Possible effects of mineralization and Lithological interactions on natural water of J. Ed Dair J. Dumbeir areas, North Kordofan State-Western Sudan

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Abstract

This paper studies possible effects of mineralization and water-Lithological interactions on natural water of J. Ed Dair – J. Dumbeir area, which is situated in Northern Kordofan state and is geographically considered to represent the northern parts of Nuba Mountains. This area is bounded by the coordinates: longitudes 30˚25´ -30˚ 55´ E and latitudes 12˚ 15´- 12˚ 55´ N . Samples of surface and underground water were collected from different localities during wet and dry seasons. Physical and Chemical analyses were performed in different laboratories according to standard methods. Seasonal variation of physico-chemical properties in j. Ed –Dair area were illustrated by drawing seasonal variation graphs and by comparing the data with WHO Standards. Analytical work shows that the constituents which significantly affect health of human being are not within the recommended value limits of the WHO guidelines, but still below the maximum values, except for fluorite and Cadmium in some localities. The suitability of the waters for irrigation purposes has been also studied in the area. Assessment of water chemistry was investigated by using different statistical techniques. We also have conducted geochemical modelling for groundwater interactions with the lithological unit.

Keywords: North Kordofan, Mineralization, water quality, Hydrochemistry.

1. Introduction

Depending on its origin, water usually contains a number of trace elements and dissolved minerals. Some of these elements are essential but there are standards and limits of element content in water; all trace elements are harmful if found in excess. In Sudan, pollution, especially water contamination, is considered to be one of the environmental problems. In Nuba Mountains, the inhabitants depend on surface and subsurface water. The subsurface water is usually shallow and the drain is mainly of crystalline basement complex. Therefore, mineralization in the area (e.g. hydrothermal mineralization and carbonitization) may contaminate these waters. The effect of this contamination has been observed by the previous researchers**. This paper aims to study the effect of natural contamination pollution due to effects of carbonitization and hydrothermal mineralization on waters in selected areas of Jabel Ed Dair –Jabel Dumbeir of Northern Kordofan in which carbonatization and anomalous radioactivity have been recorded***.

2. Climate

The climete of Northern Kordofan ranges from rich savanha to poor savanha, to semi desert; and to desert, hence it is locally rich savanha in the South to semi arid and arid in the North. Rainy seasons are the summer months between May and end of September. Annual rainfall ranges from 40 to 80 mm.

3. Water Resources in Ed Dair –Dumbeir area

Available water resources in this area are one or some of:

- Rainfall
- Surface Run-off
- Surface water
- Ground water

4. Lithological units

Field relations and petrographic studies indicate the following rock sequance from oldest to youngest down words for only Precamberian Basment Complex:

- Gneisses and schists
- Marble (metasediements)
- Calc –silicates and skarns
- Nepheline syanite
- Carbonatites

The first three rock types are the oldest rock of basement complex, while the rest from the younger basement (thus belonging to the anorogenic intrusives (El Raba'a and El Shargawi, 1972 ; Harris, et. Al 1983). Ed Dair area is cut by uraniferous fluorite veins, The mineralization magmatic solution was oversaturated in F, and had a considerable amount of strong chemical affinity to F, such as: U, Th, REE, Sr, Y, Ba, Ta, Zr, etc.) Khedir.A (1990). Part of this solution was originally sulphide in composition, which was rich in Fe, Cu, Zn, Pb.

5. Materials and Methods

The Water Samples were collected from Different places in the Morning Hours between 9 to 11am,52 water samples were collected in Polythene Bottles during wet and dray season **(**Nov.and July 2005). Physico-chemical Parameters like Water Temperature, pH were recorded imediatelly in the field.While other Parameters were analyzed in relaible labrotorys according to standard laboratory methods, A.P.H.A. , (1975 & 1984) .

computer software were used to analyze and interpret the results.

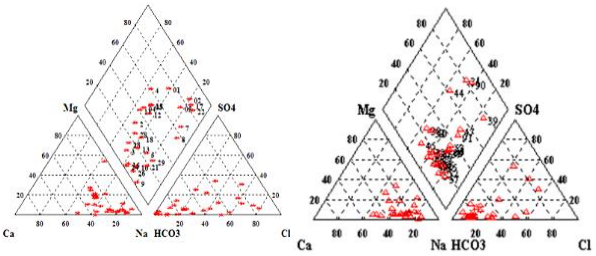
6. Hydrochemistry

This part of the study provides a geochemical and hydrochemical characteristics, genesis, types of the collected waters, and the suitability of those waters for both domestic and agricultural purposes.

The relations between rock types and groundwater composition are commonly displayed in the Piper diagram, Furtak and Langguth (1967) in Fig (1).

7. Water quality evaluation for domestic uses

In wet and dry seasons, all waters are potable based on World Health Organization guidelines (WHO 1996). However, the Na, SO_4 and Cl, values exceeded the allowable value of WHO but are still below the maximum allowable doses. However, F, Cd and Pb exceeded the maximum value of WHO In some localities



Wet Season Dry Season

Fig (1) Piper diagram classifying the analyzed samples in wet and dry seasons.

Water types in wet season divided to two zones after plotting in Piper diagram

g: Alkaline water With prevailing sulfate- chloride

f :Alkaline water With prevailing bicarbonate

The water type of samples in dry season divided to two zones:

g: Alkaline water With prevailing sulfate- chlorid

f :Alkaline water With prevailing bicarbonate

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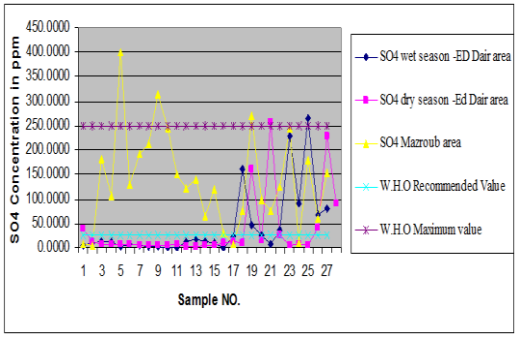
SO_4



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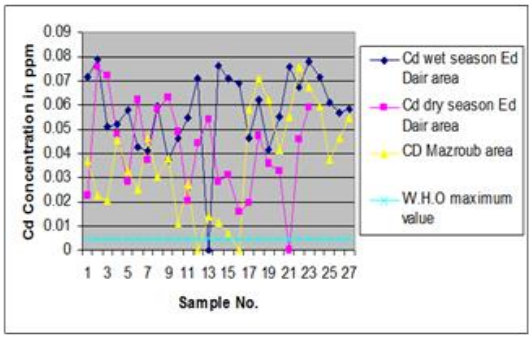

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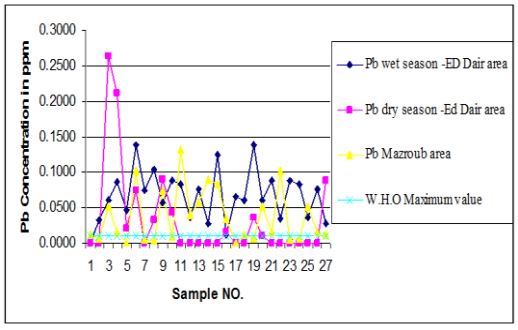


F

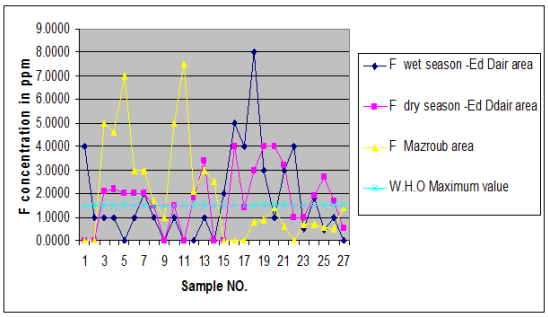


Figure 2. Correlation of analyzed data of samples collected from the study area.

Plate1: Showing the fluorosis in children teeth -Sidra Village

8. Evaluation of the surface waters and groundwater for agricultural purposes.

The samples presented on a Wilcox diagram (Wilcox 1955). 74% of collected samples classified as C1-S1 This classification lead to the fact that water can be used for irrigation of most crops on most soils. 4% of samples were classified as C2 - S1 This classification lead to the fact, that plants can be grown in most cases leaching occurs. 9% of samples are classified as C1-S3.This classification lead to the fact, no detrimental effects on plants from EC but Harmful effects could be anticipated in most soils as effects of SAR and amendments such as gypsum would be necessary to exchange sodium ions. (Fig. 4)

9. Hydro-chemical modeling

Different parameters were calculated based on the chemical analysis of the groundwater samples. The most commonly computed parameter is saturation indices that reflect the interaction between water and rocks in terms of dissolution and precipitation processes. The solubility products of certain minerals control these processes (such as calcite, dolomite, aragonite, gypsum, etc). These calculations are performed by using the (PHREEQC) computer software (Parkhurst and Appelo 2004). Equilibrium thermodynamics predicts the concentration (more precisely: activities) of various species and phases if a reaction reaches equilibrium (Ebey 2004). Mass action law defines how constituents are reacting and what are the products of the reaction (Freeze and Cherry 1979). Based on this, we have calculated SI with respect to anglesite, anhydrite, aragonite, azurite, calcite, dolomite, fluorite, goethite, gypsum, halite, hematite, magnesite, maghemite and manganite. The result are discussed subsequently.

10. SI of Anglesite (Pb SO_4)

Anglesite mineral was found in ground water in J. Ed Dair area in wet season with 51 % of collected samples The SI of Anglesite ranges from - 6.79 to -.2 where 100% of samples are in undersaturation state. In dry season Anglesite was found in 39% of collected samples. The SI ranges from -7 to -3 , where 100% of samples in undersaturation state. This means that the dissolution process will slowly continue in the rocks as evident from the produced chart (data not shown)

11. SI of Anhydrite (Ca SO_{40}) and Gypsum (CaSO4:2H2O)

Anhydrite mineral and Gypsum mineral were found in all collected ground water samples in J. Ed Dair area in wet season. The SI of Anhydrite ranges from -3.67 to -1.64 and from -3.43 to 1.47. 100% of these two minerals of samples are in undersaturation state. In dry season the Anhydrite and Gypsum were found in all collected ground water samples in J. Ed Dair area. The SI of Anhydrite ranges from - 4 to -1,-3 to -1, respectively and also in undersaturation state. This means that groundwater has potentiality to dissolve the mineral which may be explained by the removal of Ca ¬+2 by precipitation of calcite, which may cause disturbance in the chemical equilibrium state of water, thus leading to dissolution of anhydrite and gypsum and increase of Ca ¬+2 and SO4 - 2 concentrations (Freeze and Cherry, 1979).

12. SI of Aragonite ($CaCO_3$)

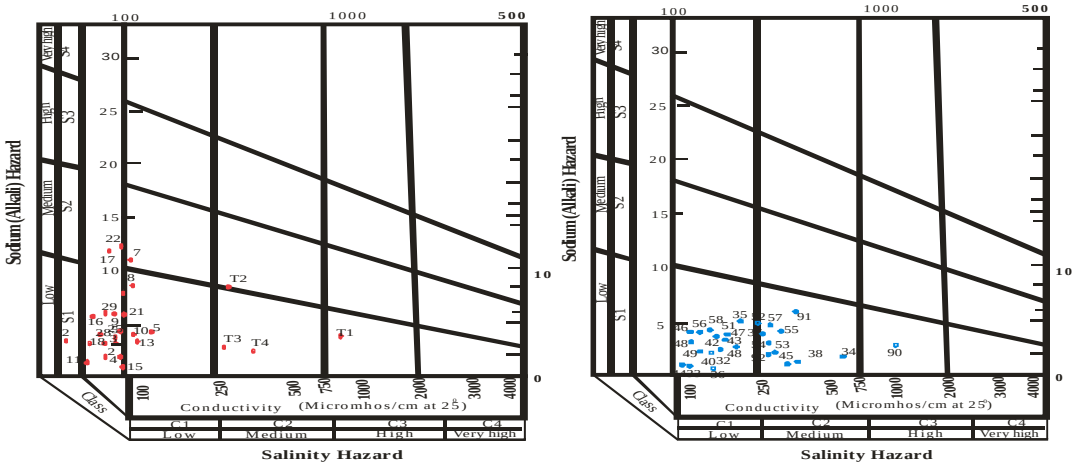
Aragonite mineral was found in all collected samples of ground water in J. Ed Dair area in wet season. The SI of Aragonite ranges from -1.99 to 1.19 where 56% of samples are in supersaturated state. The rest 44% are in undersaturated state.

In dry season Aragonite mineral were found in the same samples of groundwater .The SI range from -1 to 1.04 where 57% of samples are in supersaturation state these are represented in 15 samples.43 % are in undersaturated state.

13. SI of Calcite (Ca CO3)

Calcite mineral was found in all collected samples in J. Ed Dair area in wet season.

The SI of calcite ranges from -1.85 to 1.33 where 59 % of samples are in supersaturated state. 41% of samples are in undersaturated state.



(A) **(B)**

Fig (3): Wilcox diagram Presenting Collected Samples wet and dry seasons Ed Dair area .A in wet season, B in dry season

In dry season Calcite were found in all collected samples. The SI ranges from -1 to -1.8 where 60 % are in supersaturated state. The rest (40 %) are in undersaturated state.

14. SI of Dolomite Ca Mg (CO3)2

Dolomite mineral was found in all collected samples in J. Ed Dair area in wet season. The SI of dolomite ranges from -3.56 to 2.26 where 52% of samples are in supersaturated state. While eight percent of samples are undersaturated. In dry season dolomite was found in all collected samples The SI ranges from -3 to 2.25 where 53% are in undersaturated state and 46% are in supersaturate state. The saturation state of ground water with respect to calcite and dolomite suggests that these mineral phases are part of aquifer material and may have influenced the chemistry of groundwater.

15. SI of Fluorite (Ca F2)

Fluorite mineral was found in 70% of collected samples J. Ed Dair area in wet season. The SI of fluorite range from –1.43 to -.19 where 70% of sample are in undersaturation state. In dry season, fluorite was found in 78% of collected samples .The SI ranges from -2 to 0 where 97% are in undersaturated state. Only 3% of the samples are in supersaturated state.

16. Conclusion

Analysis of data of surface and ground waters in Ed Dair area in wet and dry season show that the constituents affecting human health significantly are not within the recommended value limits of the W.H.O guidelines, but still under the maximum Value, except for fluorite,Cadmium and Lead. On the other hand, the waters for irrigation purposes in Ed Dair area are considered suitable for irrigation. The effect of mineralization clearly appears in anomalous values of major cations, anions and trace elements. The effect of water- rocks interaction appears in saturation stat of phase minerals (persaturate, under saturate and equilibrium state).

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