# الــخلاصة

أجرت هذه الدراسة حول النيل الأزرق ما بين الكاملين و ودمدني في ولاية الجزيرة بوسط السودان, لتوضيح الخواص الهايدروجيولوجية و الهايدروكيميائية لمنطقة الدراسة.

تم تحليل البيانات الحقلية لعدد 200 بئر لتبيان الخصائص الهايدروجيولوجية و الهايدروكيميائية لمنطقة الدراسة . تبين أن أهم التركيبات الجيولوجية بالمنطقة هي: الصخور القاعدية الاساسية, تكوينات الحجر الرملي النوبي, تكوينات الجزيرة, رسوبيات الأودية المطمورة, رسوبيات الانهار و الرسوبيات الحديثة .

تعتبر تكوينات الحجر الرملي النوبي أهم خزانات المياه الجوفية بالمنطقة و التي تعلو لاتوافقياً الصخور القاعدية الأساسية, و تنكشف في الجهة الشرقية لمنطقة الدراسة, و هي ذات خواص هايدولكية متوسطة( النفاذية 397 متر$^2$ / اليوم, الموصلية الهايدرولكية 163 متر/ اليوم في منطقة البطانة بينما النفاذية 331 متر$^2$ / اليوم والموصلية الهايدرولكية 16 متر / اليوم في منطقة الجزيرة ). كما نجد أن الخواص الهايدروكيميائية تشير إلي أن نوعية المياه مقبولة وفقاً للمعايير القياسية (متوسط الاملاح الذائبة الكلية 386 جزء من المليون بالبطانة, 332 جزء من المليون بالجزيرة). صنفت مياهها بأنها عذبة ( مع وجود بعض الجيوب المالحة ).

نوعية المياه تنتمي لمجموعة بيكربونات الصوديوم والكالسيوم بالبطانة ومجموعة بيكربونات الصوديوم بالجزيرة وتمتاز بان مياهها تصلح للزراعة من مجموعة قليلة الملوحة متوسطة معامل الامتصاص للصوديوم بالجزيرة و متوسطة الملوحة قليلة معامل الامتصاص للصوديوم بالبطانة.

تكوينات الجزيرة هي الخزان الاساسي في المنطقة غرب النيل الازرق, ترسبت لاتوافقيا فوق السطح المتعري من تكوينات الحجر الرملي النوبي بسمك يتراوح بين صفر و ثمانين متراً . المياه الجوفية بخزان الجزيرة شبه محصورة و نوعية مياهه جيدة( الاملاح الذائبة الكلية 380 جزء من المليون) و تصنف بانها من مجموعة بيكربونات الصوديوم و تصلح للزراعة اذ تنتمي للمجموعة متوسطة الملوحة قليلة معامل الإمتصاص للصوديوم.

الإتجاه العام لسريان المياه الجوفية من النيل الأزرق للشرق و الشمال الشرقي في منطقة البطانة و الشمال و الشمال الغربي في منطقة الجزيرة بانحدار هايدرولكي يبلغ ( 0.00288 و بالجزيرة و 0.0072 بالبطانة ) . تقدر السعة التخزينية لتكوينات الحجر الرملي النوبي من المياه الجوفية بمنطقة الجزيرة ب $68.5 \times 10^9$ متر مكعب و بمنطقة البطانة $29.1 \times 10^9$ متر مكعب , بينما السعة التخزينية لتكوينات الجزيرة تبلغ $42.4 \times 10^9$ متر مكعب.

## ABSTRACT

This study was carried out around the Blue Nile between Kamlin and Wad Medani in the Gezira State, Central Sudan, to characterize the hydrogeology and hydrochemistry of studied area.

In this study field data from 200 boreholes were analyzed to assess the hydrogeological and hydrochemical properties of the study area. The main geological sequences in the study area are:

Basement Complex, the Nubian Sandstone Formation, Gezira formation, Buried Chemical deposits Alluvium deposits and the superficial deposits.

The main aquifer in the area is the Nubian Sandstone formation which overlies unconformably the Basement Complex and crop out at the eastern part of the study area. The Hydraulic properties of this aquifer are moderate (T = 397m2/d, K = 163m/d at Butana area and T = 331m2/d, K = 16m/d at Gezira area). The hydrochemical properties indicate that the water quality is acceptable according to standard parameters (average TDS = 386 ppm at Butana area and 332 ppm at Gezira area) .It is classified as predominately fresh water with isolated pockets of brackish water and calcium sodium bicarbonates water type, class S1C2for irrigation at Butana area, while at the Gezira area fresh water is classified as sodium bicarbonates water type and class S1C2 for irrigation purposes.

The Gezira formation is the main aquifer west of the Blue Nile River, and it rests unconformably over the Nubian sandstone formation erosional surface with a thickness ranging from zero to 80m.

The groundwater occurs under semi confined condition in the Gezira aquifer water is of good quality (TDS = 380ppm), and can be classified as sodium bicarbonate water type and class S1C2 for irrigation purposes.

The general groundwater flow directions are from Blue Nile towards east and northeast at Butana area, and north, northwest at

Gezira area with average hydraulic gradient 0.00288 and 0.00072 in Butana and Gezira area respectively. Estimated groundwater storage capacity of the Nubian Sandstone is 68.5X109 m3, at Gezira area 29.1X109 m3 at Butana area while in the Gezira aquifer is 42.4X109m3.

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# TABLE OF CONTENTS

# CHAPTER FOUR: RESULTS AND DISCUSSION

# LIST OF TABLES

**PAGE**

**PAGE**

# LIST OF FIGURES

**PAGE**

**PAGE**

**PAGE**

**PAGE**

# LIST OF SYMBOLS & ABBREVIATIONS

| | | |
|---|---|---|
| NWC | = | National Water Corperation. |
| RWC | = | Rural Water Cooperation. |
| Gezira Area | = | Study Area, West Blue Nile. |
| Butana Area | = | Study Area, East Blue Nile. |
| Exp. Of Conc. | = | Expression of concentration. |
| SAR | = | Sodium adsorption. |
| WHO | = | World Health Organization. |
| ppm | = | Part per million. |
| epm | = | Equivalent part per million. |
| epm% | = | Percentage of equivalent part per million. |
| a.m.s.L. | = | Above mean sea level. |
| F.A.I.R. | = | Cation–anion imbalance ratio. |
| GWW | = | Groundwater by windows software program. |
| S. C. | = | Specific capacity. |
| T | = | Transmissivity. |
| Q | = | Well discharge (groundwater flow discharge). |
| DS | = | Maximum drawadown. |
| K | = | Hydraulic conductivity. |
| b | = | Aquifer saturated thickness. |
| $S_w$ | = | Draw down. |
| t | = | Time since pumping started. |
| r | = | Distance from the center of the pumped well to a point where draw down measured. |
| S | = | Coefficient of storage. |
| BQ | = | Aquifer loss (laminar flow). |
| $CQ^2$ | = | Well loss (turbulent flow). |
| $h_1$, $h_2$ | = | Hydraulic head. |
| L | = | Distance. |

| | | |
|---|---|---|
| $Q_{sc}$ | = | Groundwater storage. |
| A | = | Average aquifer thickness. |
| $n_e$ | = | Effective porosity. |
| i | = | Hydraulic gradient. |
| W | = | Aquifer widith. |
| $A_{act}$ | = | Actual cross–section area. |
| A | = | Total cross–section area. |
| $V_a$ | = | Actual velocity. |
| V | = | Apparent velocity. |
| EC | = | Electrical conductivity. |
| TDS | = | Total dissolved solids. |
| TH | = | Total hardness. |
| T. ALK | = | Total alkalinity. |
| PH | = | Hydrogen ion concentration. |
| $Na^+$ | = | Sodium ion. |
| $K^+$ | = | Potassium ion. |
| $Ca^{++}$ | = | Calcium ion. |
| $Mg^+$ | = | Magnesium |
| $HCo^+_3$ | = | Bicarbonate. |
| $Cl^-$ | = | Chloride ion. |
| $So^{—}_4$ | = | Sulphate. |
| $F^-$ | = | Fluoride ion. |
| $No^-_2$ | = | Nitrite. |
| $No_3$ | = | Nitrate. |
| NW | = | Nubian sandstone aquifer west Blue Nile area. |
| NE | = | Nubian sandstone aquifer east Blue Nile area. |
| G | = | Gezira aquifer. |
| PHWN | = | Hydrogen ion concentration Nubian west Blue Nile. |
| PHG | = | Hydrogen ion concentration Gezira aquifer. |
| PHNE | = | Hydrogen ion concentration Nubian east Blue Nile. |
| Std. Dev. | = | Standard deviation. |

| | | |
|---|---|---|
| ECNW | = | Electrical conductivity of Nubian Sandstone aquifer west Blue Nile Area. |
| ECNE | = | Electrical conductivity of Nubian Sandstone aquifer east Blue Nile Area. |
| ECG | = | Electrical conductivity of Gezira aquifer. |
| TDSNW | = | Total dissolved solids Nubian west Blue Nile area. |
| TDSNE | = | Total dissolved solids east Blue Nile area. |
| TDSG | = | Total dissolved solids Gezira aquifer. |
| TALKNE | = | Total alkalinity Nubian aquifer east Blue Nile area. |
| TALKG | = | Total alkalinity Nubian aquifer east Blue Nile. |
| THNW | = | Total hardness Nubian west Blue Nile area. |
| THNE | = | Total hardness Nubian east Blue Nile area. |
| THG | = | Total hardness Gezira aquifer. |
| CANW | = | Calcium ion Nubian aquifer west Blue Nile area. |
| CANE | = | Calcium Nubian aquifer east Blue Nile area. |
| CAG | = | Calcium ion Gezira aquifer. |
| MGNW | = | Mg Nubian aquifer west Blue Nile area. |
| MGNE | = | Mg Nubian aquifer east Blue Nile area. |
| MGG | = | Mg Gezira aquifer. |
| NANW | = | Na Nubian aquifer Gezira area. |
| NANE | = | Na Nubian aquifer Butana area. |
| NAG | = | Na Gezira aquifer. |
| KNE | = | K Nubian aquifer east Blue Nile area. |
| KNW | = | K Nubian aquifer west Blue Nile area. |
| KG | = | K Gezira aquifer. |
| HCO3NW | = | Bicarbonate Nubian aquifer west Blue Nile area. |
| HCO3NE | = | Bicarbonate Nubian aquifer east Blue Nile area. |
| HCO3G | = | Bicarbonate Gezira aquifer. |
| SO4NW | = | Sulphate Nubian west Blue Nile area. |
| SO4G | = | Sulphate Gezira aquifer. |
| CLNW | = | Chloride Nubian west Blue Nile area. |

| | | |
|---|---|---|
| CLNE | = | Chloride Nubian east Blue Nile area. |
| CLG | = | Chloride Gezira aquifer. |
| FNE | = | Fluoride Nubian aquifer east Blue Nile area. |
| FG | = | Fluoride Gezira aquifer. |
| $S_1$ | = | Low sodium (alkali) hazard. |
| $S_2$ | = | Medium sodium (alkali) hazard. |
| $S_3$ | = | High sodium (alkali) hazard. |
| $S_4$ | = | Very high sodium (alkali) hazard. |
| $C_1$ | = | Low salinity hazard. |
| $C_2$ | = | Medium salinity hazard. |
| $C_3$ | = | high salinity hazard. |
| $C_4$ | = | Very high salinity hazard. |