13,06 | 5,24 | 295 | GWB | 2013-07-27 | 250 | 32,6 | 6,7 | 31,56 | 4,21 | 6,71 | 2,75 | 12,35 | 48,44 | 67,11 | 0,85 | 4,387 | 0,596 | <LD | <LD | 0,35 | 0,26 | " | CNESTEN | -3,58 | -24,05 | CNESTEN | 1,4 | 0,15 | CNESTEN |
| Kware | NIR-IAS-01 | Sokoto group | Tertiary(Upper Paleocene) | 13,22 | 5,26 | 285 | GWD | 2013-07-23 | 579 | 32,5 | 6,7 | 89,64 | 6,21 | 4,11 | 8,55 | 3,76 | 4,78 | 266 | 41,55 | 0,139 | 0,415 | 1,509 | <LD | 0,39 | 0,22 | ND | CNESTEN | -3,69 | -23,44 | CNESTEN | 3,43 | 0,2 | CNESTEN |
| Binji(General Hospital) | NIR-IAS-02 | Gwandu | Tertiary(Eocene-Miocene)CT | 13,23 | 4,91 | 252 | GWB | 2013-07-23 | 400 | 32,8 | 5,1 | 1,94 | 0,72 | 2,39 | 1,18 | 1,03 | 2,58 | 11,47 | 1,69 | 8,716 | 4,34 | 7,45 | 1,405 | 0,4 | 0,09 | " | CNESTEN | -5,05 | -29,99 | CNESTEN | -0,24 | 0,14 | CNESTEN |
| Gidan Madi | NIR-IAS-03 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,30 | 4,97 | 271,3 | GWD | 2013-07-23 | 320 | 32,0 | 5,0 | 11,76 | 3,44 | 27,61 | 17,98 | 36,24 | 2,36 | 10,98 | 87,32 | 0,452 | 1,194 | 0,796 | 0,0032 | 0,47 | 0,26 | " | CNESTEN | -4,54 | -28,19 | CNESTEN | 2,64 | 0,18 | CNESTEN |
| Gwadabawa 1 (GSSS) | NIR-IAS-06 | Sokoto group | Tertiary (Upper Paleocene) | 13,35 | 5,23 | 266 | GWB | 2013-07-23 | 1102 | 33,2 | 6,2 | 118,13 | 49,5 | 15,3 | 1,84 | 5,11 | 208,84 | 327,01 | 16,98 | 0,698 | 1,156 | 1,72 | <LD | 0,39 | 0,71 | ND | CNESTEN | -2,36 | -17,65 | CNESTEN | 1,66 | 0,14 | CNESTEN |
| Maman suka | NIR-IAS-07 | Sokoto group | Tertiary (Upper Paleocene) | 13,55 | 5,32 | 277 | GWD | 2013-07-23 | 320 | 31,6 | 7,1 | 34,24 | 9,09 | 12,59 | 4,79 | 22,3 | 15,83 | 67,11 | 69,45 | 2,128 | 16,35 | 12,74 | 0,0084 | 0,35 | 0,88 | 1,08 | CNESTEN | -4,07 | -23,96 | CNESTEN | 2,43 | 0,18 | CNESTEN |
| Shinkafi(Tudun Wada) | NIR-IAS-11 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 13,07 | 6,50 | 328 | GWD | 2013-07-24 | 245 | 31,0 | 5,6 | 15,65 | 4,89 | 22,31 | 3,56 | 12,71 | 2,69 | 111,04 | 8,14 | 1,125 | 5,968 | 17,67 | <LD | 0,25 | 0,14 | " | CNESTEN | -3,55 | -22,44 | CNESTEN | 0,12 | 0,13 | CNESTEN |
| Shinkafi(Hege Turda) | NIR-IAS-12 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 13,08 | 6,50 | 328 | GWB | 2013-07-24 | 360 | 31,0 | 5,9 | 13,21 | 5,73 | 54,69 | 4,51 | 17,7 | 8,84 | 169,85 | 35,33 | 1,382 | 9,394 | 27,52 | 0,0175 | 0,36 | 0,37 | " | CNESTEN | -4,68 | -27,71 | CNESTEN | -0,3 | 0,13 | CNESTEN |
| Tashar Bagaruwa | NIR-IAS-14 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 13,33 | 6,28 | 336 | GWB | 2013-07-24 | 470 | 32,7 | 7,5 | 4,17 | 0,93 | 101,12 | 4,85 | 12,65 | 8,44 | 266 | 0,81 | 12,59 | 272,8 | 11,19 | <LD | 0,4 | 0,97 | " | CNESTEN | -7,28 | -51,43 | CNESTEN | -0,37 | 0,12 | CNESTEN |
| Sabon Birni | NIR-IAS-16 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 13,56 | 6,32 | 306 | GWB | 2013-07-24 | 312 | 32,6 | 5,1 | 17,34 | 6,55 | 17,57 | 7,08 | 16,21 | 5,23 | 90,29 | 31,8 | 2,115 | 6,147 | 10,11 | <LD | 0,39 | 0,16 | " | CNESTEN | -4,07 | -24,29 | CNESTEN | 0,73 | 0,13 | CNESTEN |
| Tsamaye | NIR-IAS-17 | Rima Group | Creteceous(Maestrichtien) | 13,51 | 5,99 | 322 | GWD | 2013-07-24 | 100 | 31,0 | 4,6 | 5,65 | 1,42 | 10,85 | 2,12 | 3,21 | 0,22 | 5,37 | 46,18 | 6,106 | 3,48 | 10,69 | 0,1565 | 0,25 | 0,09 | " | CNESTEN | -4,32 | -25,79 | CNESTEN | 2,93 | 0,2 | CNESTEN |
| Taloka | NIR-IAS-19 | Rima Group | Creteceous(Maestrichtien) | 13,45 | 5,69 | 287 | GWD | 2013-07-24 | 1420 | 31,0 | 6,1 | 69,55 | 31,16 | 134,61 | 20,34 | 21,72 | 428,43 | 187,91 | 21,95 | 0,495 | 3,538 | 1,392 | 0,0005 | 0,31 | 0,74 | ND | CNESTEN | -2,05 | -12,75 | CNESTEN | 1,42 | 0,19 | CNESTEN |
| Hamma-Alli(Unguwan Makada) | NIR-IAS-26 | Sokoto group | Tertiary(Upper Paleocene) | 13,18 | 5,34 | 322 | GWB | 2013-07-25 | 480 | 34,2 | 7,1 | 55,11 | 14,65 | 15,83 | 10,56 | 4,34 | 135,16 | 146,42 | 2,94 | 0,253 | 3,392 | 0,742 | 0,0005 | 0,37 | 0,31 | " | CNESTEN | -6,86 | -45,56 | CNESTEN | 0,24 | 0,17 | CNESTEN |
| Tambuwal(Mosque well) | NIR-IAS-37 | Sokoto group | Tertiary(Upper Paleocene) | 12,41 | 4,62 | 254 | GWD | 2013-07-26 | 455 | 33,2 | 6,0 | 42,64 | 4,18 | 19,69 | 9,96 | 16,38 | 16,85 | 176,93 | 23,18 | 0,246 | 11,33 | 13,06 | 0,0005 | 0,39 | 0,43 | ND | CNESTEN | -3,71 | -21,49 | CNESTEN | 0,22 | 0,17 | CNESTEN |
| Tungan Isiaka | NIR-IAS-45 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,68 | 4,07 | 221 | GWB | 2013-07-27 | 250 | 34,0 | 6,8 | 10,17 | 7,58 | 20,84 | 7,73 | 4,94 | ND | 137,27 | 2,36 | <LD | 65,71 | 5,591 | 0,0041 | 0,44 | 1,04 | ND | CNESTEN | -6,89 | -47,92 | CNESTEN | -0,16 | 0,15 | CNESTEN |
| Kuka Mairafu | NIR-IAS-49 | Basement complex | Pre-Cambrain | 12,41 | 6,21 | 366 | GWB | 2013-07-28 | 600 | 28,8 | 6,7 | 46,49 | 11,27 | 31,35 | 4,2 | 3,46 | 5,64 | 280,65 | 26,6 | 2,228 | 0,44 | 2,197 | <LD | 0,43 | 0,98 | " | CNESTEN | -4,05 | -25,42 | CNESTEN | 1,95 | 0,16 | CNESTEN |
| Gidan Gado | NIR-IAS-50 | Basement complex | Pre-Cambrain | 12,04 | 6,05 | 530 | GWB | 2013-07-28 | 253 | 28,3 | 6,5 | 13,8 | 8,54 | 17,94 | 3,27 | 7,21 | 1,71 | 120,8 | 12,71 | 6,33 | 2,121 | 20,81 | <LD | 0,36 | 0,13 | " | CNESTEN | -4,19 | -27,29 | CNESTEN | 2,76 | 0,18 | CNESTEN |

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Nigeria Basin (Campaign 2)

| Site | Sample_Code | Aquifer | Aquifer 2 | Latitude | Longitude | Altitude | Type | Sampling_Date | EC (µs/cm) | Temp | pH | $Ca^{2+}$ (mg/l) | $Mg^{2+}$ (mg/l) | $Na^{+}$ (mg/l) | $K^{+}$ (mg/l) | $Cl^{-}$ (mg/l) | $SO_4^{2-}$ (mg/l) | $HCO_3^{-}$ (mg/l) | $NO_3^{-}$ (mg/l) | Li | B | SiO2 | F | Chem_Lab | $^{18}O$ | $^{2}H$ | SI_Lab | $^{3}H$ | $^{3}H$_ERR | $^{3}H$_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sifawa 1 | NIR-IAS-01-2 | Rima Group | Creteceous(Maestrichtien) | 12,81 | 5,13 | 296,0 | GWB | 11/04/2014 | 130 | 32,3 | 5,5 | 10,7 | 1,4 | 8,8 | 1,1 | 1,5 | 9,3 | 34,2 | 20,2 | 0,004432 | 0,003051 | 7,7 | 0,2 | CNESTEN | -4,94 | -28,7 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Jabo II | NIR-IAS-02-2 | Rima Group | Creteceous(Maestrichtien) | 12,51 | 4,96 | 297,0 | GWB | 11/04/2014 | 90 | 33,8 | 5,3 | 12,2 | 0,8 | 4,5 | 4,2 | 4,6 | 1,3 | 25,6 | 12,7 | 0,000604 | 0,001794 | 6,2 | 2,5 | CNESTEN | -3,94 | -26,4 | CNESTEN | 1,9 | 0,2 | HYDROSYS Labor Ltd. |
| Dogondaji I | NIR-IAS-03-2 | Rima Group | Creteceous(Maestrichtien) | 12,46 | 4,80 | 269,8 | GWB | 11/04/2014 | 220 | 33,7 | 6,2 | 40,2 | 2,6 | 5,1 | 2,3 | 6,0 | 3,3 | 126,9 | 20,4 | 0,000225 | 0,003617 | 8,7 | 0,9 | CNESTEN | -3,98 | -26,4 | CNESTEN | 4,1 | 0,3 | HYDROSYS Labor Ltd. |
| Barkeji I | NIR-IAS-04-2 | Rima Group | Creteceous(Maestrichtien) | 12,45 | 4,77 | 271,0 | GWB | 11/04/2014 | 100 | 30,4 | 5,8 | 14,3 | 1,8 | 1,6 | 1,1 | 0,8 | 1,1 | 55,6 | 6,4 | 0,000423 | 0,002939 | 8,2 | 0,1 | CNESTEN | -3,89 | -25,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Kebbi II | NIR-IAS-05-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,13 | 4,73 | 223,3 | GWB | 11/04/2014 | 420 | 32,1 | 4,7 | 43,0 | 11,6 | 11,4 | 22,5 | 31,2 | 6,2 | 11,0 | 192,7 | 0,004776 | 0,002506 | 11,8 | 0,1 | CNESTEN | -4,32 | -24,5 | CNESTEN | 3,1 | 0,3 | HYDROSYS Labor Ltd. |
| Romon Sarki | NIR-IAS-06-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,23 | 4,60 | 217,0 | GWB | 11/04/2014 | 60 | 32,8 | 5,5 | 9,6 | 1,0 | 0,9 | 2,6 | 1,0 | 0,9 | 28,1 | 8,2 | 0,000787 | 0,002321 | 7,8 | 0,1 | CNESTEN | -4,68 | -26,7 | CNESTEN | 1,7 | 0,3 | HYDROSYS Labor Ltd. |
| Sabon Gari(tambuwal) | NIR-IAS-07-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,41 | 4,65 | 273,1 | GWB | 11/04/2014 | 120 | 36,4 | 6,0 | 13,7 | 1,4 | 4,6 | 1,2 | 1,7 | 10,8 | 36,0 | 15,3 | 0,000666 | 0,003403 | 7,6 | 0,2 | CNESTEN | -4,66 | -26,6 | CNESTEN | 0,6 | 0,2 | HYDROSYS Labor Ltd. |
| Sanyinna(market) | NIR-IAS-08-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,70 | 4,86 | 231,5 | GWB | 12/04/2014 | 170 | 32,6 | 5,4 | 15,5 | 3,0 | 3,0 | 2,1 | 2,4 | 30,1 | 28,8 | 6,9 | 0,01482 | 0,008962 | 5,2 | 0,3 | CNESTEN | -5,46 | -32,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Tiggi | NIR-IAS-09-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,81 | 4,61 | 227,7 | GWB | 12/04/2014 | 90 | 32,9 | 4,6 | 5,8 | 3,4 | 1,2 | 1,8 | 1,2 | 13,2 | 25,6 | 0,8 | 0,00904 | 0,007985 | 8,4 | 0,3 | CNESTEN | -5,92 | -33,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Argungu | NIR-IAS-10-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,75 | 4,52 | 229,3 | GWB | 12/04/2014 | 160 | 33,3 | 4,2 | 8,7 | 5,1 | 1,3 | 2,8 | 1,6 | 22,6 | 31,7 | 1,6 | 0,005627 | 0,012 | 6,4 | 0,4 | CNESTEN | -7,37 | -44,9 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Rima Quarters(Birnin Kebbi) | NIR-IAS-11-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,46 | 4,22 | 229,0 | GWB | 12/04/2014 | 230 | 35,7 | 6,1 | 19,1 | 11,2 | 9,7 | 7,7 | 4,4 | 16,7 | 114,7 | 1,6 | 0,000548 | 0,04443 | 7,1 | 2,0 | CNESTEN | -7,72 | -47,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Kalgo | NIR-IAS-12-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,34 | 4,20 | 213,0 | GWB | 12/04/2014 | 70 | 35,2 | 3,2 | 5,3 | 1,7 | 2,3 | 2,0 | 1,3 | 20,2 | 6,3 | 0,6 | 0,003108 | 0,0128 | 6,0 | 0,1 | CNESTEN | -5,96 | -33,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Katami | NIR-IAS-13-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,94 | 4,73 | 233,9 | GWB | 12/04/2014 | 110 | 34,3 | 3,6 | 5,2 | 1,4 | 0,2 | 1,3 | 1,5 | 9,8 | 10,3 | 0,9 | 0,0135 | 0,00412 | 6,4 | 0,2 | CNESTEN | -6,59 | -37,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Silame | NIR-IAS-14-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,04 | 4,84 | 251,0 | GWB | 12/04/2014 | 100 | 34,3 | 5,7 | 7,9 | 0,7 | 1,9 | 2,1 | 2,1 | 6,3 | 19,5 | 4,3 | 0,004724 | 0,001743 | 6,8 | 0,9 | CNESTEN | -5,53 | -29,9 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Rugar-Kijo | NIR-IAS-23-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,69 | 5,08 | 298,8 | GWB | 14/04/2014 | 90 | 33,6 | 5,5 | 11,0 | 0,9 | 2,8 | 0,7 | 1,6 | 7,8 | 35,6 | 0,3 | 0,001936 | 0,005177 | 7,0 | 0,2 | CNESTEN | -4,89 | -27,2 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Bancho | NIR-IAS-24-2 | Rima Group | Creteceous(Maestrichtien) | 12,47 | 4,99 | 304,3 | GWB | 14/04/2014 | 40 | 31,6 | 5,7 | 4,9 | 0,4 | 3,4 | 1,0 | 1,0 | 1,1 | 10,3 | 13,8 | 0,001948 | 0,003627 | 5,8 | 0,2 | CNESTEN | -4,84 | -26,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Salah | NIR-IAS-25-2 | Rima Group | Creteceous(Maestrichtien) | 12,51 | 4,83 | 277,0 | GWB | 14/04/2014 | 510 | 33,0 | 6,4 | 50,0 | 15,0 | 2,7 | 0,8 | 2,3 | 26,3 | 207,4 | 9,1 | 0,01305 | 0,00611 | 12,6 | 0,4 | CNESTEN | -5,16 | -26,9 | CNESTEN | 0,7 | 0,2 | HYDROSYS Labor Ltd. |
| Gambuwa | NIR-IAS-28-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,69 | 4,87 | 251,8 | GWB | 14/04/2014 | 760 | 34,7 | 6,0 | 85,1 | 12,7 | 17,4 | 11,0 | 31,6 | 66,0 | 217,2 | 71,6 | 0,005132 | 0,006254 | 12,5 | 0,5 | CNESTEN | -3,99 | -26,5 | CNESTEN | 1,9 | 0,3 | HYDROSYS Labor Ltd. |
| Yabo(Torankawa) | NIR-IAS-29-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,43 | 5,60 | 299,0 | GWB | 14/04/2014 | 90 | 33,7 | 6,1 | 3,6 | 1,5 | 6,6 | 0,8 | 4,4 | 2,6 | 5,9 | 22,6 | 0,002311 | 0,001814 | 7,2 | 0,1 | CNESTEN | -4,39 | -26,8 | CNESTEN | 2,0 | 0,3 | HYDROSYS Labor Ltd. |
| Raba(GGC) I | NIR-IAS-32-2 | Rima Group | Creteceous(Maestrichtien) | 13,13 | 5,49 | 265,0 | GWB | 15/04/2014 | 100 | 37,8 | 4,8 | 6,4 | 0,5 | 9,0 | 2,5 | 4,3 | 29,5 | 4,6 | 0,9 | 0,02788 | 0,01388 | 15,1 | 0,3 | CNESTEN | -4,66 | -27,7 | CNESTEN | 0,8 | 0,2 | HYDROSYS Labor Ltd. |
| Yar Geda | NIR-IAS-37-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,58 | 6,00 | 305,0 | GWB | 16/04/2014 | 190 | 30,3 | 5,7 | 18,3 | 4,6 | 16,4 | 2,3 | 14,4 | 13,9 | 60,3 | 25,6 | 0,003953 | 0,002718 | 16,8 | 0,3 | CNESTEN | -4,85 | -28,0 | CNESTEN | 0,5 | 0,2 | HYDROSYS Labor Ltd. |
| Gidan Ciwake | NIR-IAS-19-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,75 | 5,42 | 314,0 | GWB | 13/04/2014 | 1360 | 38,4 | 5,3 | 119,4 | 44,7 | 120,9 | 22,9 | 28,8 | 567,7 | 196,4 | 3,1 | 0,00651 | 1,243 | 9,1 | 1,0 | CNESTEN | -6,58 | -48,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Wauru | NIR-IAS-20-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,77 | 5,50 | 334,5 | GWB | 13/04/2014 | 1290 | 40,4 | 5,5 | 98,1 | 35,3 | 132,2 | 20,7 | 19,1 | 532,2 | 162,3 | 7,8 | 0,006067 | 1,035 | 8,4 | 1,0 | CNESTEN | -6,85 | -48,2 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Rima Basin Complex,Sokoto | NIR-IAS-31-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,97 | 5,29 | 316,5 | GWB | 15/04/2014 | 260 | 32,4 | 5,7 | 26,1 | 3,4 | 2,4 | 4,7 | 1,0 | 55,4 | 35,1 | 2,0 | 0,02642 | 0,02166 | 5,5 | 0,5 | CNESTEN | -5,66 | -34,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Bimassa | NIR-IAS-36-2 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 12,63 | 5,67 | 308,2 | GWB | 16/04/2014 | 20 | 30,4 | 5,6 | 3,9 | 0,7 | 1,9 | 1,1 | 1,2 | 2,0 | 13,9 | 3,8 | 0,006478 | 0,000911 | 5,8 | 0,1 | CNESTEN | -5,07 | -30,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Gigane | NIR-IAS-17-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,49 | 5,24 | 256,7 | GWD | 13/04/2014 | 1620 | 30,5 | 5,7 | 154,0 | 58,3 | 94,9 | 23,0 | 76,5 | 315,3 | 239,1 | 259,0 | 0,000444 | 0,02505 | 19,2 | 6,5 | CNESTEN | -3,43 | -22,1 | CNESTEN | 4,9 | 0,4 | HYDROSYS Labor Ltd. |
| Rafinduma | NIR-IAS-21-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,86 | 5,56 | 311,8 | GWB | 13/04/2014 | 2020 | 34,4 | 3,2 | 269,6 | 114,8 | 59,8 | 21,0 | 14,8 | 1377,1 | 0,0 | 3,3 | 0,01689 | 1,18 | 22,5 | 1,1 | CNESTEN | -6,85 | -47,1 | CNESTEN | 0,7 | 0,2 | HYDROSYS Labor Ltd. |
| Tulluwa | NIR-IAS-15-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,96 | 5,16 | 287,0 | GWB | 12/04/2014 | 390 | 34,7 | 6,2 | 60,7 | 5,7 | 2,8 | 0,6 | 4,7 | 4,2 | 181,8 | 35,0 | 0,001344 | 0,002389 | 13,0 | 0,3 | CNESTEN | -4,17 | -24,6 | CNESTEN | 3,4 | 0,3 | HYDROSYS Labor Ltd. |
| Sokoto(Yauri/Gwandu Rd) | NIR-IAS-34-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,02 | 5,22 | 323,3 | GWB | 15/04/2014 | 630 | 35,8 | 5,7 | 63,2 | 8,9 | 10,7 | 1,3 | 17,9 | 8,3 | 172,0 | 65,3 | 0,002866 | 0,003475 | 14,0 | 0,5 | CNESTEN | -3,25 | -21,0 | CNESTEN | 3,6 | 0,3 | HYDROSYS Labor Ltd. |
| Sokoto(Sama Rd. Pump Station) | NIR-IAS-35-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,01 | 5,24 | 318,0 | GWB | 15/04/2014 | 550 | 32,6 | 6,3 | 80,1 | 7,4 | 18,6 | 1,9 | 27,4 | 5,8 | 185,4 | 92,0 | 0,001881 | 0,002983 | 10,6 | 0,3 | CNESTEN | -3,55 | -22,1 | CNESTEN | 2,8 | 0,3 | HYDROSYS Labor Ltd. |
| Chacho | NIR-IAS-33-2 | Rima Group | Creteceous(Maestrichtien) | 13,17 | 5,45 | 341,0 | GWB | 15/04/2014 | 250 | 35,2 | 4,9 | 31,5 | 3,4 | 2,4 | 6,3 | 1,5 | 59,0 | 51,2 | 1,1 | 0,02527 | 0,008741 | 10,8 | 0,2 | CNESTEN | -4,42 | -27,5 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Balkore(River Kainuwa) | NIR-IAS-16-2 | Surface Water | Surface Water | 13,30 | 5,23 | 261,0 | SRI | 13/04/2014 | 490 | 32,4 | 6,2 | 70,1 | 24,7 | 5,1 | 1,1 | 2,9 | 28,4 | 309,9 | 2,9 | 0,004053 | 0,007469 | 17,6 | 0,4 | CNESTEN | -1,08 | -12,0 | CNESTEN | 4,0 | 0,3 | HYDROSYS Labor Ltd. |
| Shagari(dam) | NIR-IAS-30-2 | Surface Reservoir | Surface Reservoir | 12,65 | 5,00 | 250,4 | SRE | 14/04/2014 | 80 | 30,1 | 6,2 | 8,0 | 2,7 | 4,1 | 6,6 | 2,1 | 1,7 | 54,4 | 1,3 | 0,001287 | 0,009193 | 7,6 | 0,4 | CNESTEN | 3,69 | 9,4 | CNESTEN | 4,1 | 0,3 | HYDROSYS Labor Ltd. |
| Illela | NIR-IAS-18-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,73 | 5,29 | 265,1 | GWB | 13/04/2014 | 400 | 33,8 | 4,0 | 25,3 | 20,9 | 11,8 | 5,2 | 3,8 | 146,3 | 36,0 | 2,7 | 0,02153 | 0,1021 | 32,8 | 0,9 | CNESTEN | -4,50 | -27,7 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. |
| Gada(Dan-dutse) | NIR-IAS-22-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,75 | 5,66 | 308,5 | GWD | 13/04/2014 | 690 | 32,2 | 2,1 | 93,3 | 18,5 | 19,1 | 5,6 | 16,2 | 323,8 | 9,8 | 7,9 | 0,04232 | 0,05439 | 18,2 | 0,4 | CNESTEN | -2,11 | -13,5 | CNESTEN | 3,6 | 0,3 | HYDROSYS Labor Ltd. |
| Gudun | NIR-IAS-26-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,67 | 4,83 | 275,0 | GWD | 14/04/2014 | 360 | 31,7 | 5,7 | 41,5 | 7,1 | 12,3 | 17,2 | 4,0 | 63,0 | 117,1 | 28,6 | 0,000096 | 0,007022 | 7,6 | 0,3 | CNESTEN | -4,20 | -25,7 | CNESTEN | 3,0 | 0,3 | HYDROSYS Labor Ltd. |
| Saida | NIR-IAS-27-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,68 | 4,85 | 255,5 | GWD | 14/04/2014 | 340 | 31,6 | 5,5 | 51,7 | 7,9 | 3,7 | 0,9 | 4,6 | 60,0 | 103,7 | 34,4 | 0,000775 | 0,005803 | 9,1 | 0,4 | CNESTEN | -4,38 | -27,1 | CNESTEN | 1,6 | 0,3 | HYDROSYS Labor Ltd. |

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Nigeria Basin (Campaign 3)

| Site | Sample_Code | Aquifer | Aquifer 2 | Latitude | Longitude | Altitude | Type | Sampling_Date | EC (µs/cm) | Temp | pH | $Ca^{2+}$ (mg/l) | $Mg^{2+}$ (mg/l) | $Na^{+}$ (mg/l) | $K^{+}$ (mg/l) | $Cl^{-}$ (mg/l) | $SO_4^{2-}$ (mg/l) | $HCO_3^{-}$ (mg/l) | $NO_3^{-}$ (mg/l) | Li | B | SiO2 | F | Chem_Lab | $^{18}O$ | $^{2}H$ | SI_Lab | $^{3}H$ | $^{3}H$_ERR | $^{3}H$_Lab | $^{18}O$ | $^{2}H$ | SI_Lab | $^{3}H$ | $^{3}H$_ERR | $^{3}H$_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sifawa 1 | NIR-IAS-01-2 | Rima Group | Creteceous(Maestrichtien) | 12,81 | 5,13 | 296,0 | GWB | 11/04/2014 | 130 | 32,3 | 5,5 | 10,7 | 1,4 | 8,8 | 1,1 | 1,5 | 9,3 | 34,2 | 20,2 | 0 | 0,0031 | 7,7 | 0,2 | CNESTEN | -4,94 | -28,7 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -0,50 | -6,56 | CNESTEN | 5,11 | 0,18 | CNESTEN |
| Jabo II | NIR-IAS-02-2 | Rima Group | Creteceous(Maestrichtien) | 12,51 | 4,96 | 297,0 | GWB | 11/04/2014 | 90 | 33,8 | 5,3 | 12,2 | 0,8 | 4,5 | 4,2 | 4,6 | 1,3 | 25,6 | 12,7 | 0 | 0,0018 | 6,2 | 2,5 | CNESTEN | -3,94 | -26,4 | CNESTEN | 1,9 | 0,2 | HYDROSYS Labor Ltd. | -6,87 | -45,32 | CNESTEN | 0,93 | 0,17 | CNESTEN |
| Dogondaji I | NIR-IAS-03-2 | Rima Group | Creteceous(Maestrichtien) | 12,46 | 4,80 | 269,8 | GWB | 11/04/2014 | 220 | 33,7 | 6,2 | 40,2 | 2,6 | 5,1 | 2,3 | 6,0 | 3,3 | 126,9 | 20,4 | 0 | 0,0036 | 8,7 | 0,9 | CNESTEN | -3,98 | -26,4 | CNESTEN | 4,1 | 0,3 | HYDROSYS Labor Ltd. | -7,06 | -47,19 | CNESTEN | 0,96 | 0,17 | CNESTEN |
| Barkeji I | NIR-IAS-04-2 | Rima Group | Creteceous(Maestrichtien) | 12,45 | 4,77 | 271,0 | GWB | 11/04/2014 | 100 | 30,4 | 5,8 | 14,3 | 1,8 | 1,6 | 1,1 | 0,8 | 1,1 | 55,6 | 6,4 | 0 | 0,0029 | 8,2 | 0,1 | CNESTEN | -3,89 | -25,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -4,81 | -32,21 | CNESTEN | 0,82 | 0,17 | CNESTEN |
| Kebbi II | NIR-IAS-05-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,13 | 4,73 | 223,3 | GWB | 11/04/2014 | 420 | 32,1 | 4,7 | 43,0 | 11,6 | 11,4 | 22,5 | 31,2 | 6,2 | 11,0 | 192,7 | 0 | 0,0025 | 11,8 | 0,1 | CNESTEN | -4,32 | -24,5 | CNESTEN | 3,1 | 0,3 | HYDROSYS Labor Ltd. | -5,49 | -35,63 | CNESTEN | 1,03 | 0,15 | CNESTEN |
| Romon Sarki | NIR-IAS-06-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,23 | 4,60 | 217 | GWB | 11/04/2014 | 60 | 32,8 | 5,5 | 9,6 | 1,0 | 0,9 | 2,6 | 1,0 | 0,9 | 28,1 | 8,2 | 0 | 0,0023 | 7,8 | 0,1 | CNESTEN | -4,68 | -26,7 | CNESTEN | 1,7 | 0,3 | HYDROSYS Labor Ltd. | -2,07 | -13,67 | CNESTEN | 5,59 | 0,32 | CNESTEN |
| Sabon Gari(tambuwal) | NIR-IAS-07-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,41 | 4,65 | 273,1 | GWB | 11/04/2014 | 120 | 36,4 | 6,0 | 13,7 | 1,4 | 4,6 | 1,2 | 1,7 | 10,8 | 36,0 | 15,3 | 0 | 0,0034 | 7,6 | 0,2 | CNESTEN | -4,66 | -26,6 | CNESTEN | 0,6 | 0,2 | HYDROSYS Labor Ltd. | -3,65 | -21,55 | CNESTEN | 4,24 | 0,23 | CNESTEN |
| Sanyinna(market) | NIR-IAS-08-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,70 | 4,86 | 231,5 | GWB | 12/04/2014 | 170 | 32,6 | 5,4 | 15,5 | 3,0 | 3,0 | 2,1 | 2,4 | 30,1 | 28,8 | 6,9 | 0,01 | 0,009 | 5,2 | 0,3 | CNESTEN | -5,46 | -32,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -4,30 | -28,15 | CNESTEN | 0,85 | 0,26 | CNESTEN |
| Tiggi | NIR-IAS-09-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,81 | 4,61 | 227,7 | GWB | 12/04/2014 | 90 | 32,9 | 4,6 | 5,8 | 3,4 | 1,2 | 1,8 | 1,2 | 13,2 | 25,6 | 0,8 | 0,01 | 0,008 | 8,4 | 0,3 | CNESTEN | -5,92 | -33,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -6,86 | -47,10 | CNESTEN | 0,75 | 0,3 | CNESTEN |
| Argungu | NIR-IAS-10-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,75 | 4,52 | 229,3 | GWB | 12/04/2014 | 160 | 33,3 | 4,2 | 8,7 | 5,1 | 1,3 | 2,8 | 1,6 | 22,6 | 31,7 | 1,6 | 0,01 | 0,012 | 6,4 | 0,4 | CNESTEN | -7,37 | -44,9 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -6,30 | -47,02 | CNESTEN | 0,85 | 0,28 | CNESTEN |
| Rima Quarters(Birnin Kebbi) | NIR-IAS-11-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,46 | 4,22 | 229,0 | GWB | 12/04/2014 | 230 | 35,7 | 6,1 | 19,1 | 11,2 | 9,7 | 7,7 | 4,4 | 16,7 | 114,7 | 1,6 | 0 | 0,0444 | 7,1 | 2,0 | CNESTEN | -7,72 | -47,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -6,55 | -47,70 | CNESTEN | 0,51 | 0,2 | CNESTEN |
| Kalgo | NIR-IAS-12-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,34 | 4,20 | 213,0 | GWB | 12/04/2014 | 70 | 35,2 | 3,2 | 5,3 | 1,7 | 2,3 | 2,0 | 1,3 | 20,2 | 6,3 | 0,6 | 0 | 0,0128 | 6,0 | 0,1 | CNESTEN | -5,96 | -33,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -5,76 | -37,71 | CNESTEN | 0,51 | 0,22 | CNESTEN |
| Katami | NIR-IAS-13-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,94 | 4,73 | 233,9 | GWB | 12/04/2014 | 110 | 34,3 | 3,6 | 5,2 | 1,4 | 0,2 | 1,3 | 1,5 | 9,8 | 10,3 | 0,9 | 0,01 | 0,0041 | 6,4 | 0,2 | CNESTEN | -6,59 | -37,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -3,94 | -22,16 | CNESTEN | 4,59 | 0,21 | CNESTEN |
| Silame | NIR-IAS-14-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,04 | 4,84 | 251,0 | GWB | 12/04/2014 | 100 | 34,3 | 5,7 | 7,9 | 0,7 | 1,9 | 2,1 | 2,1 | 6,3 | 19,5 | 4,3 | 0 | 0,0017 | 6,8 | 0,9 | CNESTEN | -5,53 | -29,9 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -6,36 | -47,60 | CNESTEN | 1,15 | 0,15 | CNESTEN |
| Rugar-Kijo | NIR-IAS-23-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,69 | 5,08 | 298,8 | GWB | 14/04/2014 | 90 | 33,6 | 5,5 | 11,0 | 0,9 | 2,8 | 0,7 | 1,6 | 7,8 | 35,6 | 0,3 | 0 | 0,0052 | 7,0 | 0,2 | CNESTEN | -4,89 | -27,2 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -2,34 | -16,44 | CNESTEN | 5,31 | 0,18 | CNESTEN |
| Bancho | NIR-IAS-24-2 | Rima Group | Creteceous(Maestrichtien) | 12,47 | 4,99 | 304,3 | GWB | 14/04/2014 | 40 | 31,6 | 5,7 | 4,9 | 0,4 | 3,4 | 1,0 | 1,0 | 1,1 | 10,3 | 13,8 | 0 | 0,0036 | 5,8 | 0,2 | CNESTEN | -4,84 | -26,3 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -3,93 | -21,42 | CNESTEN | 0,95 | 0,13 | CNESTEN |
| Salah | NIR-IAS-25-2 | Rima Group | Creteceous(Maestrichtien) | 12,51 | 4,83 | 277,0 | GWB | 14/04/2014 | 510 | 33,0 | 6,4 | 50,0 | 15,0 | 2,7 | 0,8 | 2,3 | 26,3 | 207,4 | 9,1 | 0,01 | 0,0061 | 12,6 | 0,4 | CNESTEN | -5,16 | -26,9 | CNESTEN | 0,7 | 0,2 | HYDROSYS Labor Ltd. | -7,84 | -50,20 | CNESTEN | 0,3 | 0,14 | CNESTEN |
| Gambuwa | NIR-IAS-28-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,69 | 4,87 | 251,8 | GWB | 14/04/2014 | 760 | 34,7 | 6,0 | 85,1 | 12,7 | 17,4 | 11,0 | 31,6 | 66,0 | 217,2 | 71,6 | 0,01 | 0,0063 | 12,5 | 0,5 | CNESTEN | -3,99 | -26,5 | CNESTEN | 1,9 | 0,3 | HYDROSYS Labor Ltd. | -4,44 | -21,12 | CNESTEN | 3,48 | 0,14 | CNESTEN |
| Yabo(Torankawa) | NIR-IAS-29-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,43 | 5,60 | 299,0 | GWB | 14/04/2014 | 90 | 33,7 | 6,1 | 3,6 | 1,5 | 6,6 | 0,8 | 4,4 | 2,6 | 5,9 | 22,6 | 0 | 0,0018 | 7,2 | 0,1 | CNESTEN | -4,39 | -26,8 | CNESTEN | 2,0 | 0,3 | HYDROSYS Labor Ltd. | -5,86 | -32,24 | CNESTEN | 0,5 | 0,13 | CNESTEN |
| Raba(GGC) I | NIR-IAS-32-2 | Rima Group | Creteceous(Maestrichtien) | 13,13 | 5,49 | 265,0 | GWB | 15/04/2014 | 100 | 37,8 | 4,8 | 6,4 | 0,5 | 9,0 | 2,5 | 4,3 | 29,5 | 4,6 | 0,9 | 0,03 | 0,0139 | 15,1 | 0,3 | CNESTEN | -4,66 | -27,7 | CNESTEN | 0,8 | 0,2 | HYDROSYS Labor Ltd. | -5,30 | -27,95 | CNESTEN | 0,01 | 0,13 | CNESTEN |
| Yar Geda | NIR-IAS-37-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 12,58 | 6,00 | 305,0 | GWB | 16/04/2014 | 190 | 30,3 | 5,7 | 18,3 | 4,6 | 16,4 | 2,3 | 14,4 | 13,9 | 60,3 | 25,6 | 0 | 0,0027 | 16,8 | 0,3 | CNESTEN | -4,85 | -28,0 | CNESTEN | 0,5 | 0,2 | HYDROSYS Labor Ltd. | -3,83 | -24,01 | CNESTEN | 2,91 | 0,26 | CNESTEN |
| Gidan Ciwake | NIR-IAS-19-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,75 | 5,42 | 314,0 | GWB | 13/04/2014 | 1360 | 38,4 | 5,3 | 119,4 | 44,7 | 120,9 | 22,9 | 28,8 | 567,7 | 196,4 | 3,1 | 0,01 | 1,243 | 9,1 | 1,0 | CNESTEN | -6,58 | -48,1 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -5,07 | -26,57 | CNESTEN | 2,56 | 0,17 | CNESTEN |
| Wauru | NIR-IAS-20-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,77 | 5,50 | 334,5 | GWB | 13/04/2014 | 1290 | 40,4 | 5,5 | 98,1 | 35,3 | 132,2 | 20,7 | 19,1 | 532,2 | 162,3 | 7,8 | 0,01 | 1,035 | 8,4 | 1,0 | CNESTEN | -6,85 | -48,2 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -0,42 | -2,15 | CNESTEN | 3,41 | 0,21 | CNESTEN |
| Rima Basin Complex,Sokoto | NIR-IAS-31-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,97 | 5,29 | 316,5 | GWB | 15/04/2014 | 260 | 32,4 | 5,7 | 26,1 | 3,4 | 2,4 | 4,7 | 1,0 | 55,4 | 35,1 | 2,0 | 0,03 | 0,0217 | 5,5 | 0,5 | CNESTEN | -5,66 | -34,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -3,84 | -24,44 | CNESTEN | 6,65 | 0,27 | CNESTEN |
| Bimassa | NIR-IAS-36-2 | Gundumi | Late Cretaceous(Upper Jurrassic) CI | 12,63 | 5,67 | 308,2 | GWB | 16/04/2014 | 20 | 30,4 | 5,6 | 3,9 | 0,7 | 1,9 | 1,1 | 1,2 | 2,0 | 13,9 | 3,8 | 0,01 | 0,0009 | 5,8 | 0,1 | CNESTEN | -5,07 | -30,4 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -4,22 | -23,83 | CNESTEN | 2,3 | 0,28 | CNESTEN |
| Gigane | NIR-IAS-17-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,49 | 5,24 | 256,7 | GWD | 13/04/2014 | 1620 | 30,5 | 5,7 | 154,0 | 58,3 | 94,9 | 23,0 | 76,5 | 315,3 | 239,1 | 259,0 | 0 | 0,0251 | 19,2 | 6,5 | CNESTEN | -3,43 | -22,1 | CNESTEN | 4,9 | 0,4 | HYDROSYS Labor Ltd. | -4,91 | -25,70 | CNESTEN | 3,22 | 0,17 | CNESTEN |
| Rafinduma | NIR-IAS-21-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,86 | 5,56 | 311,8 | GWB | 13/04/2014 | 2020 | 34,4 | 3,2 | 269,6 | 114,8 | 59,8 | 21,0 | 14,8 | 1377,1 | 0,0 | 3,3 | 0,02 | 1,18 | 22,5 | 1,1 | CNESTEN | -6,85 | -47,1 | CNESTEN | 0,7 | 0,2 | HYDROSYS Labor Ltd. | -4,93 | -31,45 | CNESTEN | 0,09 | 0,16 | CNESTEN |
| Tulluwa | NIR-IAS-15-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,96 | 5,16 | 287,0 | GWB | 12/04/2014 | 390 | 34,7 | 6,2 | 60,7 | 5,7 | 2,8 | 0,6 | 4,7 | 4,2 | 181,8 | 35,0 | 0 | 0,0024 | 13,0 | 0,3 | CNESTEN | -4,17 | -24,6 | CNESTEN | 3,4 | 0,3 | HYDROSYS Labor Ltd. | -5,27 | -28,67 | CNESTEN | 0,08 | 0,14 | CNESTEN |
| Sokoto(Yauri/Gwandu Rd) | NIR-IAS-34-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,02 | 5,22 | 323,3 | GWB | 15/04/2014 | 630 | 35,8 | 5,7 | 63,2 | 8,9 | 10,7 | 1,3 | 17,9 | 8,3 | 172,0 | 65,3 | 0 | 0,0035 | 14,0 | 0,5 | CNESTEN | -3,25 | -21,0 | CNESTEN | 3,6 | 0,3 | HYDROSYS Labor Ltd. | -7,39 | -44,32 | CNESTEN | 0,21 | 0,11 | CNESTEN |
| Sokoto(Sama Rd. Pump Station) | NIR-IAS-35-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,01 | 5,24 | 318,0 | GWB | 15/04/2014 | 550 | 32,6 | 6,3 | 80,1 | 7,4 | 18,6 | 1,9 | 27,4 | 5,8 | 185,4 | 92,0 | 0 | 0,003 | 10,6 | 0,3 | CNESTEN | -3,55 | -22,1 | CNESTEN | 2,8 | 0,3 | HYDROSYS Labor Ltd. | -1,85 | -11,39 | CNESTEN | 3,48 | 0,14 | CNESTEN |
| Chacho | NIR-IAS-33-2 | Rima Group | Creteceous(Maestrichtien) | 13,17 | 5,4515 | 341,0 | GWB | 15/04/2014 | 250 | 35,2 | 4,9 | 31,5 | 3,4 | 2,4 | 6,3 | 1,5 | 59,0 | 51,2 | 1,1 | 0,03 | 0,0087 | 10,8 | 0,2 | CNESTEN | -4,42 | -27,5 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -7,17 | -48,83 | CNESTEN | 0,07 | 0,18 | CNESTEN |
| Balkore(River Kainuwa) | NIR-IAS-16-2 | Surface Water | Surface Water | 13,30 | 5,23 | 261,0 | SRI | 13/04/2014 | 490 | 32,4 | 6,2 | 70,1 | 24,7 | 5,1 | 1,1 | 2,9 | 28,4 | 309,9 | 2,9 | 0 | 0,0075 | 17,6 | 0,4 | CNESTEN | -1,08 | -12,0 | CNESTEN | 4,0 | 0,3 | HYDROSYS Labor Ltd. | -6,32 | -42,61 | CNESTEN | 0,04 | 0,19 | CNESTEN |
| Shagari(dam) | NIR-IAS-30-2 | Surface Reservoir | Surface Reservoir | 12,65 | 5,00 | 250,4 | SRE | 14/04/2014 | 80 | 30,1 | 6,2 | 8,0 | 2,7 | 4,1 | 6,6 | 2,1 | 1,7 | 54,4 | 1,3 | 0 | 0,0092 | 7,6 | 0,4 | CNESTEN | 3,69 | 9,4 | CNESTEN | 4,1 | 0,3 | HYDROSYS Labor Ltd. | -4,80 | -28,62 | CNESTEN | 0,05 | 0,21 | CNESTEN |
| Illela | NIR-IAS-18-2 | Gwandu | Tertiary(Eocene-Miocene) CT | 13,73 | 5,29 | 265,1 | GWB | 13/04/2014 | 400 | 33,8 | 4,0 | 25,3 | 20,9 | 11,8 | 5,2 | 3,8 | 146,3 | 36,0 | 2,7 | 0,02 | 0,1021 | 32,8 | 0,9 | CNESTEN | -4,50 | -27,7 | CNESTEN | < 0.4 | | HYDROSYS Labor Ltd. | -3,98 | -18,93 | CNESTEN | 0,26 | 0,2 | CNESTEN |
| Gada(Dan-dutse) | NIR-IAS-22-2 | Sokoto Group | Tertiary(Upper Paleocene) | 13,75 | 5,66 | 308,5 | GWD | 13/04/2014 | 690 | 32,2 | 2,1 | 93,3 | 18,5 | 19,1 | 5,6 | 16,2 | 323,8 | 9,8 | 7,9 | 0,04 | 0,0544 | 18,2 | 0,4 | CNESTEN | -2,11 | -13,5 | CNESTEN | 3,6 | 0,3 | HYDROSYS Labor Ltd. | -5,19 | -31,62 | CNESTEN | 0,28 | 0,19 | CNESTEN |
| Gudun | NIR-IAS-26-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,67 | 4,83 | 275,0 | GWD | 14/04/2014 | 360 | 31,7 | 5,7 | 41,5 | 7,1 | 12,3 | 17,2 | 4,0 | 63,0 | 117,1 | 28,6 | 0 | 0,007 | 7,6 | 0,3 | CNESTEN | -4,20 | -25,7 | CNESTEN | 3,0 | 0,3 | HYDROSYS Labor Ltd. | -3,55 | -23,04 | CNESTEN | 1,76 | 0,33 | CNESTEN |
| Saida | NIR-IAS-27-2 | Sokoto Group | Tertiary(Upper Paleocene) | 12,68 | 4,85 | 255,5 | GWD | 14/04/2014 | 340 | 31,6 | 5,5 | 51,7 | 7,9 | 3,7 | 0,9 | 4,6 | 60,0 | 103,7 | 34,4 | 0 | 0,0058 | 9,1 | 0,4 | CNESTEN | -4,38 | -27,1 | CNESTEN | 1,6 | 0,3 | HYDROSYS Labor Ltd. | -7,24 | -49,06 | CNESTEN | 1,4 | 0,25 | CNESTEN |
| Birnin Kebbi, GRA | NIR-IAS-38-3 | Gwandu Formation | Tertiary(Eocene-Miocene) CT | 12,46 | 4,21 | 245 | GWB | 2015/11/23 | 209 | 32,1 | 8,15 | 18,64 | 11,1 | 0,76 | 7,38 | 4,43 | 18,71 | 115,9 | 1,94 | 0,57 | <LD | <LQ | 9,42 | 0,499 | 2,368 | <LD | <LD | 5,321 | 40,29 | CNESTEN | -7,35 | -49,95 | CNESTEN | 0,51 | 0,25 | CNESTEN |
| Goru (Birnin Kebbi) | NIR-IAS-39-3 | Gwandu Formation | Tertiary(Eocene-Miocene) CT | 12,39 | 4,20 | 217 | GWB | 2015/11/23 | 177,5 | 29,3 | 8,1 | 16,42 | 8,85 | 0,66 | 6,08 | 4,1 | 30,35 | 80,52 | 2,71 | 0,42 | <LD | <LQ | 7,41 | 5,974 | 1,841 | <LD | <LD | 7,941 | 33,05 | CNESTEN | -6,32 | -39,24 | CNESTEN | 0,2 | 0,21 | CNESTEN |
| Gwandu Town | NIR-IAS-40-3 | Gwandu Formation | Tertiary(Eocene-Miocene) CT | 12,51 | 4,63 | 272 | GWB | 2015/11/23 | 10,1 | 30,6 | 6,92 | 0,4 | 0,26 | 0,62 | 1,42 | 1,81 | 0,46 | 6,1 | 1,72 | 0,13 | <LD | <LQ | 1,54 | 1,809 | 20,41 | <LD | <LD | 5,138 | <LD | CNESTEN | -4,56 | -26,64 | CNESTEN | 1,01 | 0,28 | CNESTEN |
| Chacho | NIR-IAS-41-3 | Rima Group | Creteceous(Maestrichtien) | 13,17 | 5,45 | 341 | GWB | 2015/11/24 | 211 | 33,5 | 7,5 | 33,53 | 3,81 | 0,53 | 8,26 | 3,08 | 65,04 | 62 | 1,86 | 0,27 | <LD | <LQ | 3,43 | 30,83 | 27,88 | <LD | 511,8 | 10,72 | 5,889 | CNESTEN | -4,34 | -29,70 | CNESTEN | 0,17 | 0,19 | CNESTEN |
| Shinkafi | NIR-IAS-42-3 | Gundumi Formation | Late Cretaceous(Upper Jurrassic) CI | 13,08 | 6,50 | 328 | GWB | 2015/11/24 | 1161 | 30,0 | 7,94 | 69,39 | 26,2 | 156,5 | 23,91 | 112,94 | 66,85 | 318,42 | 202,1 | 0,67 | <LD | 0,4 | 4,47 | 0,698 | 132,3 | <LD | 2,851 | 20,79 | 17,69 | CNESTEN | -4,10 | -21,62 | CNESTEN | 2,63 | 0,27 | CNESTEN |
| Gidan Sale | NIR-IAS-43-3 | Gundumi Formation | Late Cretaceous(Upper Jurrassic) CI | 13,18 | 6,14 | 332,2 | GWB | 2015/11/24 | 44,9 | 30,5 | 7,26 | 2,29 | 0,75 | 4,23 | 3,2 | 1,56 | 0,34 | 15,86 | 11,81 | 0,21 | <LD | <LQ | 0,69 | 2,433 | 3,271 | <LD | 2,737 | 6,224 | 1,144 | CNESTEN | -5,78 | -34,87 | CNESTEN | 0 | 0,18 | CNESTEN |
| Bagudo Motor Park | NIR-IAS-44-3 | Illo Formation | CI | 11,41 | 4,23 | 173 | GWB | 2015/11/26 | 325 | 31,7 | 7,94 | 21,01 | 6,63 | 38,63 | 12,49 | 43,52 | 19,09 | 118,95 | 2,42 | 0,22 | <LD | <LQ | 1,06 | 0,325 | 634,1 | <LD | 19,31 | 5,95 | 5,106 | CNESTEN | -2,69 | -15,22 | CNESTEN | 1,04 | 0,25 | CNESTEN |
| Tuga Village | NIR-IAS-45-3 | Illo Formation | CI | 11,35 | 4,18 | 160 | GWD | 2015/11/26 | 1669 | 28,5 | 8,28 | 119,65 | 35,4 | 95,59 | 220 | 196,77 | 122,36 | 396,5 | 220,04 | 0,32 | 1,39 | 0,29 | 1,66 | 1,678 | 2,656 | <LD | <LD | 13,94 | 74,11 | CNESTEN | -4,24 | -21,91 | CNESTEN | 2,19 | 0,26 | CNESTEN |
| River Niger Tuga bridge | NIR-IAS-46-3 | Surface Water | Surface Water | 11,34 | 4,18 | 145 | SRI | 2015/11/26 | 57,8 | 28,2 | 7,76 | 4,62 | 1,88 | 4,6 | 3,38 | 2,98 | 1,38 | 31,72 | 1,13 | 0,16 | <LD | <LQ | 0,64 | 1,088 | 5,71 | 1,957 | 919,6 | 7,471 | 1,385 | CNESTEN | -2,05 | -15,78 | CNESTEN | 3,31 | 0,24 | CNESTEN |
| Kaoje | NIR-IAS-47-3 | Illo Formation | CI | 11,18 | 4,12 | 216 | GWD | 2015/11/26 | 1334 | 29,9 | 8,11 | 94,01 | 35,95 | 41,13 | 164,58 | 86,07 | 76,36 | 112,24 | 465,16 | 0,28 | <LD | 0,21 | 1,15 | 4,275 | 466,8 | 0,024 | 3,325 | 5,47 | 2,638 | CNESTEN | -4,15 | -20,09 | CNESTEN | 1,46 | 0,23 | CNESTEN |
| Daranna | NIR-IAS-48-3 | Illo Formation | CI | 11,13 | 3,99 | 268 | GWB | 2015/11/27 | 127,6 | 31,5 | 7,9 | 14,3 | 3,26 | 3,51 | 4,74 | 11,18 | 0,37 | 19,52 | 42,47 | 0,18 | <LD | <LQ | 0,61 | 2,91 | 9,895 | <LD | 0,656 | 15,96 | <LD | CNESTEN | -4,27 | -21,67 | CNESTEN | 1,86 | 0,23 | CNESTEN |
| Bakin Ruwa | NIR-IAS-49-3 | Illo Formation | CI | 11,10 | 3,96 | 264 | GWB | 2015/11/27 | 85,2 | 31,2 | 6,52 | 5,47 | 4,16 | 1,99 | 6,05 | 5,54 | 0,01 | 15,86 | 30,63 | 0,16 | <LD | <LQ | 0,74 | 2,299 | 16,17 | <LD | 4,254 | 15,47 | <LD | CNESTEN | -3,91 | -21,48 | CNESTEN | 1,17 | 0,19 | CNESTEN |
| Maje | NIR-IAS-50-3 | Illo Formation | CI | 11,08 | 3,87 | 241 | GWB | 2015/11/27 | 88,2 | 31,3 | 6,85 | 28,25 | 13,97 | 5,43 | 9,35 | 30,59 | 0,55 | 19,52 | 115,77 | 0,16 | <LD | <LQ | 0,61 | 4,194 | 33,05 | <LD | <LD | 17,11 | <LD | CNESTEN | -4,28 | -21,52 | CNESTEN | 0,69 | 0,17 | CNESTEN |
| Kangiwa | NIR-IAS-51-3 | Illo Formation | CI | 11,34 | 3,71 | 186 | GWB | 2015/11/27 | 33,3 | 31,0 | 7,49 | 18,86 | 1,91 | 1,87 | 5,12 | 2,22 | 0,2 | 82,96 | 1,15 | 0,2 | <LD | <LQ | 0,59 | 2,751 | 0,65 | <LD | 0,318 | 14,68 | <LD | CNESTEN | -4,18 | -23,03 | CNESTEN | 0 | 0,19 | CNESTEN |
| Kabara | NIR-IAS-52-3 | Illo Formation | CI | 11,37 | 3,71 | 192 | GWB | 2015/11/27 | 65,9 | 32,3 | 7,16 | 14,44 | 5,12 | 3,56 | 5,76 | 10,74 | 0,01 | 15,86 | 57,37 | 0,18 | <LD | <LQ | 0,51 | 2,752 | 5,934 | <LD | 9,681 | 15,3 | <LD | CNESTEN | -4,54 | -24,88 | CNESTEN | 1,12 | 0,25 | CNESTEN |
| Illo (Awala) | NIR-IAS-53-3 | Illo Formation | CI | 11,55 | 3,70 | 175 | GWB | 2015/11/27 | 115,4 | 31,6 | 7,05 | 9,38 | 3,29 | 4,61 | 8,04 | 9,23 | 4,61 | 18,3 | 35,65 | 0,14 | <LD | <LQ | 0,58 | 3,322 | 10,42 | <LD | 18 | 12,1 | <LD | CNESTEN | -4,27 | -23,00 | CNESTEN | 2,08 | 0,25 | CNESTEN |
| Danai(CGC yard) | NIR-IAS-54-3 | Illo Formation | CI | 11,56 | 3,70 | 178 | GWB | 2015/11/27 | 57,9 | 33,8 | 7 | 5,77 | 1,43 | 2,72 | 3,72 | 0,83 | 0,18 | 32,94 | 3,18 | 0,07 | <LD | <LQ | 0,49 | 2,281 | 16,18 | <LD | 34,18 | 15,7 | <LD | CNESTEN | -3,89 | -20,43 | CNESTEN | 2,52 | 0,26 | CNESTEN |
| Lolo River(River Niger Upstream) | NIR-IAS-55-3 | Surface Reservoir | Surface Reservoir | 11,66 | 3,61 | 160 | SRI | 2015/11/27 | 41 | 27,4 | 7,03 | 3,15 | 1,54 | 3,73 | 2,7 | 2,26 | 0,21 | 30,5 | 0,8 | 0,11 | <LD | <LQ | 0,57 | 0,216 | 0,268 | <LD | 52,56 | 5,175 | <LD | CNESTEN | -2,64 | -16,42 | CNESTEN | 2,05 | 0,22 | CNESTEN |
| Lolo (Tungan Kungi) | NIR-IAS-56-3 | Illo Formation | CI | 11,66 | 3,60 | 166 | GWB | 2015/11/27 | 192,8 | 31,8 | 7,72 | 22,02 | 3,44 | 14,28 | 4,48 | 12,06 | 3,27 | 81,74 | 34,15 | 0,09 | <LD | <LQ | 0,68 | 1,357 | <LD | <LD | 0,096 | 18,98 | <LD | CNESTEN | -4,19 | -23,52 | CNESTEN | 1,35 | 0,19 | CNESTEN |
| Runtuwa Buli | NIR-IAS-57-3 | Illo Formation | CI | 11,67 | 3,58 | 166 | GWB | 2015/11/27 | 195,7 | 32,4 | 7,97 | 33,92 | 4,3 | 3,4 | 5 | 2,11 | 1,63 | 134,2 | 6,04 | 0,13 | <LD | <LQ | 0,52 | 1,509 | 1,044 | <LD | 2,328 | 15,08 | <LD | CNESTEN | -4,09 | -23,62 | CNESTEN | 0,45 | 0,17 | CNESTEN |
| Sabon Birni 2 | NIR-IAS-58-3 | Illo Formation | CI | 11,44 | 3,56 | 218 | GWB | 2015/11/27 | 69,8 | 30,8 | 7,71 | 7,9 | 1,5 | 1,86 | 7,99 | 1,93 | 0,22 | 47,58 | 0,22 | 0,18 | <LD | <LQ | 0,62 | 2,572 | <LD | <LD | 3,253 | 21,8 | <LD | CNESTEN | -5,16 | -27,06 | CNESTEN | 3,24 | 0,22 | CNESTEN |
| Shanji | NIR-IAS-59-3 | Illo Formation | CI | 11,29 | 3,55 | 259 | GWB | 2015/11/27 | 529 | 31,0 | 7,09 | 35,43 | 32,62 | 6,33 | 15,84 | 57,92 | 0,43 | 15,86 | 215,78 | 0,19 | <LD | <LQ | 0,65 | 6,642 | 36,08 | <LD | <LD | 19,02 | <LD | CNESTEN | -4,24 | -23,22 | CNESTEN | 0,49 | 0,19 | CNESTEN |
| Sambe | NIR-IAS-60-3 | Illo Formation | CI | 11,39 | 3,55 | 236 | GWB | 2015/11/27 | 45,9 | 30,8 | 7,58 | 5,82 | 1,97 | 2,41 | 6,97 | 1,76 | 0,01 | 39,65 | 3,17 | 0,16 | <LD | <LQ | 0,56 | 1,904 | 0,015 | <LD | <LD | 18,75 | <LD | CNESTEN | -4,79 | -26,22 | CNESTEN | 0,05 | 0,21 | CNESTEN |
| Koko, | NIR-IAS-61-3 | Gwandu Formation | Tertiary(Eocene-Miocene) CT | 11,42 | 4,53 | 207 | GWB | 2015/11/28 | 26,9 | 27,7 | 7,04 | 0,44 | 0,32 | 4,13 | 2,44 | 2,2 | 0,01 | 6,1 | 10,69 | 0,1 | <LD | <LQ | 0,5 | 1,238 | 16,92 | <LD | 0,677 | 4,581 | <LD | CNESTEN | -3,69 | -21,35 | CNESTEN | 0,26 | 0,2 | CNESTEN |
| Bunza, PHC | NIR-IAS-62-3 | Gwandu Formation | Tertiary(Eocene-Miocene) CT | 12,09 | 4,02 | 181 | GWB | 2015/11/28 | 354 | 31,5 | 8,21 | 68,61 | 3,35 | 7,88 | 7,44 | 13,3 | 6,52 | 190,32 | 29,11 | 0,54 | <LD | 0,11 | 0,68 | 1,602 | 0,577 | <LD | 0,763 | 9,602 | 23,08 | CNESTEN | -4,43 | -22,13 | CNESTEN | 1,28 | 0,23 | CNESTEN |

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Benin Basin (Campaign 1)

| Region | Sample_Code | Aquifer | Longitude | Latitude | Altitude | Type | depth | Sampling_Date | EC | Temp | pH | Alk | $Cl^-$ (mg/l) | $NO_3^-$ (mg/l) | $SO_4^{2-}$ (mg/l) | $CO_3^{2-}$ (mg/l) | $HCO_3^-$ (mg/l) | $Na^+$ (mg/l) | $K^+$ (mg/l) | $Mg^{2+}$ (mg/l) | $Ca^{2+}$ (mg/l) | TDS (mg/l) | $\delta^2H$ (‰ vs Smow) | $^2H$_ERR | $\delta^{18}O$ (‰ vs Smow) | $^{18}O$_ERR | EC | H3 | H3_ERR | C13 | C14 | C14_ERR | C14_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kandi, Illumeden | BK01-01 | Nappe phreatique | 3,22 | 11,98 | 171,1 | GWD | 6,7 | 07/03/2013 | 686 | 32,5 | 6,6 | 372 | 41,1 | 52,7 | 21,9 | 0 | 180,0 | 20,8 | 55,3 | 21,2 | 38,4 | 396,1 | -25,8 | 1,3 | -4,13 | 0,17 | 686 | 3,04 | 0,33 | | | | |
| Kandi, Illumeden | BK04-01 | Nappe phreatique | 3,19 | 12,07 | 172,6 | GWD | 16,7 | 07/03/2013 | 1050 | 30,5 | 7,4 | 686 | 44,1 | 93,2 | 42,0 | 0 | 359,9 | 44,7 | 8,8 | 64,2 | 46,4 | 652,0 | -25,8 | 0,9 | -4,35 | 0,17 | 1050 | 2,56 | 0,26 | | | | |
| Kandi, Illumeden | BK08-01 | Nappe phreatique | 3,23 | 11,84 | 166,7 | GWD | 2,8 | 08/03/2013 | 800 | 28,2 | 7,0 | 183 | 93,1 | 165,1 | 27,1 | 0 | 122,0 | 42,0 | 13,1 | 31,3 | 71,7 | 566,3 | -23,1 | 0,7 | -3,88 | 0,20 | 800 | 3,11 | 0,32 | | | | |
| Kandi, Illumeden | BK10-01 | Nappe phreatique | 3,23 | 11,94 | 167,9 | GWD | 2,4 | 08/03/2013 | 143 | 29,6 | 7,0 | 67 | 4,7 | 22,4 | 1,3 | 0 | 67,1 | 6,7 | 4,5 | 6,2 | 14,5 | 127,9 | -29,6 | 0,5 | -4,55 | 0,17 | 143 | 2,99 | 0,35 | | | | |
| Kandi, Illumeden | BK12-01 | Nappe phreatique | 3,26 | 11,90 | 159,8 | GWD | 4,6 | 08/03/2013 | 95 | 30,3 | 6,2 | 76 | 46,7 | 36,9 | 14,6 | 0 | 48,8 | 19,1 | 15,7 | 7,6 | 26,1 | 215,2 | -30,6 | 1,3 | -4,96 | 0,21 | 95 | 4,85 | 0,28 | | | | |
| Kandi, Illumeden | BK14-01 | Nappe phreatique | 3,29 | 11,92 | 158,5 | GWD | 1,4 | 08/03/2013 | 118 | 28,6 | 6,1 | 79 | 8,2 | 4,8 | 3,3 | 0 | 54,9 | 6,2 | 3,5 | 4,2 | 12,6 | 91,3 | -20,7 | 1,3 | -3,51 | 0,20 | 118 | 3,03 | 0,26 | | | | |
| Kandi, Illumeden | BK19-01 | Nappe phreatique | 3,31 | 11,76 | 177,2 | GWD | 20,3 | 08/03/2013 | 121 | 31,7 | 5,1 | 21 | 1,1 | 45,6 | 2,1 | 0 | 24,4 | 14,5 | 2,6 | 2,6 | 6,7 | 103,1 | -19,3 | 0,8 | -3,71 | 0,08 | 121 | 1,95 | 0,33 | | | | |
| Kandi, Illumeden | BK24-01 | Nappe phreatique | 3,42 | 11,86 | 165,5 | GWD | 2,7 | 09/03/2013 | 488 | 31,6 | 6,7 | 162 | 53,6 | 43,2 | 37,2 | 0 | 103,7 | 30,5 | 34,8 | 12,1 | 35,0 | 332,0 | -20,0 | 0,5 | -3,61 | 0,15 | 488 | 4,36 | 0,32 | | | | |
| Kandi, Illumeden | BK27-01 | Nappe phreatique | 3,40 | 11,78 | 173,5 | GWD | 17,2 | 09/03/2013 | 120 | 31,8 | 5,8 | 24 | 2,4 | 40,5 | 0,5 | 0 | 24,4 | 6,0 | 4,6 | 3,0 | 9,1 | 98,9 | -24,6 | 0,6 | -3,81 | 0,09 | 120 | 2,62 | 0,31 | | | | |
| Kandi, Illumeden | BK28-01 | Nappe phreatique | 3,47 | 11,80 | 175,5 | GWD | 8,1 | 09/03/2013 | 350 | 30,9 | 4,7 | 6 | 25,0 | 108,9 | 1,7 | 0 | 24,4 | 21,7 | 8,3 | 7,9 | 16,7 | 225,3 | -22,7 | 0,7 | -3,41 | 0,18 | 350 | 2,94 | 0,33 | | | | |
| Kandi, Illumeden | BK32-01 | Nappe phreatique | 3,52 | 11,75 | 176,0 | GWD | | 09/03/2013 | 202 | 29,7 | 5,9 | 46 | 21,1 | 16,5 | 3,2 | 0 | 61,0 | 16,2 | 10,7 | 3,4 | 10,4 | 142,3 | -21,1 | 1,2 | -3,38 | 0,08 | 202 | 2,75 | 0,31 | | | | |
| Kandi, Illumeden | BK33-01 | Nappe phreatique | 3,55 | 11,71 | 166,4 | GWD | 6,6 | 09/03/2013 | 180 | 29,6 | 6,3 | 34 | 5,9 | 48,8 | 0,5 | 0 | 51,8 | 6,9 | 3,3 | 3,7 | 19,1 | 152,5 | -19,6 | 0,9 | -3,49 | 0,20 | 180 | 2,86 | 0,18 | | | | |
| Kandi, Illumeden | BK35-01 | Nappe phreatique | 3,50 | 11,62 | 213,9 | GWD | 15,6 | 09/03/2013 | 327 | 30,6 | 6,3 | 52 | 16,8 | 87,7 | 0,6 | 0 | 51,8 | 5,4 | 8,7 | 9,2 | 26,2 | 229,2 | -22,2 | 1,2 | -3,70 | 0,20 | 327 | 2,06 | 0,31 | | | | |
| Kandi, Illumeden | BK38-01 | Nappe phreatique | 3,51 | 11,56 | 203,3 | GWD | 10,5 | 09/03/2013 | 83 | 30,1 | 5,7 | 34 | 3,6 | 13,5 | 0,4 | 0 | 31,5 | 2,7 | 3,2 | 3,0 | 7,4 | 72,0 | -21,7 | 0,2 | -4,22 | 0,11 | 83 | 2,51 | 0,26 | | | | |
| Kandi, Illumeden | BK39-01 | Nappe phreatique | 3,39 | 11,65 | 209,1 | GWD | 41,7 | 09/03/2013 | 40 | 29,9 | 5,2 | 18 | 1,2 | 13,4 | 0,2 | 0 | 12,2 | 5,3 | 1,4 | 0,8 | 2,6 | 37,0 | -25,9 | 1,0 | -4,34 | 0,15 | 40 | 2,44 | 0,30 | | | | |
| Kandi, Illumeden | BK42-01 | Nappe phreatique | 3,55 | 10,93 | 310,0 | GWD | 9,1 | 10/03/2013 | 377 | 29,2 | 5,3 | 18 | 24,2 | 99,9 | 8,8 | 0 | 42,4 | 13,0 | 40,4 | 7,3 | 16,7 | 252,4 | -21,0 | 1,0 | -3,37 | 0,08 | 377 | 3,83 | 0,33 | | | | |
| Kandi, Illumeden | BK44-01 | Nappe phreatique | 3,69 | 10,93 | 178,5 | GWD | 9,7 | 10/03/2013 | 1145 | 29,7 | 5,2 | 18 | 125,2 | 398,2 | 10,1 | 0 | 14,2 | 59,8 | 25,7 | 30,0 | 100,7 | 775,0 | -21,4 | 0,3 | -3,97 | 0,18 | 1145 | 2,89 | 0,25 | | | | |
| Kandi, Illumeden | BK47-01 | Nappe phreatique | 3,55 | 11,03 | 171,0 | GWD | 9,2 | 10/03/2013 | 19 | 29,9 | 4,6 | 15 | 0,6 | 3,9 | 2,1 | 0 | 12,2 | 2,7 | 1,1 | 0,7 | 2,2 | 26,3 | -29,3 | 0,6 | -4,87 | 0,21 | 19 | 3,45 | 0,24 | | | | |
| Kandi, Illumeden | BK49-01 | Nappe phreatique | 3,45 | 11,24 | 183,9 | GWD | 7,1 | 10/03/2013 | 83 | 28,5 | 5,3 | 24 | 3,9 | 17,2 | 1,7 | 0 | 24,4 | 6,6 | 3,2 | 0,8 | 8,1 | 64,8 | -25,1 | 0,8 | -4,56 | 0,23 | 83 | 4,58 | 0,27 | | | | |
| Kandi, Illumeden | BK50-01 | Nappe phreatique | 3,38 | 11,12 | 305,0 | GWD | 13,8 | 10/03/2013 | 305 | 29,7 | 6,3 | 116 | 20,5 | 28,3 | 15,1 | 0 | 137,0 | 19,3 | 10,3 | 10,8 | 35,7 | 256,1 | -23,5 | 0,6 | -4,02 | 0,14 | 305 | 2,54 | 0,31 | | | | |
| Kandi, Illumeden | BK57-01 | Nappe phreatique | 3,06 | 11,18 | 259,3 | GWD | 16,1 | 11/03/2013 | 861 | 29,5 | 6,7 | 363 | 19,7 | 137,1 | 42,6 | 0 | 250,1 | 17,1 | 161,7 | 16,5 | 42,8 | 677,0 | -25,4 | 0,7 | -4,30 | 0,23 | 861 | 2,94 | 0,29 | | | | |
| Kandi, Illumeden | BK59-01 | Nappe phreatique | 3,27 | 11,34 | 224,7 | GWD | 28,0 | 11/03/2013 | 21 | 30,1 | 4,9 | 9 | 0,8 | 5,1 | 0,0 | 0 | 12,2 | 3,7 | 1,3 | 1,1 | 0,8 | 24,1 | -25,4 | 0,6 | -4,65 | 0,15 | 21 | 0,09 | 0,21 | | | | |
| Kandi, Illumeden | BK62-01 | Nappe phreatique | 2,98 | 10,73 | 304,4 | GWD | 8,0 | 11/03/2013 | 1929 | 28,5 | 6,5 | 174 | 123,2 | 524,6 | 77,3 | 0 | 152,5 | 75,5 | 196,2 | 44,3 | 97,5 | 1269,0 | -21,4 | 0,6 | -4,10 | 0,11 | 1929 | 2,43 | 0,31 | | | | |
| Kandi, Illumeden | BK65-01 | Nappe phreatique | 2,84 | 10,84 | 328,5 | GWD | | 11/03/2013 | 479 | 29,9 | 7,1 | 250 | 52,0 | 18,5 | 0,0 | 0 | 186,0 | 21,5 | 7,3 | 23,6 | 37,0 | 337,5 | -23,4 | 0,9 | -4,39 | 0,10 | 479 | 1,13 | 0,32 | | | | |
| Kandi, Illumeden | BK67-01 | Nappe phreatique | 3,47 | 10,29 | 397,4 | GWD | 7,1 | 12/03/2013 | 704 | 28,9 | 6,8 | 101 | 103,5 | 78,1 | 9,0 | 0 | 122,0 | 41,8 | 65,2 | 15,4 | 31,3 | 462,6 | -20,2 | 0,8 | -4,01 | 0,22 | 704 | 2,56 | 0,30 | | | | |
| Kandi, Illumeden | BK69-01 | Nappe phreatique | 3,22 | 10,37 | 329,0 | GWD | 12,9 | 12/03/2013 | 777 | 29,5 | 6,4 | 146 | 76,2 | 50,8 | 8,3 | 0 | 174,0 | 25,6 | 8,3 | 20,6 | 60,2 | 469,1 | -22,2 | 1,3 | -4,29 | 0,18 | 777 | 3,10 | 0,26 | | | | |
| Kandi, Illumeden | BK71-01 | Nappe phreatique | 3,15 | 10,36 | 304,0 | GWD | 4,7 | 12/03/2013 | 319 | 29,4 | 6,8 | 165 | 21,2 | 21,2 | 3,9 | 0 | 122,0 | 20,6 | 4,6 | 5,8 | 27,2 | 226,1 | -23,9 | 1,3 | -4,34 | 0,24 | 319 | 1,29 | 0,27 | | | | |
| Kandi, Illumeden | BK73-01 | Nappe phreatique | 2,94 | 11,13 | 276,3 | GWD | 1,9 | 13/03/2013 | 169 | 28,1 | 6,8 | 70 | 25,0 | 25,0 | 2,0 | 0 | 24,4 | 11,9 | 11,7 | 2,9 | 10,0 | 123,0 | -23,9 | 1,3 | -4,41 | 0,20 | 169 | 2,19 | 0,34 | | | | |
| Kandi, Illumeden | BK75-01 | Nappe phreatique | 3,14 | 10,71 | 314,3 | GWD | | 13/03/2013 | 687 | 29,2 | 7,7 | 153 | 71,6 | 62,2 | 20,3 | 0 | 186,0 | 19,8 | 40,4 | 28,6 | 54,6 | 454,7 | -26,3 | 1,2 | -4,84 | 0,08 | 687 | 2,96 | 0,35 | | | | |
| Kandi, Illumeden | BK09-01 | Nappe phreatique | 3,23 | 11,84 | 174,0 | GWB | 76,0 | 08/03/2013 | 353 | 31,4 | 7,9 | 281 | 34,1 | 12,0 | 15,3 | 0 | 189,1 | 72,7 | 4,6 | 8,0 | 20,3 | 332,0 | -40,0 | 1,3 | -5,61 | 0,09 | 353 | 0,18 | 0,20 | | | | |
| Kandi, Illumeden | BK05-01 | Nappe phreatique | 3,19 | 12,07 | 171,7 | GWB | 57,0 | 07/03/2013 | 725 | 31,5 | 7,2 | 616 | 10,5 | 21,1 | 18,6 | 0 | 396,5 | 31,3 | 6,1 | 40,1 | 65,1 | 562,0 | -24,3 | 1,3 | -3,89 | 0,17 | 725 | 4,56 | 0,34 | | | | |
| Kandi, Illumeden | BK02-01 | Nappe phreatique | 3,22 | 11,98 | 174,1 | GWB | 43,0 | 07/03/2013 | 172 | 31,7 | 6,2 | 137 | 1,4 | 1,6 | 3,8 | 0 | 112,0 | 8,7 | 10,2 | 5,9 | 17,2 | 158,6 | -11,1 | 0,8 | -0,90 | 0,19 | 172 | 2,37 | 0,34 | | | | |
| Kandi, Illumeden | BK11-01 | Nappe phreatique | 3,26 | 11,90 | 160,4 | GWB | 70,0 | 08/03/2013 | 143 | 32,1 | 6,1 | 43 | 1,6 | 17,8 | 2,8 | 0 | 30,5 | 8,1 | 2,9 | 2,3 | 6,2 | 79,3 | -21,9 | 0,3 | -3,80 | 0,12 | 143 | 5,12 | 0,34 | | | | |
| Kandi, Illumeden | BK15-01 | Nappe phreatique | 3,29 | 11,92 | 162,4 | GWB | 25,8 | 08/03/2013 | 445 | 31,3 | 6,4 | 159 | 61,9 | 0,2 | 17,5 | 0 | 85,4 | 41,4 | 3,6 | 7,4 | 24,1 | 265,0 | -17,0 | 0,7 | -2,40 | 0,16 | 445 | 1,60 | 0,28 | | | | |
| Kandi, Illumeden | BK40-01 | Nappe phreatique | 3,38 | 11,80 | 168,2 | SRI | | 09/03/2013 | 37 | 29,3 | 5,8 | 24 | 1,0 | 1,9 | 0,4 | 0 | 31,5 | 3,3 | 2,4 | 1,3 | 4,7 | 48,7 | -22,0 | 1,1 | -3,78 | 0,21 | 37 | 0,70 | 0,23 | | | | |
| Kandi, Illumeden | BK41-01 | Nappe phreatique | 3,40 | 10,96 | 294,5 | GWB | | 10/03/2013 | 12 | 28,8 | 4,7 | 9 | 1,3 | 0,7 | 0,4 | 0 | 12,2 | 2,1 | 0,7 | 0,5 | 1,6 | 21,3 | -24,8 | 0,9 | -4,37 | 0,20 | 12 | 0,42 | 0,29 | | | | |
| Kandi, Illumeden | BK43-01 | Nappe phreatique | 3,68 | 10,94 | 265,9 | GWB | | 10/03/2013 | 48 | 30,7 | 5,1 | 31 | 0,8 | 1,9 | 0,2 | 0 | 30,5 | 2,1 | 4,9 | 2,0 | 3,4 | 44,3 | -23,2 | 1,2 | -4,15 | 0,24 | 48 | 0,34 | 0,32 | | | | |
| Kandi, Illumeden | BK45-01 | Nappe phreatique | 3,69 | 10,91 | 194,5 | GWB | 36,5 | 10/03/2013 | 40 | 31,2 | 5,1 | 24 | 0,4 | 0,3 | 0,3 | 0 | 30,4 | 0,9 | 4,5 | 1,7 | 4,0 | 42,0 | -23,9 | 0,8 | -4,26 | 0,07 | 40 | 0,36 | 0,30 | | | | |
| Kandi, Illumeden | BK46-01 | Nappe phreatique | 3,55 | 11,03 | 270,8 | GWB | 43,0 | 10/03/2013 | 14 | 30,1 | 4,5 | 9 | 0,4 | 2,1 | 0,3 | 0 | 9,2 | 2,2 | 0,8 | 0,3 | 0,9 | 17,4 | -23,6 | 0,6 | -4,14 | 0,15 | 14 | 3,54 | 0,32 | | | | |
| Kandi, Illumeden | BK63-01 | Nappe phreatique | 2,84 | 10,69 | 335,2 | GWB | 22,0 | 11/03/2013 | 348 | 30,2 | 6,9 | 226 | 5,1 | 6,7 | 1,9 | 0 | 186,0 | 19,4 | 5,9 | 14,0 | 27,1 | 255,3 | -24,1 | 1,0 | -4,10 | 0,06 | 348 | 1,07 | 0,29 | | | | |
| Kandi, Illumeden | BK64-01 | Nappe phreatique | 2,79 | 10,72 | 328,6 | GWB | 42,9 | 11/03/2013 | 222 | 30,4 | 6,6 | 162 | 0,0 | 0,2 | 0,1 | 0 | 122,0 | 11,6 | 4,5 | 9,4 | 16,4 | 157,6 | -23,4 | 1,1 | -3,78 | 0,06 | 222 | 0,87 | 0,28 | | | | |
| Kandi, Illumeden | BK68-01 | Nappe phreatique | 3,38 | 10,29 | 406,3 | GWB | 61,3 | 12/03/2013 | 59 | 28,8 | 5,7 | 18 | 8,3 | 6,9 | 0,1 | 0 | 18,8 | 5,0 | 2,2 | 1,1 | 4,9 | 52,0 | -22,2 | 1,0 | -4,10 | 0,20 | 59 | 2,53 | 0,30 | | | | |
| Kandi, Illumeden | BK70-01 | Nappe phreatique | 3,22 | 10,37 | 323,2 | GWB | 43,6 | 12/03/2013 | 680 | 29,9 | 6,6 | 241 | 110,3 | 85,1 | 5,8 | 0 | 152,5 | 31,8 | 10,4 | 22,9 | 65,4 | 501,2 | -22,4 | 1,0 | -3,80 | 0,14 | 680 | 2,35 | 0,35 | | | | |
| Kandi, Illumeden | BK72-01 | Nappe phreatique | 3,15 | 10,36 | 309,3 | GWB | 43,7 | 12/03/2013 | 811 | 29,0 | 6,6 | 336 | 96,4 | 96,4 | 17,4 | 0 | 225,7 | 41,9 | 8,0 | 20,6 | 84,3 | 545,5 | -20,7 | 0,8 | -3,69 | 0,19 | 811 | 2,87 | 0,31 | | | | |
| Kandi, Illumeden | BK74-01 | Nappe phreatique | 3,13 | 10,72 | 320,0 | GWB | | 13/03/2013 | 738 | 29,6 | 6,5 | 186 | 81,2 | 82,7 | 33,7 | 0 | 146,4 | 20,7 | 96,3 | 20,4 | 42,9 | 490,5 | -23,8 | 1,0 | -4,44 | 0,17 | 738 | 2,38 | 0,30 | | | | |
| Kandi, Illumeden | BK54-01 | Grès de Kandi (CI) | 3,07 | 11,05 | 266,6 | GWB | | 10/03/2013 | 49 | 29,4 | 5,1 | 31 | 0,2 | 0,6 | 0,8 | 0 | 30,5 | 2,6 | 4,9 | 2,9 | 1,9 | 48,5 | -24,3 | 1,1 | -4,03 | 0,19 | 49 | 0,13 | 0,34 | | | | |
| Kandi, Illumeden | BK55-01 | Grès de Kandi (CI) | 2,97 | 11,12 | 296,3 | GWB | 60,0 | 11/03/2013 | 20 | 28,7 | 5,3 | 18 | 0,5 | 3,5 | 1,0 | 0 | 15,2 | 2,2 | 0,8 | 0,9 | 2,9 | 29,1 | -22,5 | 1,3 | -3,99 | 0,19 | 20 | 1,74 | 0,24 | | | | |
| Kandi, Illumeden | BK58-01 | Grès de Kandi (CI) | 3,06 | 11,19 | 276,6 | GWB | | 11/03/2013 | 36 | 30,9 | 5,5 | 24 | 0,5 | 1,5 | 0,9 | 0 | 30,5 | 2,9 | 2,4 | 1,4 | 5,4 | 50,1 | -24,0 | 1,2 | -4,27 | 0,04 | 36 | 1,34 | 0,29 | | | | |
| Kandi, Illumeden | BK56-01 | Grès de Kandi (CI) | 2,97 | 11,13 | 315,2 | GWB | 76,0 | 11/03/2013 | 13 | 30,8 | 5,2 | 15 | 1,3 | 1,7 | 0,7 | 0 | 8,6 | 1,1 | 0,7 | 0,7 | 1,8 | 17,0 | -26,5 | 1,3 | -3,87 | 0,19 | 13 | 0,43 | 0,26 | | | | |
| Kandi, Illumeden | BK34-01 | Grès de Kandi (CI) | 3,55 | 11,71 | 166,0 | GWB | 43,1 | 09/03/2013 | 99 | 31,9 | 5,9 | 43 | 1,5 | 14,0 | 1,0 | 0 | 38,6 | 4,3 | 1,7 | 2,2 | 10,6 | 81,0 | -23,8 | 0,8 | -4,02 | 0,11 | 99 | 4,54 | 0,31 | | | | |
| Kandi, Illumeden | BK53-01 | Grès de Kandi (CI) | 3,11 | 11,03 | 272,2 | GWB | 26,0 | 10/03/2013 | 30 | 28,5 | 4,9 | 15 | 0,9 | 4,1 | 0,2 | 0 | 15,8 | 1,1 | 1,3 | 1,4 | 3,4 | 30,0 | -24,8 | 0,8 | -4,28 | 0,20 | 30 | 0,33 | 0,33 | | | | |
| Kandi, Illumeden | BK48-01 | Grès de Kandi (CI) | 3,45 | 11,24 | 179,1 | GWB | 43,2 | 10/03/2013 | 21 | 29,7 | 4,6 | 15 | 0,6 | 2,5 | 1,6 | 0 | 12,2 | 3,3 | 1,1 | 0,4 | 1,6 | 24,1 | -25,5 | 0,2 | -4,59 | 0,10 | 21 | 1,10 | 0,23 | | | | |
| Kandi, Illumeden | BK22-01 | cambro-silurien | 3,04 | 11,32 | 244,1 | GWB | | 08/03/2013 | 548 | 30,3 | 5,9 | 122 | 55,6 | 96,6 | 13,9 | 0 | 85,4 | 19,7 | 7,7 | 15,4 | 52,3 | 369,7 | -22,3 | 1,3 | -3,89 | 0,08 | 548 | 1,86 | 0,31 | | | | |
| Kandi, Illumeden | BK23-01 | cambro-silurien | 3,38 | 11,87 | 285,2 | GWB | | 09/03/2013 | 803 | 32,1 | 6,1 | 46 | 78,5 | 282,6 | 36,8 | 0 | 49,5 | 47,5 | 27,5 | 18,9 | 90,1 | 680,0 | -20,2 | 1,0 | -3,42 | 0,16 | 803 | 3,13 | 0,27 | | | | |
| Kandi, Illumeden | BK37-01 | cambro-silurien | 3,51 | 11,58 | 204,7 | GWB | 50,0 | 09/03/2013 | 143 | 31,2 | 5,8 | 92 | 0,3 | 1,8 | 0,9 | 0 | 85,4 | 1,6 | 4,2 | 1,9 | 21,1 | 119,3 | -26,9 | 0,6 | -4,68 | 0,21 | 143 | 0,15 | 0,30 | | | | |
| Kandi, Illumeden | BK17-01 | Cambro Siluren | 3,29 | 11,86 | 157,6 | GWB | 33,4 | 08/03/2013 | 523 | 31,3 | 6,2 | 122 | 28,9 | 137,7 | 13,9 | 0 | 122,0 | 12,7 | 41,6 | 20,0 | 49,2 | 390,0 | -26,9 | 0,7 | -4,90 | 0,21 | 523 | 0,99 | 0,22 | | | | |
| Kandi, Illumeden | BK20-01 | Cambro Siluren | 3,22 | 11,73 | 188,4 | GWB | 60,0 | 08/03/2013 | 841 | 31,1 | 6,2 | 207 | 62,0 | 193,6 | 21,1 | 0 | 174,2 | 32,1 | 75,4 | 29,3 | 64,2 | 592,7 | -25,3 | 0,8 | -4,18 | 0,16 | 841 | 3,14 | 0,34 | | | | |

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, the Benin Basin (Campaign 1)

| Region | Sample_Code | Aquifer | Longitude | Latitude | Altitude | Type | depth | Sampling_Date | EC | Temp | pH | Alk | $Cl^-$ (mg/l) | $NO_3^-$ (mg/l) | $SO_4^{2-}$ (mg/l) | $CO_3^{2-}$ (mg/l) | $HCO_3^-$ (mg/l) | $Na^+$ (mg/l) | $K^+$ (mg/l) | $Mg^{2+}$ (mg/l) | $Ca^{2+}$ (mg/l) | TDS (mg/l) | $\delta^2H$ (‰ vs Smow) | $^2H$_ERR | $\delta^{18}O$ (‰ vs Smow) | $^{18}O$_ERR | EC | H3 | H3_ERR | C13 | C14 | C14_ERR | C14_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kandi, Illumeden | BK21-01 | Cambro Siluren | 3,12 | 11,56 | 214,9 | GWB | 42,7 | 08/03/2013 | 43 | 30,8 | 5,3 | 31 | 1,8 | 2,3 | 2,0 | 0 | 24,4 | 3,3 | 7,2 | 1,0 | 2,4 | 42,2 | -25,1 | 1,2 | -4,21 | 0,16 | 43 | 1,26 | 0,26 | | | | |
| Kandi, Illumeden | BK29-01 | Cambro Siluren | 3,47 | 11,80 | 172,9 | GWB | 34,0 | 09/03/2013 | 67 | 32,0 | 4,7 | 12 | 7,5 | 12,7 | 3,5 | 0 | 12,2 | 4,0 | 4,9 | 1,9 | 4,0 | 52,5 | -24,1 | 0,9 | -4,19 | 0,21 | 67 | 0,38 | 0,17 | | | | |
| Kandi, Illumeden | BK36-01 | Cambro Siluren45 | 3,50 | 11,61 | 218,6 | GWB | 45,0 | 09/03/2013 | 349 | 31,0 | 5,9 | 64 | 17,4 | 94,0 | 0,7 | 0 | 51,8 | 3,2 | 7,5 | 5,7 | 36,4 | 237,5 | -27,6 | 0,3 | -4,86 | 0,10 | 349 | 0,67 | 0,22 | | | | |
| Kandi, Illumeden | BK51-01 | Cambro Siluren | 3,28 | 10,98 | 257,6 | GWB | 49,7 | 10/03/2013 | 18 | 28,9 | 5,0 | 9 | 0,2 | 1,8 | 1,9 | 0 | 15,3 | 2,4 | 2,1 | 0,8 | 1,6 | 28,7 | -25,4 | 0,7 | -3,96 | 0,21 | 18 | 1,36 | 0,28 | | | | |
| Kandi, Illumeden | BK66-01 | Socle Panafricain | 3,75 | 10,84 | 319,0 | GWB | 45,3 | 11/03/2013 | 335 | 30,7 | 7,2 | 250 | 11,5 | 9,1 | 0,6 | 0 | 186,0 | 20,7 | 10,3 | 13,9 | 27,6 | 265,2 | -25,9 | 0,8 | -4,04 | 0,14 | 335 | 0,23 | 0,23 | | | | |
| Kandi, Illumeden | BK18-01 | Socle Panafricain | 3,38 | 11,81 | 172,1 | GWB | 73,7 | 08/03/2013 | 30 | 32,8 | 5,0 | 9 | 0,9 | 11,4 | 0,6 | 0 | 6,6 | 1,8 | 2,1 | 0,9 | 2,4 | 27,0 | -26,7 | 1,1 | -3,49 | 0,08 | 30 | 3,52 | 0,31 | | | | |
| Kandi, Illumeden | BK03-01 | Fleuve | 3,19 | 12,08 | 169,2 | SRI | | 07/03/2013 | 61 | 30,6 | 6,9 | 52 | 1,6 | 0,4 | 1,3 | 0 | 34,5 | 4,4 | 2,6 | 2,5 | 4,1 | 49,3 | -9,7 | 1,0 | -0,65 | 0,16 | 61 | 3,23 | 0,26 | | | | |
| Kandi, Illumeden | BK06-01 | Fleuve | 3,23 | 11,92 | 173,8 | SRI | | 07/03/2013 | 165 | 33,8 | 7,8 | 131 | 3,6 | 1,6 | 4,1 | 0 | 103,7 | 8,5 | 6,4 | 6,2 | 18,4 | 147,8 | 9,7 | 1,2 | 3,77 | 0,08 | 165 | 3,41 | 0,29 | | | | |
| Kandi, Illumeden | BK13-01 | Fleuve | 3,30 | 11,91 | 162,9 | SRI | | 08/03/2013 | 62 | 29,8 | 6,9 | 49 | 1,0 | 2,0 | 0,3 | 0 | 42,5 | 5,3 | 2,9 | 2,4 | 4,7 | 60,8 | -14,2 | 1,1 | -0,72 | 0,19 | 62 | 3,32 | 0,31 | | | | |
| Kandi, Illumeden | BK16-01 | Fleuve | 3,28 | 11,91 | 163,2 | SRI | | 08/03/2013 | 88 | 32,0 | 7,1 | 73 | 2,1 | 0,5 | 0,5 | 0 | 48,8 | 4,4 | 3,0 | 3,4 | 7,9 | 69,0 | -9,4 | 1,2 | -0,13 | 0,21 | 88 | 2,44 | 0,26 | | | | |
| Kandi, Illumeden | BK25-01 | Fleuve | 3,42 | 11,86 | 155,5 | SRI | | 09/03/2013 | 38 | 31,8 | 7,3 | 34 | 0,9 | 4,1 | 0,2 | 0 | 24,2 | 3,3 | 2,9 | 1,2 | 4,4 | 42,2 | -16,5 | 1,3 | -2,71 | 0,17 | 38 | 0,62 | 0,23 | | | | |
| Kandi, Illumeden | BK30-01 | Fleuve | 3,52 | 11,79 | 153,5 | SRI | | 09/03/2013 | 62 | 30,5 | 6,1 | 46 | 0,7 | 1,0 | 0,1 | 0 | 42,2 | 5,3 | 3,0 | 2,4 | 5,6 | 60,6 | -7,2 | 0,7 | 0,18 | 0,10 | 62 | 2,24 | 0,30 | | | | |
| Kandi, Illumeden | BK52-01 | Fleuve | 3,25 | 10,98 | 214,7 | SRI | | 10/03/2013 | 58 | 28,6 | 6,0 | 40 | 0,4 | 0,9 | 1,8 | 0 | 36,6 | 2,7 | 3,7 | 2,1 | 6,0 | 56,8 | -17,8 | 1,0 | -2,62 | 0,20 | 58 | 1,17 | 0,33 | | | | |
| Kandi, Illumeden | BK60-01 | Fleuve | 3,29 | 11,33 | 193,4 | SRI | | 11/03/2013 | 42 | 30,2 | 5,7 | 37 | 0,3 | 0,8 | 0,1 | 0 | 36,6 | 2,8 | 2,2 | 4,9 | 1,4 | 52,8 | -20,3 | 0,9 | -2,67 | 0,20 | 42 | 4,47 | 0,35 | | | | |
| Kandi, Illumeden | BK61-01 | fleuve | 2,98 | 10,73 | 303,2 | GWB | | 11/03/2013 | 129 | 29,9 | 5,5 | 31 | 6,1 | 23,3 | 3,0 | 0 | 30,5 | 4,8 | 12,3 | 3,2 | 7,9 | 99,7 | -24,5 | 0,6 | -4,67 | 0,22 | 129 | 3,39 | 0,29 | | | | |
| Kandi, Illumeden | BK07-01 | Fleuve | 2,94 | 11,14 | 280,8 | GWB | | 08/03/2013 | 294 | 30,1 | 7,2 | 256 | 1,9 | 0,2 | 0,5 | 0 | 189,0 | 16,8 | 5,3 | 12,5 | 28,7 | 233,5 | -27,1 | 0,3 | -5,03 | 0,09 | 294 | 0,10 | 0,24 | | | | |
| Kandi, Illumeden | BK26-01 | fleuve | 3,40 | 11,79 | 168,6 | GWB | 40,0 | 09/03/2013 | 547 | 31,5 | 6,3 | 116 | 15,1 | 130,8 | 16,9 | 0 | 109,8 | 9,5 | 54,8 | 13,7 | 35,0 | 357,5 | -26,2 | 0,9 | -4,33 | 0,11 | 547 | 2,98 | 0,26 | | | | |
| Kandi, Illumeden | BK31-01 | fleuve | 3,52 | 11,75 | 168,4 | GWB | | 09/03/2013 | 141 | 31,3 | 5,8 | 95 | 0,1 | 0,7 | 0,3 | 0 | 85,4 | 2,7 | 3,9 | 2,7 | 19,9 | 119,0 | -37,0 | 1,0 | -5,47 | 0,17 | 141 | 0,02 | 0,17 | | | | |

# Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, Benin Basin (Campaign 2)

| N° | Code | Aquifère | depth | Latitude | Longitude | Alt (m) | CE mS/cm | T°C | pH | Alcalinité mg/l | Sampling Date | $Cl^-$ (mg/l) | $NO_3^-$ (mg/l) | $SO_4^{2-}$ (mg/l) | $CO_3^{2-}$ (mg/l) | $HCO_3^-$ (mg/l) | $Na^+$ (mg/l) | $K^+$ (mg/l) | $Mg^{2+}$ (mg/l) | $Ca^{2+}$ (mg/l) | TDS (mg/l) | $SiO^{2+}$ | Fe | $\delta^2H$ (‰ vs Smow) | $^2H$_ERR | $\delta^{18}O$ (‰ vs Smow) | $^{18}O$_ERR | $^3H$ | $^3H$_ERR | $^3H$_Lab | $^{13}C$ | $^{14}C$ | 14C_ERR | 14C_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | BK04-02 | Quaternaire | 16,7 | 12,07 | 3,19 | 172,6 | 1152 | 26,1 | 6,78 | 1010 | 01/11/13 | 59,54 | 136,56 | 43,29 | 18,00 | 320 | 56,59 | 15,84 | 67,77 | 35,79 | 753 | 9,75 | <0,02 | -24,5 | 0,9 | -4,3 | 0,2 | | | | | | | |
| 12 | BK14-02 | Quaternaire | 1,43 | 11,92 | 3,29 | 158,5 | 139 | 25,4 | 6,2 | 115 | 01/11/13 | 11,54 | 1,88 | 5,1 | 0 | 73,2 | 10,04 | 2,99 | 4,51 | 13,72 | 122,98 | 6,62 | <0,02 | -21,3 | 1,1 | -3,5 | 0,1 | | | | | | | |
| 13 | BK15-02 | Quaternaire | 25,78 | 11,92 | 3,29 | 162,4 | 254 | 26,9 | 6,31 | 195 | 01/11/13 | 20,66 | 0,43 | 7,41 | 0 | 79,3 | 16,638 | 2,609 | 4,907 | 14,035 | 145,989 | 7,49 | <0,02 | -14,0 | 0,7 | -1,8 | 0,2 | | | | | | | |
| 18 | BK23-02 | Quaternaire | | 11,87 | 3,38 | 285,2 | 950 | 27 | 6,17 | 70 | 01/11/13 | 85,6 | 253,8 | 35,7 | 0 | 30,5 | 55,39 | 38,84 | 18,6 | 68,6 | 587,03 | 4,83 | <0,02 | -21,3 | 0,3 | -3,2 | 0,1 | | | | | | | |
| 19 | BK24-02 | Quaternaire | 2,67 | 11,86 | 3,42 | 165,5 | 649 | 24,9 | 6,43 | 215 | 01/11/13 | 68,415 | 46,595 | 39,665 | 0 | 104 | 37,03 | 38,93 | 14,425 | 38,735 | 387,795 | 1,72 | <0,02 | -24,0 | 0,7 | -3,9 | 0,1 | | | | | | | |
| 23 | BK28-02 | Quaternaire | 8,1 | 11,80 | 3,47 | 175,5 | 422 | 27,5 | 5,29 | 5 | 31/10/13 | 30,2 | 137,47 | 3,31 | 0 | 12,2 | 25,745 | 10,215 | 10,6 | 27,515 | 257,255 | 5,21 | <0,02 | -22,8 | 1,0 | -3,8 | 0,2 | | | | | | | |
| 24 | BK29-02 | Quaternaire | 34 | 11,80 | 3,47 | 172,9 | 34 | 27,9 | 5,24 | 10 | 31/10/13 | 2,316 | 5,468 | 1,307 | 0 | 9,2 | 2,067 | 1,508 | 1,007 | 2,47 | 25,343 | 1,26 | <0,02 | -24,6 | 1,2 | -4,4 | 0,1 | | | | | | | |
| 3 | BK03-02 | Fleuve Niger | | 12,08 | 3,19 | 169,2 | 41 | 24,5 | 6,71 | 50 | 01/11/13 | 3,30 | 0,38 | 1,50 | 0,00 | 33 | 5,34 | 2,08 | 1,73 | 3,83 | 51 | 3,49 | 0,85 | -24,6 | 0,5 | -3,4 | 0,1 | | | | | | | |
| 6 | BK06-02 | Fleuve Alibori | | 11,92 | 3,23 | 173,8 | 99 | 25,4 | 7,67 | 100 | 01/11/13 | 7,35 | 2,28 | 3 | 0 | 61 | 9,708 | 3,206 | 3,813 | 8,413 | 98,77 | 3,89 | 1,34 | -16,2 | 1,0 | -2,7 | 0,2 | | | | | | | |
| 11 | BK13-02 | Fleuve Niger | | 11,91 | 3,30 | 162,9 | 97 | 25,6 | 6,31 | 115 | 01/11/13 | 5,72 | 2,496 | 2,109 | 0 | 54,9 | 5,5 | 3,58 | 3,656 | 10,011 | 87,972 | 4,06 | 1,32 | -16,0 | 1,2 | -2,6 | 0,2 | | | | | | | |
| 20 | BK25-02 | Fleuve Sota | | 11,86 | 3,42 | 155,5 | 79 | 23 | 6,79 | 80 | 01/11/13 | 2,477 | 1,602 | 0,825 | 0 | 48,8 | 5,804 | 2,786 | 2,243 | 7,175 | 71,712 | 2,57 | 0,57 | -17,8 | 1,2 | -3,1 | 0,2 | | | | | | | |
| 25 | BK30-02 | Fleuve Niger | | 11,79 | 3,52 | 153,5 | 49 | 25,2 | 5,9 | 60 | 31/10/13 | 0,664 | 0,821 | 0,452 | 0 | 36,6 | 2,946 | 1,899 | 2,033 | 4,807 | 50,222 | 2,35 | 0,8 | -24,6 | 1,1 | -3,7 | 0,2 | | | | | | | |
| 33 | BK40-02 | Fleuve Sota | | 11,80 | 3,38 | 168,2 | 80 | 22,4 | 7,09 | 85 | 01/11/13 | 2,27 | 1,66 | 0,622 | 0 | 48,8 | 5,371 | 2,519 | 2,307 | 7,853 | 71,402 | 3,62 | 1,92 | -17,7 | 0,5 | -3,0 | 0,1 | | | | | | | |
| 54 | BK52-02 | Fleuve Sota | | 10,98 | 3,25 | 214,7 | 77 | 18,5 | 7,51 | 1159 | 04/12/13 | 2,164 | 1,025 | 0,664 | 0 | 48,8 | 5,15 | 2,588 | 2,33 | 6,67 | 69,391 | 6,1 | <0,02 | -15,7 | 0,9 | -2,7 | 0,2 | | | | | | | |
| 59 | BK60-02 | Fleuve Sota | | 11,33 | 3,29 | 193,4 | 70 | 22,5 | 6,63 | 1037 | 05/12/13 | 3,523 | 1,46 | 3,547 | 0 | 36,6 | 5,32 | 2,73 | 2,29 | 6,77 | 62,24 | 4,32 | <0,02 | -17,9 | 0,9 | -3,3 | 0,2 | | | | | | | |
| 40 | BK76-02 | Fleuve Sota | | 10,72 | 3,06 | | 73 | 23,6 | 6,52 | 70 | 30/10/13 | 3,037 | 0,739 | 0,698 | 0 | 42,7 | 5,9 | 1,93 | 1,9 | 7,033 | 63,937 | 5,64 | 1,571 | -17,5 | 1,1 | -3,1 | 0,1 | | | | | | | |
| 74 | BK85-02 | Rivière Irané | | 11,06 | 3,06 | 220,4 | 93 | 18,3 | 6,5 | 1281 | 06/12/13 | 3,696 | 2,256 | 0,962 | 0 | 48,8 | 5,317 | 2,487 | 2,862 | 6,871 | 73,251 | 4,73 | <0,02 | -19,6 | 0,6 | -3,0 | 0,1 | | | | | | | |
| 70 | BK81-02 | Rivière Bouli | | 10,45 | 2,92 | 273 | 103 | 19,5 | 7,31 | 3294 | 03/12/13 | 3,027 | 3,717 | 0 | 0 | 61 | 7,083 | 2,256 | 2,89 | 9,035 | 89,008 | 6,97 | 0,235 | -14,7 | 0,9 | -2,3 | 0,1 | | | | | | | |
| 72 | BK83-02 | Ruisseau à Dougoulaye ouest | | 10,72 | 3,05 | 250,2 | 93 | 20,5 | 7,32 | 1281 | 03/12/13 | 3,364 | 0,431 | 0,978 | 0 | 48,8 | 6,487 | 2,718 | 2,788 | 7,398 | 72,964 | 6,41 | 0,258 | -15,4 | 1,0 | -2,3 | 0,1 | | | | | | | |
| 1 | BK01-02 | Cambro Ordovicien | 6,7 | 11,98 | 3,22 | 171,1 | 551 | 26,8 | 6,3 | 350 | 01/11/13 | 43,90 | 32,70 | 21,07 | 0,00 | 189,1 | 18,35 | 35,76 | 15,00 | 41,28 | 397 | 9,13 | <0,02 | -27,3 | 1,0 | -4,5 | 0,2 | | | | | | | |
| 2 | BK02-02 | Cambro Ordovicien | 43 | 11,98 | 3,22 | 174,1 | 182 | 27,3 | 6,45 | 175 | 01/11/13 | 1,33 | 1,40 | 5,14 | 0,00 | 97,6 | 7,31 | 7,78 | 5,17 | 15,57 | 141 | 6,76 | <0,02 | -10,3 | 0,9 | -0,9 | 0,2 | | | | | | | |
| 5 | BK05-02 | Cambro Ordovicien | 73 | 12,07 | 3,19 | 171,7 | 800 | 26,8 | 7,19 | 930 | 01/11/13 | 13,50 | 18,36 | 19,40 | 24,00 | 207 | 34,57 | 4,50 | 38,78 | 15,61 | 376 | 6,81 | <0,02 | -22,6 | 0,9 | -3,4 | 0,2 | | | | | | | |
| 7 | BK07-02 | Cambro Ordovicien | | 11,14 | 2,94 | 280,8 | 196 | 25,7 | 7,15 | 180 | 01/11/13 | 7,7 | 0,1 | 0,84 | 0 | 97,6 | 10,094 | 4,817 | 4,945 | 14,902 | 140,998 | 11,13 | <0,02 | -24,0 | 0,7 | -4,0 | 0,2 | | | | -15,01 | 103,13 | 0,41 | Groningen |
| 41 | BK08-02 | Cambro Ordovicien | 2,8 | 11,84 | 3,23 | 166,7 | 732 | 24,7 | 6,64 | 4026 | 05/12/13 | 86,675 | 84,94 | 30,8 | 0 | 152,5 | 48,17 | 65,7 | 18,32 | 49,435 | 536,54 | 3,17 | <0,02 | -25,1 | 0,3 | -4,3 | 0,2 | | | | | | | |
| 42 | BK09-02 | Cambro Ordovicien | 76 | 11,84 | 3,23 | 174 | 453 | 25,5 | 7,13 | 4880 | 05/12/13 | 35,2 | 10,96 | 11,9 | 0 | 201,3 | 76,05 | 5,6 | 5,684 | 22,336 | 369,03 | 5,22 | <0,02 | -36,8 | 1,0 | -6,0 | 0,2 | | | | -14,16 | 17,26 | 0,14 | Groningen |
| 8 | BK10-02 | Cambro Ordovicien | 2,4 | 11,94 | 3,23 | 167,9 | 222 | 25,5 | 6,42 | 160 | 01/11/13 | 13,24 | 18,11 | 4,65 | 0 | 97,6 | 11,84 | 4,707 | 7,5 | 19 | 176,647 | 6,17 | <0,02 | -24,9 | 0,8 | -4,4 | 0,2 | | | | | | | |
| 9 | BK11-02 | Cambro Ordovicien | 70 | 11,90 | 3,26 | 160,4 | 125 | 26,8 | 5,6 | 35 | 31/10/13 | 1,419 | 16,77 | 2,02 | 0 | 42,7 | 10,054 | 2,529 | 2,184 | 7,051 | 84,727 | 5,13 | <0,02 | -23,8 | 1,0 | -4,0 | 0,2 | | | | | | | |
| 10 | BK12-02 | Cambro Ordovicien | 4,6 | 11,90 | 3,26 | 159,8 | 365 | 25,9 | 6,37 | 125 | 01/11/13 | 39,432 | 22,412 | 14,108 | 0 | 97,7 | 20,04 | 18,716 | 6,59 | 23,372 | 242,37 | 5,12 | <0,02 | -27,5 | 1,2 | -4,6 | 0,2 | | | | | | | |
| 14 | BK17-02 | Cambro Ordovicien | 33,4 | 11,86 | 3,29 | 157,6 | 592 | 26 | 6,16 | 100 | 31/10/13 | 26,3 | 151,15 | 17,5 | 0 | 97,6 | 11,8 | 38,9 | 18,35 | 48 | 409,6 | 1,87 | <0,02 | -23,6 | 0,9 | -4,1 | 0,2 | | | | | | | |
| 15 | BK19-02 | Ordovicien Terminal à Silurien | 20,25 | 11,76 | 3,31 | 177,2 | 121 | 27,1 | 6,88 | 35 | 31/10/13 | 2,82 | 36,98 | 0 | 0 | 24,4 | 10,69 | 2,14 | 0,88 | 7,92 | 85,83 | 2,49 | <0,02 | -21,9 | 0,8 | -4,0 | 0,1 | | | | | | | |
| 16 | BK20-02 | Cambro Ordovicien | 60 | 11,73 | 3,22 | 188,4 | 906 | 26,4 | 6,02 | 340 | 31/10/13 | 55,25 | 171,75 | 28,5 | 0 | 169 | 30,5 | 59,9 | 28,58 | 65,5 | 608,98 | 1,58 | <0,02 | -26,1 | 1,0 | -4,4 | 0,1 | | | | | | | |
| 17 | BK21-02 | Cambro Ordovicien | 42,7 | 11,56 | 3,12 | 214,9 | 38 | 26 | 6,42 | 40 | 31/10/13 | 3,225 | 1,183 | 0,598 | 0 | 30,5 | 4,081 | 6,3366 | 1,335 | 3,132 | 50,3906 | 4,58 | <0,02 | -25,8 | 0,5 | -4,3 | 0,1 | | | | | | | |
| 21 | BK26-02 | Ordovicien Terminal à Silurien | 40 | 11,79 | 3,40 | 168,6 | 570 | 27,1 | 5,85 | 190 | 31/10/13 | 16,42 | 130,61 | 21,09 | 0 | 115,9 | 9,555 | 51,795 | 13,675 | 44,39 | 403,435 | 1 | <0,02 | -26,4 | 0,8 | -4,4 | 0,2 | | | | | | | |
| 22 | BK27-02 | Ordovicien Terminal à Silurien | 17,15 | 11,78 | 3,40 | 173,5 | 125 | 26,8 | 5,6 | 35 | 31/10/13 | 2,674 | 36,915 | 0,825 | 0 | 18,3 | 5,471 | 3,412 | 2,731 | 8,674 | 79,002 | 3,69 | <0,02 | -24,1 | 1,0 | -4,0 | 0,1 | | | | | | | |
| 26 | BK31-02 | Ordovicien Terminal à Silurien | | 11,75 | 3,52 | 168,4 | 141 | 27,3 | 5,88 | 155 | 31/10/13 | 0 | 0 | 1,917 | 0 | 79,3 | 1,204 | 3,502 | 2,29 | 20,647 | 108,86 | 2,01 | <0,02 | -38,8 | 0,5 | -6,5 | 0,1 | | | | -12,75 | 49,6 | 0,26 | Groningen |
| 27 | BK33-02 | Ordovicien Terminal à Silurien | 6,55 | 11,71 | 3,55 | 166,4 | 266 | 26,4 | 6,14 | 105 | 31/10/13 | 9,798 | 51,294 | 9,812 | 0 | 54,9 | 11,206 | 3,652 | 4,934 | 26,66 | 172,256 | 5,39 | <0,02 | -22,1 | 1,2 | -4,3 | 0,2 | | | | | | | |
| 28 | BK34-02 | Ordovicien Terminal à Silurien | 43,13 | 11,71 | 3,55 | 166 | 103 | 28,6 | 5,93 | 70 | 31/10/13 | 1,254 | 16,513 | 0,991 | 0 | 36,6 | 4,447 | 1,932 | 1,95 | 11,736 | 75,423 | 6,64 | <0,02 | -24,7 | 1,3 | -4,7 | 0,1 | | | | | | | |
| 29 | BK35-02 | Ordovicien Terminal à Silurien | 15,55 | 11,62 | 3,50 | 213,9 | 252 | 26,2 | 6,4 | 120 | 31/10/13 | 14,728 | 45 | 8,064 | 0 | 61 | 9,02 | 10,06 | 7,058 | 23,518 | 178,448 | 2,77 | <0,02 | -25,1 | 0,6 | -4,4 | 0,2 | | | | | | | |
| 30 | BK36-02 | Ordovicien Terminal à Silurien | 45 | 11,61 | 3,50 | 218,6 | 374 | 26,9 | 5,92 | 85 | 31/10/13 | 15,65 | 98,33 | 1,655 | 0 | 54,9 | 1,085 | 6,545 | 6,56 | 51 | 235,725 | 4,82 | <0,02 | -25,8 | 0,7 | -5,0 | 0,1 | | | | | | | |
| 31 | BK37-02 | Ordovicien Terminal à Silurien | 50 | 11,58 | 3,51 | 204,7 | 138 | 26,8 | 6,08 | 155 | 31/10/13 | 0 | 0 | 0,162 | 0 | 79,3 | 0,641 | 3,715 | 2,243 | 23,176 | 109,237 | 4,11 | <0,02 | -26,0 | 0,8 | -4,6 | 0,2 | | | | -14,37 | 86,27 | 0,36 | Groningen |
| 32 | BK38-02 | Ordovicien Terminal à Silurien | 10,45 | 11,56 | 3,51 | 203,3 | 123 | 26,3 | 6,24 | 60 | 31/10/13 | 5,618 | 17,53 | 0,9 | 0 | 36,6 | 3,77 | 3,88 | 4,056 | 10,02 | 82,374 | 4,64 | <0,02 | -23,3 | 0,5 | -4,4 | 0,2 | | | | | | | |
| 43 | BK39-02 | Ordovicien Terminal à Silurien | 41,7 | 11,65 | 3,39 | 209,1 | 37 | 25,7 | 5,8 | 122 | 05/12/13 | 1,88 | 12,72 | 0,793 | 0 | 6,1 | 4,443 | 1,028 | 0,7 | 2,63 | 30,294 | 1,31 | <0,02 | -26,0 | 1,2 | -4,6 | 0,1 | | | | | | | |
| 44 | BK41-02 | Cambro Ordovicien | | 10,96 | 3,40 | 294,5 | 13 | 24,3 | 6,64 | 183 | 04/12/13 | 0,52 | 0,68 | 0,21 | 0 | 9 | 1,059 | 0,486 | 0,47 | 1,724 | 14,149 | 1,74 | <0,02 | -24,0 | 0,6 | -4,3 | 0,2 | | | | | | | |
| 45 | BK42-02 | Cambro Ordovicien | 9,1 | 10,93 | 3,55 | 310 | 429 | 24,6 | 5,89 | 488 | 04/12/13 | 27,9 | 112,05 | 13,25 | 0 | 18,3 | 13,815 | 38,43 | 8,41 | 23,205 | 255,36 | 2,82 | 0,03 | -20,1 | 0,9 | -3,0 | 0,2 | | | | | | | |

## Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, presented for the Benin Basin (Campaign 2)

| N° | Code | Aquifère | depth | Latitude | Longitude | Alt (m) | CE mS/cm | T°C | pH | Alcalinité mg/l | Sampling Date | $Cl^-$ (mg/l) | $NO_3^-$ (mg/l) | $SO_4^{2-}$ (mg/l) | $CO_3^{2-}$ (mg/l) | $HCO_3^-$ (mg/l) | $Na^+$ (mg/l) | $K^+$ (mg/l) | $Mg^{2+}$ (mg/l) | $Ca^{2+}$ (mg/l) | TDS (mg/l) | $SiO^{2+}$ | Fe | $\delta^2H$ (‰ vs Smow) | $^2H$_ERR | $\delta^{18}O$ (‰ vs Smow) | $^{18}O$_ERR | $^3H$ | $^3H$_ERR | $^3H$_Lab | $^{13}C$ | $^{14}C$ | 14C_ERR | 14C_Lab |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | BK43-02 | Ordovicien Terminal à Silurien | | 10,94 | 3,68 | 265,9 | 47 | 26,1 | 5,99 | 671 | 04/12/13 | 0,29 | 0 | 0,147 | 0 | 28,5 | 0,865 | 4,282 | 2,041 | 3,957 | 40,082 | 7,93 | <0,02 | -23,7 | 1,1 | -3,9 | 0,2 | | | | | | | |
| 47 | BK44-02 | Ordovicien Terminal à Silurien | 9,65 | 10,93 | 3,69 | 178,5 | 1278 | 24,9 | 6,11 | 610 | 04/12/13 | 135,65 | 344,07 | 5,88 | 0 | 48 | 69,13 | 36,4 | 37,02 | 85,4 | 761,55 | 5,95 | <0,02 | -21,6 | 1,0 | -3,6 | 0,2 | | | | | | | |
| 48 | BK45-02 | Ordovicien Terminal à Silurien | 36,5 | 10,91 | 3,69 | 194,5 | 47 | 26,4 | 6,05 | 671 | 04/12/13 | 0,465 | 0,3 | 0,44 | 0 | 30,5 | 1,107 | 4,874 | 1,584 | 3,8 | 43,07 | 6,98 | <0,02 | -23,7 | 1,1 | -4,3 | 0,2 | | | | | | | |
| 49 | BK46-02 | Cambro Ordovicien | 43 | 11,03 | 3,55 | 270,8 | 13 | 25,5 | 5,72 | 122 | 04/12/13 | 0,64 | 1,188 | 0,363 | 0 | 6,1 | 1,3 | 0,22 | 0,44 | 0,9 | 11,151 | 5,24 | <0,02 | -24,9 | 0,6 | -4,3 | 0,2 | | | | | | | |
| 50 | BK47-02 | Cambro Ordovicien | 9,2 | 11,03 | 3,55 | 171 | 23 | 24,9 | 5,84 | 366 | 04/12/13 | 2,112 | 2,907 | 0,866 | 0 | 12,2 | 2,56 | 0,45 | 0,53 | 3,72 | 25,345 | 4,54 | <0,02 | -26,9 | 1,2 | -4,8 | 0,2 | | | | | | | |
| 51 | BK48-02 | Ordovicien Terminal à Silurien | 43,2 | 11,24 | 3,45 | 179,1 | 20 | 25,1 | 5,81 | 244 | 04/12/13 | 0,701 | 0,848 | 0,391 | 0 | 12,2 | 3 | 0,745 | 0,51 | 1,24 | 19,635 | 5,43 | <0,02 | -23,2 | 0,8 | -4,5 | 0,1 | | | | | | | |
| 52 | BK49-02 | Ordovicien Terminal à Silurien | 7,1 | 11,24 | 3,45 | 183,9 | 79 | 23,1 | 6,03 | 488 | 04/12/13 | 4,374 | 17 | 1,5 | 0 | 18,3 | 6,092 | 3,31 | 0,85 | 7,6 | 59,026 | 5,28 | <0,02 | -24,8 | 1,0 | -4,9 | 0,2 | | | | | | | |
| 53 | BK50-02 | Ordovicien Terminal à Silurien | 13,8 | 11,12 | 3,38 | 305 | 324 | 24,7 | 6,48 | 2684 | 04/12/13 | 8,538 | 49,228 | 5,012 | 0 | 103,7 | 6,72 | 6,032 | 7,36 | 39,46 | 226,05 | 5,18 | <0,02 | -23,4 | 0,9 | -4,3 | 0,2 | | | | | | | |
| 55 | BK53-02 | Cambro Ordovicien | 26 | 11,03 | 3,11 | 272,2 | 22 | 23,7 | 6,28 | 305 | 06/12/13 | 1,073 | 4 | 0,3 | 0 | 12,2 | 1,47 | 1,16 | 1,21 | 2,39 | 23,803 | 2,45 | <0,02 | -24,9 | 0,8 | -4,5 | 0,2 | | | | -11,59 | 89,32 | 0,37 | Groningen |
| 56 | BK54-02 | Cambro Ordovicien | | 11,05 | 3,07 | 266,6 | 46 | 24,5 | 6,06 | 671 | 06/12/13 | 1,167 | 0,792 | 1,408 | 0 | 24,4 | 2,54 | 2,87 | 1,82 | 2,6 | 37,597 | 5,28 | <0,02 | -23,9 | 0,8 | -4,4 | 0,2 | | | | -11,26 | 81,14 | 0,35 | Groningen |
| 34 | BK55-02 | Cambro Ordovicien | 60 | 11,12 | 2,97 | 296,3 | 27 | 25,1 | 6,31 | 30 | 30/10/13 | 0,467 | 0,672 | 0,854 | 0 | 18,3 | 2,03 | 1,58 | 1 | 2,92 | 27,823 | 3,39 | <0,02 | -24,2 | 1,1 | -4,7 | 0,1 | | | | | | | |
| 57 | BK57-02 | Cambro Ordovicien | 16,05 | 11,18 | 3,06 | 259,3 | 343 | 24 | 6,48 | 1891 | 06/12/13 | 18 | 61,85 | 16 | 0 | 79,3 | 9,6 | 18,2 | 10,7 | 33,65 | 247,3 | 4,94 | <0,02 | -22,8 | 0,5 | -4,6 | 0,1 | | | | | | | |
| 58 | BK59-02 | Cambro Ordovicien | 28 | 11,34 | 3,27 | 224,7 | 19 | 26,1 | 6,68 | 183 | 05/12/13 | 5,499 | 5,084 | 3,635 | 0 | 6,1 | 3,7 | 1,61 | 1,02 | 2,5 | 29,148 | 3,84 | <0,02 | -22,2 | 1,0 | -4,3 | 0,2 | < 1.3 | | ISODETECT | -13,47 | 101,45 | 0,41 | Groningen |
| 35 | BK61-02 | Cambro Ordovicien | | 10,73 | 2,98 | 303,2 | 141 | 26,4 | 6,64 | 40 | 30/10/13 | 8,48 | 25,5 | 6,707 | 0 | 18,3 | 5,22 | 11,78 | 3,06 | 8,58 | 87,627 | 2,49 | <0,02 | -22,6 | 1,0 | -4,5 | 0,1 | | | | | | | |
| 36 | BK62-02 | CI | 8 | 10,73 | 2,98 | 304,4 | 2906 | 25,4 | 6,36 | 845 | 30/10/13 | 249,78 | 765,08 | 131,24 | 24 | 298,9 | 129,34 | 285,4 | 67,54 | 208,8 | 2160,08 | 3,92 | <0,02 | -18,5 | 0,8 | -3,5 | 0,2 | | | | | | | |
| 38 | BK64-02 | Cambro Ordovicien | 42,92 | 10,72 | 2,79 | 328,6 | 213 | 26,3 | 6,72 | 305 | 30/10/13 | 2,202 | 1,218 | 1,802 | 6 | 115,9 | 12,26 | 5,28 | 9,08 | 20,252 | 173,994 | 10,25 | <0,02 | -21,5 | 1,2 | -4,2 | 0,2 | | | | | | | |
| 39 | BK73-02 | Cambro Ordovicien | 1,9 | 11,13 | 2,94 | 276,3 | 88 | 24,4 | 6,8 | 40 | 02/12/13 | 8,45 | 10,878 | 3,224 | 0 | 24,4 | 7,786 | 7,43 | 1,78 | 3,8 | 67,748 | 5,84 | 0,224 | -21,5 | 0,9 | -3,9 | 0,2 | | | | | | | |
| 37 | BK63-02 | Socle Panafricain | 22 | 10,69 | 2,84 | 335,2 | 339 | 26,5 | 6,5 | 410 | 30/10/13 | 11,715 | 6,5 | 4,6 | 18 | 158,6 | 22,4 | 7,1 | 13,195 | 34,5 | 276,61 | 10,8 | <0,02 | -22,4 | 0,5 | -4,3 | 0,1 | | | | | | | |
| 60 | BK66-02 | Socle Panafricain | 45,3 | 10,84 | 3,75 | 319 | 350 | 25,3 | 7,29 | 5368 | 03/12/13 | 8,5 | 11 | 10 | 12 | 183 | 21,85 | 5,75 | 14,85 | 40,15 | 307,1 | 11,55 | <0,02 | -26,6 | 1,1 | -4,2 | 0,2 | | | | | | | |
| 61 | BK67-02 | Socle Panafricain | 7,1 | 10,29 | 3,47 | 397,4 | 696 | 24,6 | 6,67 | 3416 | 02/12/13 | 53,705 | 149,34 | 12,965 | 0 | 85,4 | 40,315 | 60,35 | 14,25 | 33,9 | 450,225 | 3,08 | <0,02 | -21,4 | 0,7 | -3,1 | 0,1 | | | | | | | |
| 62 | BK69-02 | Socle Panafricain | 12,92 | 10,37 | 3,22 | 329 | 1283 | 24,6 | 6,75 | 5246 | 02/12/13 | 160,87 | 255,71 | 35,51 | 6 | 136,2 | 76,3 | 65,8 | 34,4 | 92,5 | 863,29 | 10,67 | <0,02 | -21,6 | 0,3 | -3,3 | 0,1 | | | | | | | |
| 63 | BK70-02 | Socle Panafricain | 43,59 | 10,37 | 3,22 | 323,2 | 704 | 25,9 | 6,87 | 6710 | 02/12/13 | 49,88 | 109,135 | 15,7 | 12 | 164,7 | 27,75 | 6,55 | 23,6 | 61,35 | 470,665 | 12,4 | <0,02 | -23,1 | 0,9 | -3,8 | 0,1 | | | | | | | |
| 64 | BK71-02 | Socle Panafricain | 4,65 | 10,36 | 3,15 | 304 | 390 | 24,5 | 7,03 | 5612 | 02/12/13 | 26,285 | 30,215 | 10,505 | 6 | 134,2 | 30,2 | 8,75 | 6 | 37,4 | 289,555 | 12,35 | <0,02 | -22,4 | 0,5 | -3,8 | 0,2 | | | | | | | |
| 65 | BK72-02 | Socle Panafricain | 43,66 | 10,36 | 3,15 | 309,3 | 841 | 24,5 | 6,88 | 10370 | 02/12/13 | 75,595 | 75,655 | 32,715 | 6 | 256,2 | 49,5 | 10,5 | 21,98 | 90 | 618,145 | 12,66 | <0,02 | -20,7 | 1,0 | -3,8 | 0,2 | | | | | | | |
| 66 | BK77-02 | Socle Panafricain | | 10,40 | 3,58 | 330,3 | 175 | 25,2 | 6,88 | 4026 | 02/12/13 | 2,604 | 0,2 | 0 | 0 | 103,7 | 13,178 | 3,88 | 5,55 | 12,3 | 141,412 | 11,18 | <0,02 | -22,2 | 0,7 | -4,0 | 0,1 | 2,2 | 0,7 | | | | | |
| 67 | BK78-02 | Socle Panafricain | | 10,21 | 3,14 | 344,3 | 383 | 24,3 | 7,16 | 7747 | 02/12/13 | 11,222 | 0,2 | 2,546 | 12 | 183 | 28,4 | 4,4 | 6,06 | 32 | 279,828 | 9,15 | <0,02 | -22,0 | 1,0 | -3,8 | 0,1 | 3,1 | 0,7 | | | | | |
| 68 | BK79-02 | Socle Panafricain | | 10,54 | 2,73 | 329,1 | 385 | 24,7 | 7,2 | 5856 | 03/12/13 | 26,605 | 28,19 | 8,92 | 12 | 140,3 | 24 | 5,25 | 14 | 36,5 | 295,765 | 8,42 | <0,02 | -22,2 | 1,1 | -3,7 | 0,2 | 2,5 | 0,7 | | | | | |
| 69 | BK80-02 | Socle Panafricain | 16,18 | 10,45 | 2,82 | 301,5 | 609 | 24,3 | 7,13 | 4026 | 03/12/13 | 38,455 | 145,705 | 15,96 | 0 | 110 | 33,35 | 24,3 | 16 | 54,5 | 438,27 | 17,19 | <0,02 | -21,3 | 1,1 | -3,7 | 0,1 | | | | | | | |
| 71 | BK82-02 | Socle Panafricain | 15,97 | 10,67 | 2,67 | 341,3 | 549 | 24,4 | 7,14 | 2928 | 03/12/13 | 48,995 | 121,78 | 9,665 | 12 | 122 | 27,86 | 9,02 | 27 | 52 | 430,32 | 9,41 | <0,02 | -21,3 | 0,6 | -3,6 | 0,1 | | | | | | | |
| 73 | BK84-02 | Socle Panafricain | | 10,98 | 3,28 | 242 | 218 | 23,6 | 6,29 | 366 | 04/12/13 | 18,88 | 58,57 | 5,6 | 0 | 12,2 | 8,966 | 16,084 | 3,832 | 12,702 | 136,834 | 1,73 | <0,02 | -23,2 | 1,2 | -3,9 | 0,1 | | | | | | | |

## Field, hydrochemical and isotope data generated in the framework of the project RAF/7/011, presented for the Benin Basin (Campaign 3)

| N° | Code | Aquifère | depth | Latitude | Longitude | Alt (m) | CE µS/cm | T°C | pH | Sampling Date | $Cl^-$ (mg/l) | $NO_3^-$ (mg/l) | $SO_4^{2-}$ (mg/l) | $CO_3^{2-}$ (mg/l) | $HCO_3^-$ (mg/l) | $Na^+$ (mg/l) | $K^+$ (mg/l) | $Mg^{2+}$ (mg/l) | $Ca^{2+}$ (mg/l) | TDS (mg/l) | $\delta^2H$ (‰ vs Smow) | $^2H$_ERR | $\delta^{18}O$ (‰ vs Smow) | $^{18}O$_ERR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BK86-03 | | | 11,86 | 3,42 | 156.2 | 71 | 32.4 | 7,13 | 03/04/2016 | 0,89 | < 0,01 | 0,31 | < 0,01 | 30,50 | 2,54 | 1,67 | 1,83 | 3,87 | 41,61 | -20,10 | 1,42 | -2,96 | 0,15 |
| 2 | BK87-03 | Ordovicien Terminal à Silurien | 44.9 | 11,79 | 3,48 | 176.4 | 15 | 32 | 6,98 | 04/04/2017 | 1,03 | 2,66 | 0,18 | < 0,01 | 4,00 | 1,66 | 0,57 | 0,19 | 0,53 | 10,82 | -23,48 | 1,10 | -3,83 | 0,16 |
| 3 | BK88-03 | Cambro Ordovicien | 52 | 11,85 | 3,21 | 172.6 | 270 | 33.7 | 7,95 | 04/04/2017 | 1,58 | 4,39 | 4,93 | < 0,01 | 146,40 | 22,46 | 4,95 | 4,44 | 19,77 | 208,92 | -25,61 | 1,05 | -3,83 | 0,19 |
| 4 | BK89-03 | Cambro Ordovicien | 76 | 11,84 | 3,23 | 174 | 437 | 33 | 7,85 | 04/04/2017 | 33,14 | 10,64 | 9,20 | < 0,01 | 183,00 | 67,06 | 3,80 | 9,06 | 15,15 | 331,05 | -33,81 | 0,53 | -4,28 | 0,19 |
| 5 | BK90-03 | Ordovicien Terminal à Silurien | 54.79 | 11,80 | 3,52 | 162.7 | 135 | 33.4 | 7,52 | 03/04/2016 | < 0,01 | < 0,01 | 0,91 | < 0,01 | 73,20 | 1,38 | 3,59 | 2,75 | 18,44 | 100,27 | -38,62 | 1,20 | -5,48 | 0,19 |
| 6 | BK91-03 | Ordovicien Terminal à Silurien | 49.9 | 11,79 | 3,52 | 160.5 | 51 | 33.4 | 6,85 | 03/04/2016 | 0,10 | < 0,01 | < 0,01 | < 0,01 | 30,50 | 1,12 | 1,39 | 0,82 | 6,08 | 40,01 | -29,55 | 0,90 | -4,67 | 0,17 |
| 7 | BK92-03 | Ordovicien Terminal à Silurien | 54.94 | 11,75 | 3,52 | 168.4 | 231 | 32.2 | 6,97 | 03/04/2016 | 0,42 | < 0,01 | 2,05 | < 0,01 | 134,20 | 1,97 | 4,86 | 3,99 | 35,01 | 182,51 | -43,36 | 1,33 | -6,07 | 0,16 |
| 8 | BK93-03 | Ordovicien Terminal à Silurien | 61 | 11,69 | 3,44 | 169.7 | 17 | 34.2 | 7,35 | 03/04/2016 | 0,38 | 0,35 | < 0,01 | < 0,01 | 9,80 | 1,84 | 0,67 | 0,28 | 1,24 | 14,56 | -25,92 | 1,19 | -4,52 | 0,12 |
| 9 | BK94-03 | | | 11,81 | 3,40 | 165.4 | 41 | 35 | 7,12 | 03/04/2016 | 0,85 | 0,23 | < 0,01 | < 0,01 | 21,20 | 1,98 | 1,65 | 0,87 | 3,44 | 30,22 | -19,89 | 1,13 | -2,72 | 0,11 |
| 10 | BK95-03 | | | 11,82 | 3,40 | 162.6 | 38 | 34.2 | 7,21 | 03/04/2016 | 0,67 | < 0,01 | 0,37 | < 0,01 | 21,20 | 1,89 | 1,69 | 0,89 | 3,49 | 30,39 | -19,52 | 1,23 | -3,81 | 0,12 |
| 11 | BK96-03 | | | 11,84 | 3,40 | 159.1 | 39 | 33.1 | 7,16 | 03/04/2016 | 0,46 | < 0,01 | < 0,01 | < 0,01 | 21,20 | 1,78 | 1,60 | 0,92 | 3,41 | 29,36 | -22,33 | 1,16 | -4,49 | 0,12 |
| 12 | BK97-03 | | | 11,78 | 3,39 | 168.5 | 38 | 31.9 | 8,25 | 04/04/2016 | 0,89 | < 0,01 | 0,23 | < 0,01 | 18,90 | 1,86 | 1,65 | 0,88 | 3,37 | 27,78 | -21,30 | 1,07 | -3,64 | 0,07 |
| 13 | BK98-03 | Cambro Ordovicien | 52 | 11,88 | 3,22 | 171.8 | 253 | 33.5 | 7,95 | 04/04/2016 | 1,13 | 0,62 | 4,99 | < 0,01 | 140,30 | 16,43 | 5,06 | 5,89 | 22,06 | 196,48 | -31,28 | 1,47 | -5,55 | 0,16 |
| 14 | BK99-03 | Cambro Ordovicien | 52.8 | 11,85 | 3,21 | 170.5 | 265 | 34.4 | 8,10 | 04/04/2016 | 0,61 | < 0,01 | 4,84 | < 0,01 | 140,30 | 24,95 | 5,67 | 3,38 | 15,51 | 195,26 | -31,94 | 1,45 | -4,79 | 0,19 |
| 15 | BK100-03 | Cambro Ordovicien | 61 | 11,84 | 3,22 | 172.2 | 313 | 33.3 | 7,79 | 04/04/2016 | 4,64 | < 0,01 | 7,05 | < 0,01 | 152,50 | 25,97 | 4,80 | 5,03 | 20,72 | 220,70 | -29,16 | 1,33 | -4,40 | 0,16 |
| 16 | BK101-03 | | | 11,85 | 3,41 | 157.5 | 42 | 32.3 | 7,21 | 05/04/2016 | 0,78 | < 0,01 | 0,09 | < 0,01 | 21,20 | 1,96 | 1,80 | 0,94 | 3,60 | 30,37 | -18,27 | 1,48 | -3,00 | 0,19 |