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Research Article
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New Diagram Useful for Classification of Groundwater Quality

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Abstract

Due to human and human activities the groundwater is polluted. This is the serious problem now a century. Thus the analysis of the water quality is very important to preserve and prefect the natural ecosystem. The primary objective of this paper is to study the groundwater quality parameters.

The mechanism of chemical reactions leading to the change in the composition of groundwater and source of the dissolved ions in the groundwater can be understood by Banaga's diagram. The Banaga method is not only shows graphically the nature of a given water sample and dictates the relationship to other samples but there are a number of different methods and schemes used to classify natural water quality, source, origin and determine their suitability for different purposes depending on the concentrations of the basic components.

The new diagram is useful for better understanding the evolution of hydrochemical parameters of groundwater that can be by plotting the concentration of major cations and anions in percentage of meq/l, and it is divides the water quality into five types. The results of this analysis were compared with the water quality standards of Piper diagram.

Keywords: New diagram; Banaga diagram; Groundwater quality

Introduction

To understanding the quality of groundwater is as important as it is quantity because it is the main factor determining the suitability for domestic, drinking, agricultural and industrial purposes depending mainly on Banaga's diagram. Groundwater is the most important natural resource and it is vital for all life forms on earth crust, but the quality of groundwater is controlled by several factors including rock types, climate and human activities, and generally, groundwater quality refers to the chemical, physical, biological and isotope characteristics. There is a general belief that groundwater is purer and safer than the surface water due to the protective qualities of the soil cover, depending mainly on its usage and consumption, it can be a renewable resource. Etu-Efeotor [1] announced that the Groundwater is never really chemically pure as water invariably dissolves some of the minerals it comes in contact with, at any given time. Hydro-chemical processes such as dissolution, precipitation, ion exchange processes and the residence time along the flow path control the chemical composition of groundwater, and hydro-chemical characterization of water body presents the condition of water with respect to its quality measuring parameters considered under the study. Groundwater vary spatially and temporally, depending on the geology and chemical characteristics of the aquifer as well as, dissolved major elements in the groundwater generally express the intensity of water-rock interactions in the geological formation as they play important role in the study of water chemical, although several sources contribute to the dissolved contents of groundwater the major elements released via various sources are used as proxies for weathering rates for which the identification of their different origins is required [2]. It can also act as a strong weathering agent apart from general solution effect. Consequently, the chemical composition of groundwater will vary depending upon several factors like frequency of precipitation, which will leach out the salts, time of stay of rain water in the root-zone and intermediate zone, presence of organic matter etc. [3].

On the other hand, the dissolved constituents in groundwater are primarily controlled by the original chemical characters and temperature of the water entering the zone of saturation; the distribution, solubility and exchange capacity of minerals in the rock; the porosity and permeability of the aquifer and the flow path ways of the water [4-7].

Methodology

The movement of percolating water through larger pores is much more rapid than through the finer pores. The overall effect of all these factors is that the composition of groundwater varies from time to time and from place to place. All groundwater contains salts in solution that are derived from the location and past movement of the water through the different formations. It can also act as a strong weathering agent apart from general solution effect. Consequently, the chemical composition of groundwater will vary depending upon several factors like frequency of precipitation, which will leach out the salts, time of stay of rain water in the root-zone and intermediate zone, presence of organic matter etc. In this paper was innovate and create new graphs, which are more useful for bringing out the chemical relationships amongst groundwater samples and display a brief description of the water quality data. The graphs can aid in comparing analysis and for emphasizing similarities and differences between the other standard possible plotting methods as Piper [8] and Banaga diagrams. The Banaga method independently developed a diagram similar to Piper diagram which is consist mainly of two triangles separated for both cations and anions in meq/l percent and one diamond-shaped field (Figure 1), but the Banaga diagram including only one diamond-shape (Figure 2).

Hydrochemical facies

The geological formations, water-rock interactions and relative

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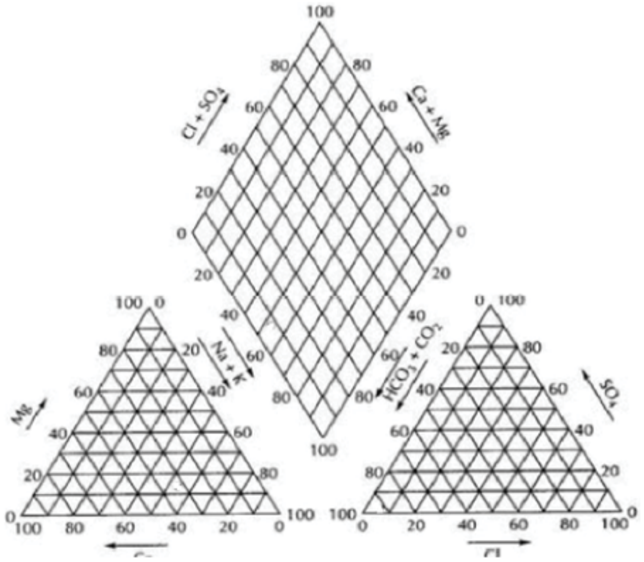

Figure 1: Trilinear diagram [8].

mobility of ions are the prime factors determining the geochemistry of groundwater [9]. The relationship between groundwater flow, hydrogeologic properties and hydrochemistry has been studied by many researchers [5,10,11]. The chemical quality of groundwater is related to the lithology of the area.

The concept of hydrochemical facies presented by Walton [12] to understand and identify the water composition in different classes based on the dominance of certain cations and anions in solutions, depending mainly on the above-mentioned the values obtained from the groundwater samples analyzing, and their plot on the Banaga diagrams reveal that the dominant cations and anions in different types of water. It clearly explains the variation or domination of major ions concentration, which is explaining the chemical quality of groundwater, is related to the lithology (geologic materials) of the area.

Hydrochemistry graphical methods

Different graphical and statistical techniques have been developed to describe the concentrations or relative abundances of major constituents and the pattern of variability in the different water samples. Banaga diagram is made of combination of four different fields that has been recently used to classify the water into different water types based upon the cations and anions concentrations in the form of major ions percentage in triangle fields and their combined condition in two diamonds. Percentages are calculated in terms of equivalent in millions of main ions (Figure 2).

Banaga diagram

The Banaga plotting systems not only graphically represents the nature of a given water sample, but were used in the study of water chemistry and quality developed by Banaga and Piper methods. The first Banaga diagram is construct relatively abundance of chief cations with the percent meq/l of Ca^{2+}, Mg^{2+} Na^{+} and K^{+} are plotted on diamond-shaped, while relative abundance concentration of anions with the percent meq/l of HCO^{3-}+CO_3^{2-}, Cl- and SO_4^{2-} are plotted on diamond-shaped (Figure 2). The Banaga diagram is the planned division of arithmetic to distinguish the various groundwater groups in terms of the main chemical components and the most important characteristic of this scheme is the speed and ease of dropping points it is composed of one particular represent only the upper and lower positive and negative ions together, which increases the concentration of weak base and strong acid up while concentrations of strong bases and weak acids ratios increase to the bottom of the plot or the opposite form (Figure 2A), either planned (Figure 2B) is subject to increasing concentrations of weak bases and acids ratios up together. In contrast, increasing the concentration of strong bases and acids ratios down, or the opposite.

Result

The chemical composition of groundwater results from the geochemical processes occurring as water reacts with the geologic materials which it flows [6]. The concept of hydrochemical facies was developed in order to understand and identify the water composition in different classes. Hydrochemical facies are distinct zones that possess cation and anion concentration categories. For example, by classifying samples on the Banaga diagram, we can identify geologic units with chemically similar water, and define the evaluation in water chemistry along the flow path. The Banaga diagrams (Figure 2) are useful in bringing out chemical relationships among groundwater samples in more definite terms rather than with other possible plotting methods. Generally, these diagrams reveal the different types of water, which are shown in Table 1.

Discussion

To knowledge and study the initial properties of the water that has been planned is divided into five different zones of quality Table 1, after dropping a column from the middle of each rib passes the point 50%, the waters that fall within the zone (1) classified as alkaline earth metals (bicarbonate and calcium), where bicarbonate and calcium increase more than 50% and this kind of water have a temporary hardness, and hydrogeologically formation described as shallow and fresh water

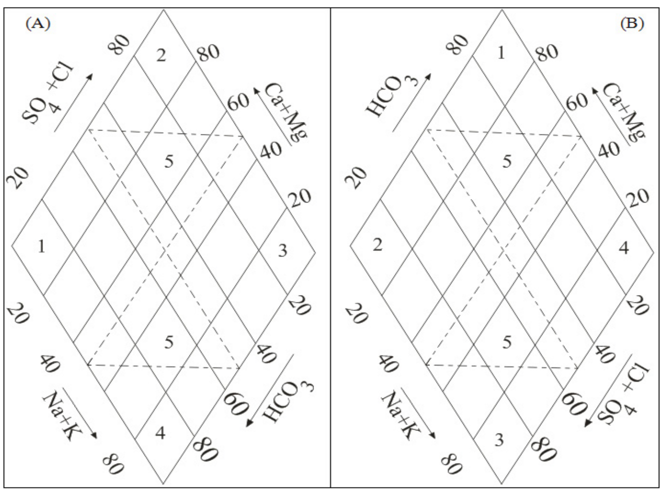

Figure 2: Scheme Banaga second, which will identify the properties of the initial water after divided into five bands (A) to increase the concentration of weak bases and strong acids ratios up while increasing the concentration ratios bases and weak acids to bottom or to opposite (B) increased concentrations ratios rules and weak acids up while increasing the concentration of bases and strong acids to the bottom or to opposite ratios.

Zone No.	Type of water
1	Alkaline bicarbonate
2	Alkaline sulphate chloride
3	Alkali sulphate chloride
4	Alkali bicarbonate
5	No cation-anion pair exceeds 50%

Table 1: It divides the quality of water to five different types.

(recharge area), the groundwater model actually within the zone (2) shows that with a permanent hardness water, while zone (3), describe the water is old and ancient marine (discharge area), and it is danger for irrigation operations because they contain a high concentration of sodium ion. Water is described in the zone (4) as bicarbonate sodium potassium, but for the field of reality middle or internal zone (5), it includes all water elements, but at rates less than 50% and therefore there is no majority for any ions Table 1.

Conclusion

Many researchers have studied the groundwater quality, and each of them has used different methods for research. Banaga method one of these methods useful for assess groundwater quality type and its components can be easily realized. In general, higher concentration of ions in the groundwater occurs due to weathering of silicate rocks and from human activities, beside the evaporation which is leads to the concentration of ions there by increasing the chemical budget of groundwater.

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