EDITORIAL

Hill- Piper diagram for drinking water quality in Ingessana area - Blue Nile State, Sudan.

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)
(1) Faculty of engineering, department of Science. Blue Nile University, Damazein, Sudan. Email: **Author E-mail:** youseifadam@gmail.com

(2) Department of Applied Chemistry and Chemical Technology, Faculty of Engineering and Technology, University of Gezira, Sudan.

Abstract

This study, aims to assess the effect of mineralization on drinking water quality and its visages in Ingessana area, which is located in the southwestern part of the Blue Nile State (Sudan). Forty drinking water samples from various sources in the study area were collected during four seasons, and then analyzed, using atomic absorption spectrometer, Flame photometer, UV spectrophotometer and conventional titration methods. Different computer software's were used to interpret data as Aquachem. The results showed that calcium, and magnesium, were the main predominant cations in the samples, while bicarbonate and chloride were the dominant anions in wet and dry seasons. Calcium, magnesium and bicarbonate are due to the presence of marble, calcite CaCO3, dolomite CaCO3, Mg (CO_3), aragonite, gabbros, and schist in under saturated state. Calcium chloride and bicarbonate indicate the presence of dolomite, aragonite, halite (NaCl), magnsite, gypsum and carbonate rocks as an interfere layers in the study area. These minerals occur in the fractured zone in study area. The Hill-Piper result shows that, all groundwater visages in wet seasons are normal earth alkaline and alkaline with prevailing bicarbonate, while in dry season is earth alkaline with increased portion of alkalis in water and the processes that control these visages are ion exchange and simple dissolution or mixing processes. Comparing the results with (WHO) standard, calcium, magnesium and lead are of higher levels than (WHO) drinking water standard. This may be due to mineralization in the study area. There is an impossibility to determine the effect of these augment on native's health, because most of them are medicated by traditional medicines. As a final result most of drinking water in the area of study needs treatment before use

. **Key words**: Mineral in water, water classification, drinking water standard, some trace elements. 2

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

1. Introduction;-

Water is the major chemical component of living systems and a universal solvent. It is the principal medium for metabolic processes (1) (Nason, 1965). Water that exists today has been on earth for billions of years. It covers four-fifth of our world (2). (Armand,1965). But less than 1 % of it is fresh and/ or drinkable water. Drinking water is defined as water intended primarily for human consumption, but which has other domestic uses, it may be consumed directly as it comes from source, or indirectly in beverages or food prepared with water, or with other uses as bathing and swimming. The water in environment can generally be characterized as a dilute aqueous solution, containing a large variety of organic and inorganic chemical substances, dissolved and suspended. The qualitative and quantitative compositions of these substances reveal the nature of particular environmental problem in drinking water (3) (Leonard, 1991). To an important extent, the chemical composition of waters is determined by the composition of rocks it is abstracted from, depending on geochemical processes however, similar types of rocks may lead to different types of minerals in water. The concentration of most components increases with respect to the original composition of aquifers in which water stays as stagnant. The water chemistry highly depends on the availability of mineralizing agents, such as temperature, CO_2 concentration, redox conditions and the type of adsorption complex(4).(Zuurdeeg, and et al, 1985). It makes up to about 70 percent of human body weight. All forms of life need water to survive. It is the only substance on earth that is naturally present in all three forms of liquid, solid, and gas. 3

EDITORIAL

Hill- Piper diagram for drinking water quality in Ingessana area - Blue Nile State, Sudan.

Water quality is determined as the presence and quantity of contaminables by physical or chemical factors, as pH and conductivity, by number of salts present and by the presence of nutrients. One basic measure of water quality is the total dissolved solids (TDS), which is the total amount of solid in milligrams per liter that remains when a water sample is evaporated to dryness(5) (WHO,Geneva,1993). A wide range of compounds or constituents can potentially be found in water and affect its quality. They fall into several categories; physical and chemical including inorganic and organic compounds (6). (WHO, 2006). Drinking water should be conforming to the following water quality characteristics: Free from pathogens organisms, clear (i.e. colorless; low turbidity), Less saline. (Salty).free from compounds that cause changing to the taste and odor and make it unpalatable, free from compounds that have adverse effects on human health, Low in concentrations of compounds that are acutely toxic or that have serious long – term effects on human health such as lead and Free from chemicals, which may stain clothes washed in it(7). (CEHA), Nicosi, 1993).The study area lies on a basement terrain encompassing a mineralization zone or belt, which is possibly a source of trace elements. This may signify that ground water hosted in these basement rocks may leach trace elements in situ and /or transported. The presence of trace elements such as: Cr, As, Pb, Mn, Cd …etc. is known to be health hazardous to human health. Most of the water supply systems in this area are hand pumps which abstract water from fractured basement rocks where water lies as stagnant water in contact with interference different rock layers. The Ingessana area is known of its mineralization; including trace elements, as water is hosted and move through these rocks, it may interact with mineral containing rocks, so the water consequently is effected by solute minerals. 4

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

On the other hand; springs are second sources of surface water in the area, and in some locations, the artificial hollow (named Haffeira) is the other sources of seasonal drinking water, which depends on rainfall and area drainages. The seasonal khors in the area are originating from the high lands of the terrains and mostly aligned with fracture lines and springs trending towards southeast (SE). The Ingessana area is well-known by its heavy rainfalls which produce khors runoffs in flat areas. When water flow through these khors corrodes rocks and soils, dissolves, removes and deposits minerals and materials which may affect the chemical and physical properties of drinking water. This study has been carried out in Ingessana area, which is situated between; latitudes 11º .20¯N-11º.33¯N and longitudes 34º .03E -34º .10¯ E, in the western part of the Blue Nile State (Sudan). Its remote area is located about 70 Km at southeastern of El Damazein the capital of the state. It is limited from Baggies at northeastern part to Bau at southeastern part; the area is very sparsely populated. The area is inaccessible, especially during the rainy period from May to October, in dry season it is accessible through primitive unpaved roads. It lies within the rich Savanna climate, which is characterized by its high rainfall in autumn and high temperature during summer (May – Nov.). It has warm climate, the temperature reachs 40 °c in the daytime and decreases at night. The rainy season starts as early as May and extends up to end of November. The average annual rainfall is around 800-1000 millimeters reaching its peak in august and September. The travel to the area becomes impossible during the rainy season. The area shown in map Fig (1). 5

EDITORIAL

Hill- Piper diagram for drinking water quality in Ingessana area - Blue Nile State, Sudan.
Fig. (1) Sampling map. 6

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

2- MATERIAL AND METHODS:-

A total of 40 samples were collected from different locations, at different seasons from the study area.(Fig.1). Their pH and temperature were recorded at sampling points, most of samples taste brackish to saline. The samples were saved for laboratory examinations to determine its physical and chemical parameters including, EC, pH, TDS, total hardness, chloride, CaCO3 , Sulphate, Fluoride , Sodium, Calcium, Iron, lead ,Manganese, Magnesium , standard procedures were used for the experimental tests. The results were compared with (WHO) drinking water guideline. Physical and chemical parameters were analyzed using the standard method suggested by(8) APHA (1985). EC and pH were determined as insitu using field kit. TDS was calculated from EC by empirical formula TDS= 0.64*EC. Chloride, hardness, nitrate, carbonate and bicarbonate, were determined by traditional titration. Flame photometer was used to measure the sodium and potassium, sulphate, magnesium, calcium and other trace elements were determined by spectrophotometer. Analytical precision was maintained throughout the experiments. Aquachem. version 3.6 software package was used to plot the piper diagrams.

3- Results and discussion:-

All the water samples were mainly collected from hand pumps (groundwater), spring and surface water (huffier), surrounded by plants, trees or rocks. The values of the physical and chemical parameters in the four seasons are tabulated in table (1), which indicates that the results of analysis in the first and second dry seasons (A, B) show a high level of EC, very hard (> 300 mg/l), with a high concentration of Ca^{+2}, Mg^{+}, exceeding 7

EDITORIAL

the WHO admissible levels (200 – 150 mg/l) respectively, with a high TDS in most samples. The results of analysis in first and second wet seasons (C, D) in table 1, show high EC levels of most samples with moderate to high hardness and high concentrations of Ca^{+2} , Mg^{+2} and lead (Pb), that exceed WHO admissible levels.

Ground water has a wide range of chemical composition, as a result of the interaction between the groundwater and rocks it flows through. This interaction may be dissolved inorganic matter with low quantity that contributes in ground water (9),(Freeze & Cherry; 1979). In order to get a better understanding of hydro chemical processes responsible for groundwater or water from rocky areas, the water should first be classified into more types. Hill- Piper diagram have been used to illustrate and discuss the results. The Hill –Piper diagram is used to interpret hydro- geochemical facies(10),(Piper; 1953). Which plots include two triangles, one for plotting cations and the other for anions. The cations and anions fields are combined to show a single point in diamond- shaped field, from which inference is drawn on the basis of hydro- geochemical facies concept. These tri- linear diagrams are useful in bringing out chemical relationships among ground water samples in more definite terms rather than with other possible plotting methods. The results of chemical analysis of water samples were plotted on piper diagrams Fig :(2, 3, 4, 5) for the four seasons. The first dry season samples diagram (Fig 2) show that most of water samples are normal earth alkaline with bicarbonate and sulphate plus chloride. That is the case in all samples except samples 7, 8, and 9 which show earth alkaline with increased portion of alkalis dominated by calcium and bicarbonate. Thus the water exhibits non- carbonate permanent hardness. 8

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

Fig (2): Hill- piper diagram for first dry season parameters.

In second dry season samples, the Piper diagram was plotted as in Fig (3), which show that most of samples are dominated by cations of Ca^{+2}, Mg^{+2} and anions of Cl^{-}, HCO_3^{-}. These indicate that most of water samples are located in alkaline earth and exhibits non-carbonate permanent hardness.

Fig (3) Hill- piper diagram in second dry season parameters 9

EDITORIAL

Hill- Piper diagram for drinking water quality in Ingessana area - Blue Nile State, Sudan.

For the other two wet seasons parameters of water samples are shown in Figs (4, 5), which show that the above results repeated as shown below. According to these results the water samples were dominated by Ca^{+2}, Mg^{+2} as cations, and Cl^{-}, HCO_3^{-}.as anions. Thus, most of samples exhibit earth alkaline with increased portion of alkalis with prevailing bicarbonate.

Fig (4) Hill- Piper diagram in first wet season parameters

Fig (5) Hill- Piper diagram in second wet season parameters 10

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

4- conclusion:-

In the present study all the samples are confined to a, b, c and e fields in Hill- Piper (see Fig.5) in all seasons. A majority of samples are plotted in fields representing Ca – Mg – Cl – HCO_3 as dominant types, sometime Na – Mg – HCO_3 as in sample No. 6 in second dry season. The results of the hydrochemistry suggest that all water samples are alkaline in nature. Major processes that control the water quality in the area are mineral dissolution, cation exchange, inverse cation exchange or mixing processes. Topographical undulations of the area and ground water flow were identified as the other supporting factors for the hydrochemical processes. Groundwater types were assessed that most of water samples were (Ca – Mg- Cl or Ca- Mg-HCO_3) types in all seasons. However, in dry seasons water samples including (Ca^{+2} – Mg^{+2} – Cl^- -HCO_3^-) types which found in most samples, and (Na^+- Mg^{+2} –HCO_3^-) which belonging to the normal earth alkaline with prevailing bicarbonate. From all the above, water samples has pointed to the probable presence of the minerals in fracture zones in the study area as calcite ($CaCO_3$), delaminate (Ca Mg $(CO_3)_2$), halite (NaCl), magnetite ($MgCO_3$), anhydrite (CaSO4) and other rock types as granite(CaO, MgO, Na_2O) and magnesium ultra rock which contains about 31- 44% of magnesium. Generally; water quality in the study area is affected by mineralization and associated minerals in the basement rocks. Commonly, the present parameter results such as: TDS, hardness (Ca, Mg) are of higher levels than WHO standards. The low levels of some minerals which appeared in some water samples suggest that they may be sampled from non-mineralization areas (sandstone aquifers).

5-ACKNOWLEDGEMENT:-

The author wishes to express his thanks to Dr. Musa Eltayeb Babiker, Dr. Kheir Alla for the review and comments to the paper. 11

EDITORIAL

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2) 13

EDITORIAL

EDITORIAL

Youseif. A. H. Adam*(1), Mohammed Osman Babiker(2), Fatah Elrahaman Abass(2)

6- REFERENCES:-

1- NASON. ALVIN. (1985)," modern biology", Harper Collinns publisher INC., New York.
2- Armand. Louis. (1965)." water treatment - Hand Book". Stephen Austin & SONS LTd, Caxton Hill, Rotterdam. great Britain., 3- Leonard Cicco, (1991)."Water and water pollution Handbook. "Volume1 Marcel,Dekkr, INC. New York.
4- Zuurdeeg,BW, Weiden. MJJ van der,(1985)"Geochemical aspects of European botted water. In:Geochemics thermal- mineral waters and hydrogeology. Theopgrastus publications S.A.Athens.
5- WHO,(1993)."Guideline for drinking water quality." 2nd. Ed.,Geneva.
6- WHO.,(2006).,"Guideline of drinking water quality.," volume1, recommendations, 3rd Ed., Geneva.
7- CEHA.,(1993).,"Fire, wood, water reaping the benefits". United Nations Environmental Health Activities, Nicosia.
8- American Public Health Association (APHA)., (1985).,"Standard methods for examination of water and waste water. Washington, DC, USA; . 16th ed.
9- Freeze, R.A., Cherry. J.A., (1979)."Groundwater" prentice-Hall, Inc, Englewood cliffs.Nj.
10- Piper, A.M.,(1953)., "Graphic procedure I, The geo-chemical interpretation of water analysis, USGS groundwater Note NO.1953,-12. 15

EDITORIAL

Hill- Piper diagram for drinking water quality in Ingessana area - Blue Nile State, Sudan.

APPENDEX (1)

Fig. (6): Explanation of Hill- Piper diagram and water type.

Water types

Normal earth alkaline

a- With prevailing bicarbonate

b- With prevailing bicarbonate and sulfate or chloride.

c- with prevailing sulfate or chloride

Earth alkaline water with increase portion of alkalis

d- With prevailing bicarbonate.

e- With prevailing sulfate and chloride.

Alkaline water

f- With prevailing bicarbonate.

g- With prevailing sulfate – chloride. 16

EDITORIAL

2016 هـ 1437المجل الحاد د عشر ي العد ، الاو د يرل للهندس ة والعلو ة التطبيقي م ة مجل ال ة جز

الخلاصة

ة ي منطق ا ف ب ومحياه هـ الشر ة ميا ى جود ن عل ر التمعد م أث د وتقيي ة لتحدي اس در هـ ال ف هذ تهد هـ ة ميا ن عين ت أربعو . جمع ق(السودان)ل الأزر ة الني ي لولاي ي الغرب ء الجنوب ي الجز ة ف ، الواقع الانقسنا ء أربع ة أثنا اس در ة ال ي منطق ة ف ر مختلف ن مصاد ب م شر ل ة فصو مختلفة ز ل جها ت باستعما م حلل . ث ا ص لامتصا ة ق المعاير ة وطر ق البنفسجي ة فو ص الأشع ز امتصا ى وجها ف اللهب ، والمطيا الذري التقليدية، ة م لترجم م الاكواكي وباستخدا و ت ل البيانا تحلي . و ن م ال ، نتائج م ح الكالسيو ن املا د ا وج ت ت كان ت والكلوريدا ا البيكربونا ، بينم ي العينات ة ف ة الرئيسي ح السائد ت الأملا ، كان والمغنيسيوم . و ة والجافة ل الرطب ي الفصو ة ف ت المهيمن الانيونا د ى وجو يعز ت م والبيكربونا م والمغنيسيو الكالسيو ي إل ، والارجينتنا م ،الدولمايت د الرخا وجو د ة. وكلوري ت المشبع ة تح ي الحال ت ف ، والشيس ، والغابرو ت ي و س ، الجب ات يز ، ماغن ت ، الهالاي ن الدولميت ل م د ك ي وجو ن إل ا ير ت يش م والبيكربونا الكالسيو ق ة الشقو ي منطق ن ف ث هذاالمتعد . ويحد اسة در ة ال ي منطق ت ف ة الطبقا ة المتداخل ر الكربوني الصخو ي من ة ف الموجود ل م ا . وباستخدا اسة در ة ال طق Hill–Piperة ب بالمنطق هـ الشر ع ميا ل انوا ن ك ح ا اتضي ف .ا البيكربونات ة تسوده ة ارضي ة قلوي ت طبيع ة ذا ل الرطب الفصوا بينمي فة ة قلوي ل الجاف الفصوة ع زياد ة م ارضيي فة ت الكيميائي ن العمليا . وم القلوياتي التر تسيطا ا المحي ى هذ علي هت عملياو ط أ ل البسي ي والتحل ل الآيون التبادا ع ن م العمليتاة ة العالمي ة الصح ر هيئ ع معيا ج م ة النتائ . وبمقارن ة ة العالمي ة الصح ر هيئ ن معيا ى م ز اعل اكي تر ت ص ذا م والرصا م والمغنيسيو ، الكالسيو د ان وجك ن هنال لا ا . ا اسة در ة ال ي منطق ن ف ب التمعد ك بسب ن ذل ن يكو ل ا . ويحتم هـ الشرب هـ لميا ح ب المسموة استحالر هذ ر تأثي لتقدية . وكنتيج ة التقليدية ج بالأدوي م يتعال ن معظمه ، لأ ة المواطن ى صح ا عل ل الا ة قب ج ج لمعال ة تحتا اس در ة ال ي منطق ب ف هـ الشر ب ميا ن أغل د ا ة وج نهائي .ستعمال