# New innovation benefit for classification of groundwater quality

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**Abstract:** The purpose of this paper was to develop new innovation with detection for the chemistry of water quality. A simple, precise, fast and selective method has been developed for interpreting the hydrochemical facies. This method is able to provide sufficient information on the chemical quality of water, particularly the origin for the rock. Banaga scheme used in the field of hydrochemical studies and classification of groundwater quality, which reveals that there are eight different groundwater types divided into two groups. Among the most important components of this invention is the presence of two triangles, one is located at the top side with a view to signing ratios negative ions values and the other triangle is located at the bottom of the general form of the invention the side and it is signed ratios cation values also in addition to two diamonds, which including the right hand side and the left side of the chart, the former it classifies water quality of groundwater at the present time, and the other shows is that evolution will happen to the groundwater in the future.

[Elhag A.B. **New innovation benefit for classification of groundwater quality.** *J Am Sci* 2015;11(12):154-156]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 20. doi:10.7537/marsjas111215.20.

**Keywords:** groundwater quality, Banaga scheme, two trilinears and diamonds.

## 1. Introduction

Groundwater is a major source of water supply, which is facing severe quantity and quality problems, fore example mony countries drinking the water directly from the source without proper treatment are a tough task. In the present century the tremendous increase in the population increased the stress on both surface and the groundwater.However, increasing population growth and rising living standards in many countries necessitate higher quality water resources for various uses as agriculture, industry and drinking (Rahmani, 2010). Nadiri, A. A. et al (2013) announced that the hydrogeochemical processes are influenced by many factors, such as geogenic factors (i.e., rock–water interaction) and anthropogenic activities (i.e., agricultural, industrial and domestic activi-ties).

Water being an excellent solvent tends to dissolve the minerals in the geological system. In evaluation of groundwater, the goal is water quality investigation and planning for sustainable application of these sources. The hydrochemical facies (water type) evaluation is extremely useful in providing a preliminary idea about the complex hydrochemical processes in the subsurface. Determination of hydrochemical facies was extensively used in the chemical assessment of groundwater and surface water for several decades. The chemistry of water is very dynamic, largely controlled and modified by its contact of water bearing formation. Zaporozec (1972) announced that the ratio of calcium to magnesium may be useful in studying water from carbonate rocks. The ratio of sodium to total cations is useful in sediments having cation exchange properties. The ratio of chlorides to other ions may be useful in studies of seawater intrusion or brine contamination. There are several methods to determine water quality, the most common method to assess water quality for drinking purpose, is Piper diagram that provides possibility of water study at a certain point in the area.

Banaga scheme is improved to permit analysis of chemical composition and provides a convenient method to classify and compare groundwater types; also the new method is the more advance and rapid to interpretated the type of water after ploting the percentage values of major ionic composition of different water samples, which is independently developed a diagram similar to Piper diagram. The trilinear plot utilizes two triangles separated for both cations and anions in meq/l percent, and also the graph including two diamonds represent the type of groundwater. The graph shows the distribution of selected chemical types of water in a given range of mineralization, and their relationship to hydrogeological units, by the use of different symbols for plots.

## 2. Material and Methods

Banaga scheme was made in such a way that the milliequivalents percentages of the major cations and anions are plotted in two triangles like Piper diagram (Fig. 1). These plotted points are provides the overall character of the water, as well as, the idea behind this invention in the study of groundwater chemistry and that the representation of cations and anions basic sample groundwater one point in each of the two triangles alone, the upper triangle is used for the signing of negative ions, while the values of the lower triangle is used to determine how the cation values and then is connected to those two points and an imaginary line on the appointees, and therefore can put several analyzes (points) scheme for comparison and extrapolation with the possibility of division into different groups hydrochemical quality and after extraction of the percentage of each essential components of groundwater samples (Fig. 2). These plotted points are provides the overall character of the water, for the difference in milliequivalent percentage between weak acidic anions (carbonate plus bicarbonate) and strong acidic anions (chloride plus sulphate) are plotted on the upper triangle, and the difference in milliequivalent percentage between alkaline earths (calcium plus magnesium) and alkali metals (sodium plus potassium), expressed as percentage reacting values, are plotted on the bottom triangle.

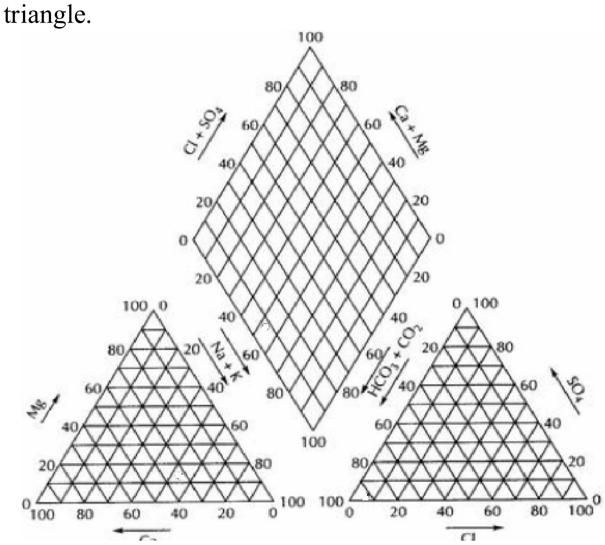


Figure 1: represented the Piper diagram.

Thus Banaga scheme for the rest of the schemes and other customary including Piper scheme that gives a rating to the quality of groundwater in the present time as well as the interpretation of development that will happen to the water in the future during the reaction and movement of groundwater (horizontally and vertically) with the geological formation and which may increase or decrease salinity, depending on recharge and discharge as pumping aquifer, depending mainly on the succession during the development of goundwater into effect as follows:-

$$HCO_3^- \rightarrow HCO_3^- + SO_4^{-2} \rightarrow SO_4^{-2} + \mathrm{r}HCO_3^- \rightarrow SO_4^{-2} + Cl^- \rightarrow Cl^- + SO_4^- \rightarrow Cl^-$$

This invention aims to design two triangles and diamonds so that the general shape similar to the hexagonal crystal metal body; it's known that when water freezes be crystallization hexagonal, this confirms that water is a metal after freezeing.

**3. Results**

Results of this diagram represent type and facies of groundwater types, we can classify the sample points into eight essential fields divided in two diamonds, which including good, acceptable, average, and not-potable water for consumption for human. On the right diamond the first zone, the type of water that predominates is ($CaMgSO_4Cl$), primary salinity (permanent hardness) which is mostly due to the geology of the area which comprises Gypsum and/or Anhydride groundwater and mine drainage. The second zone the type of water that predominates is alkaline bicarbonate ($CaHCO_3$), water typical of shallow and fresh as well as, water of low mineralization and low hardness which is mainly recharge area due to the geology of the area which comprises limestone. In the third zone, the type of water is ($NaKHCO_3$), which is typical of deep groundwater influenced by ion exchange. However, in the fourth zone, the type of water that predominates is ($NaKSO_4Cl$), primary salinity (alkali salinity) which is mainly discharge area typical of marine and deep ancient groundwater and mostly due to the geology of the area which comprises halite. More complete properties of groundwater can be achieved by the use of the left diamond. He distinguished four types of water including: (1) primary salinity (permanent hardness) formed by salts of strong acids and weak bases; (2) primary salinity tertiary alkali and metals formed by salts of strong acids, strong bases, and metals; (3) tertiary salinity (strong and weak acids) and tertiary alkali and metals; (4) tertiary salinity permanent hardness (Fig. 2). These graphics are set out in the table below.

**Table 1:** Chemical analyses are plotted as points in appropriate boxes of the graph; each box indicates one type of water.

| Zone No. | Water quality at the left of diamond | Water quality at the right of diamond |
|---|---|---|
| 1 | Cl+Ca | $SO_4$+Cl+Ca+Mg |
| 2 | Cl+Mg+Na+K | $HCO_3$+ Ca+Mg |
| 3 | HCO3+SO4+Mg+Na+K | $HCO_3$+Na+K |
| 4 | HCO3+SO4+Ca | $SO_4$+Cl+Na+K |

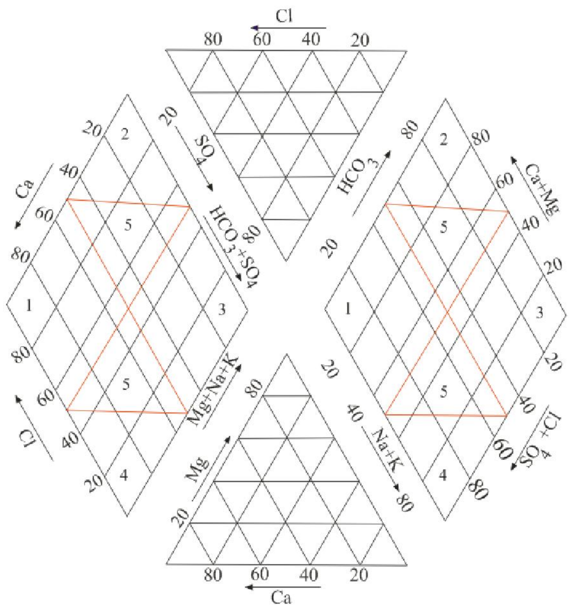


Figure 2: Banaga scheme classified water types in the present and future time respectively.

## 4. Discussion

During weathering and water circulation in rocks and soils, ions leached out and dissolved in groundwater Yousef, A. F., et al (2009). Chemical analysis of water samples provides much information which is useful for many practical problems such as study of mixing of waters from different sources, groundwater quality condition, effect of different structures on water quality, and investigation of origin of salinity.

This invention requires hexagonal illustrations consist of two triangles, one of the top signed by the negative ions values attributed that increase their proportions in the opposite direction to the clock design the other triangle is down to sign it cation values attributed that increase attributed in a clockwise direction in addition to a certain one of them right hand to explain the groundwater quality at the present time and the other on the left shows the development that is going to happen to the quality of groundwater in the future.

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12/8/2015