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1) The Average Rainfall in a watershed is 80 inches Per year and Andrage Evapotranspiration is 56 inches Per year assume no water crosses the water shed boundary what is the stream runoff in feet for year what fraction of rainfall is Evapotranspiration? what fraction is runoff?

Solution :-

Given data

Precipitation (P) = 80 inches per year

Evapotranspiration (ET) = 56 in/y

Run off (RU) = ?

Formula

$$P = ET + RU$$

$$80 = 56 + RU$$

$$RU = P - ET$$

$$RU = 80 - 56$$

$$RU = 24$$

$$= \frac{80 in}{y} - \frac{56 in}{y}$$

$$RU = \frac{24 in}{y}$$

Fraction :- $\frac{ET}{P} = \frac{56}{80} = 0.7$

Problem - 2

2. The average rainfall in a watershed is 120 inches per year and average Evapotranspiration is 92 inches per year. Assume no ground water crosses the water shed boundary. What is the stream runoff in feet per year what fraction of rainfall is E.T ? What fraction is runoff ?

Solution :-

Given data

Average Precipitation (P) = 120 in/y

Average Evapotranspiration (ET) = 92 in/y

Run off (RU) = ?

Formula :- $P = ET + RU$

$RU = P - ET$

$= \frac{120 in}{y} - \frac{92 in}{y}$

$RU = 28$ inches/y

Fraction :-

$\frac{ET}{P} = \frac{92}{120} = \cancel{0.76}$

Problem - 3

34) The Average rainfall in watershed 50 inches and Evapotranspiration 32 inches per year assume no water crosses the water shed boundary what is the stream runoff in feet per year? what Fraction of year is ET? what fraction is runoff?

Solution:-

Given data

Average Evapotranspiration (ET) = 32 in/y

Average Precipitation (P) = 50 in/y

Runoff (RU) = ?

Formula:-

$$P = ET + RU$$

$$RU = P - ET$$

$$= \frac{50 in}{y} - \frac{32 in}{y}$$

$$RU = \frac{18 in}{y}$$

Fraction:-

$$\frac{ET}{P} = \frac{32}{50}$$

$$= 0.64 \text{ in/y}$$

4. In a closed watershed where ground water doesn't cross the watershed boundary we find the following average values Rainfall 41 inches per year. Recharge 32 inches per year. over land flow = 8 subsurface flow is 9 inches the Evapotranspiration is 21 inches per year Find over land flow?

Solution:-

Given data

Average Precipitation (P) = 41 in/y
Average Recharge (R) = 32 in/y
Average Subsurface flow (SS) = 9 in/y
Average Evapotranspiration (ET) = 21 in/y
Average overland flow (O) = 8

Formula :-

$$P = ET + O + SS + R$$

$$O = P - ET - SS - R$$

$$= 41 - 21 - 9 - 32$$

$$= 21 \text{ in/y}$$

Problem - 5

5) In a closed water shed where ground water does not cross the water shed boundary we find the following average value of Rainfall 56 inches per year. Recharge 39 in/y overland flow 12 inches per year Subsurface flow = ? and ET 9 inches per year find subsurface flow ?

Solution:-

Given data

Average Pricipitation (P) = 56 in/y
Average Recharge (R) = 39 in/y
Average overland flow (O) = 6 in/y
Average Evapotranspiration (ET) = 9 in/y
Average Subsurface flow (SS) = ?

Formula:- $P = ET + O + S_S + R$

$\Rightarrow S_S = P - ET - O - R \qquad S_S = 56 - 9 - 6 - 39$

$S_S = 56 - 54$

$S_S = 2$ in/y

Problem - 6

6) In a closed what water shed where ground water does not cross the water shed boundary we find the following average values Rainfall 60 in/y recharge 10 in/y overland flow 1 in/y subsurface flow is 7 in/y what is the ET Flux?

Solution :-

Given data

Pricipitation (P) = 60 in/y

Recharge (R) = 10 in/y

overland flow (O) = 1 in/y

Subsurface flow (S_S) = 7 in/y

Evapotranspiration (ET) = ?

Formula :-

$$P = ET + O + SS + R$$

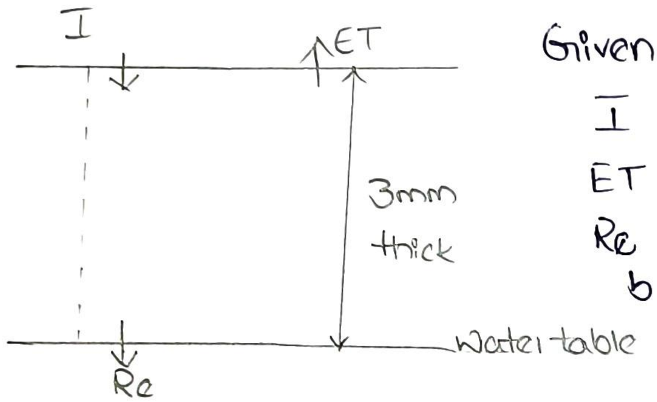
$$ET = P - O - S_S - R$$

$$ET = \frac{60in}{y} - \frac{1in}{y} - \frac{7in}{y} - \frac{10in}{y}$$

$$ET = 42\,in/y$$

Method -3 Problem - 7

7) You hava a flat field underlaying by Permeable Soil, During 1 month the infiltration is 0.1cm, ET is 0.03m Recharge is 0.01m the Vadose zone is 3mt thick What is the change in average water Content ?



Given data

$I = 0.1m$

$ET = 0.03m$

$Re = 0.01m$

$b = 3m$

Formula :-

$$I = ET + Re + \frac{D_{rs}}{A} \Rightarrow \frac{D_{rs}}{A} = \Delta\theta b$$

$$I = ET + Re + \Delta\theta b$$

$$\Delta\theta = \frac{1}{b}(I - ET - Re)$$

$$= \frac{1}{3}(0.1m - 0.03m - 0.01m)$$

$$= \frac{1}{3}(0.6)$$

$$= 0.02m$$

8) You have a flat field underlying by Permeable soil, During 1 month the infiltration is 0.4m, E.T is 0.05mm recharge is 0.03m the vadose zone is 4m thick. What is the change in average water content?

Solution:- Given data

$I = 0.4m$

$ET = 0.05$

$Re = 0.03$

$b = 4m$

Formula :- $I = ET + Re + \frac{Drs}{A}$

$\Rightarrow \frac{Drs}{A} = \Delta\theta b$

$\Rightarrow I = ET + Re + \Delta\theta b$

$\Delta\theta = \frac{1}{b}(I - ET - Re)$

$= \frac{1}{4}(0.4 - 0.05 - 0.03)$

$= \frac{1}{4}(0.32)$

$= 0.2$

9) You have a flat field underlying by Permeable Soil, During 1 month the infiltration is 0.2m ET is 0.04m. Recharge is 0.02m, the vadose zone is 5m thick, what is the change in average water Content?

Solution:-

Given data:-

$$I = 0.2m$$

$$ET = 0.04m$$

$$Re = 0.02m$$

$$b = 5m$$

Formula:- $I = ET + Re + \frac{D_rS}{A}$

$$\Rightarrow \frac{D_rS}{A} = \Delta\theta b$$

$$I = ET + Re + \Delta\theta b$$

$$\Delta\theta = \frac{1}{b}(I - ET - Re)$$

$$= \frac{1}{5}(0.2 - 0.04 - 0.02)$$

$$= \frac{1}{5}(0.14)$$

$$= 0.028.$$

Problem - 10 Method - 4

10) Determine the storage coefficient for a confined sandy stratum of 30mt thickness that has an average porosity of 30 percent?

Solution:-

Given data:-

$b = 30mt$

$n = 0.3mt$

$\gamma_w = 1000$

Standed values:-

$[E_W = 2.14 \times 10^8 \, kg/m^2$

$E_S = 3.05 \times 10^7 \, kg/m^2]$

Formula:-

$$S = \gamma_w . nb \left(\frac{1}{E_W} + \frac{1}{nE_S}\right)$$

$$S = 1000 \times 0.3 \times 30 \left(\frac{1}{2.14 \times 10^8} + \frac{1}{0.3 \times 3.05 \times 10^7}\right)$$

$$= (0.042 + 0.98) \times 10^{-3}$$

$$= 1.02 \times 10^{-3}$$

Problem - 11

11) Determine the storage coefficient for a confined sandy strom of 44mt thickness that has an average porosity of 35%.

Solution :- Given data

$b = 44mt$

$n = 0.35$

$\gamma_w = 1000$

Standed values :-

$[E_W = 2.14 \times 10^8 \, kg/m^2$

$E_S = 3.05 \times 10^7 kg/m^2]$

Formula :- $S = \gamma_w . nb \left(\frac{1}{E_w} + \frac{1}{nE_S} \right)$

$S = 1000 \times 0.35 \times 44 \left(\frac{1}{2.14 \times 10^8} + \frac{1}{0.35 \times 3.05 \times 10^7} \right)$

$S = 124^2 \times 6,473$

Problem -12

12) Determine the storage coefficient for a confined sandy stratum of 60mt thickness that has an average porosity of 50 percent.

Solution :-

Standed value

$$\left[\begin{aligned} E_w &= 2.14 \times 10^8 \ kg/m^2 \\ E_s &= 3.05 \times 10^7 \ kg/m^2 \end{aligned} \right]$$

Given data

$b = 60mt$

$n = 30\% = 0.5$

$\gamma_w = 1000$

Formula :-

$$S = \gamma_w . nb \left(\frac{1}{E_w} + \frac{1}{nE_s} \right)$$

$$S = 1000 \times 0.5 \times 60 \left(\frac{1}{2.14 \times 10^8} + \frac{1}{0.5 \times 3.05 \times 10^7} \right)$$

$$S = 173^2 \times 4,270$$

Problem - 13 Method 5

13) A Pump test was preformed on a tube well near bareilly and an analysis of the data gave the value of transmissivity $T = 1450\ m^2/day$ for an aquifer is 65 mt depth the average d_{10} size of the aquifer is 0.165 mm. Determine the hydrolic conductivity k, from the Pump test data from Allow Hazem formula & Compare the two?

Solution:-

Given data

$T = 1450\ m^2/day$

$b = 65\ mt$

$d = 0.165\ m$

$k = 850\ d^2_{10}.$

$$H.C = k = \frac{T}{b} = \frac{1450}{65}$$

$$= 22.30\ m^2/day$$

By Allen Hazen formula

$$k = 850 d^2_{10} = 850 \times 10.165^2 = 22.95\ m/day$$

The values obtained by the two methods carry as well.

Problem - 14

14\. A Pump test was performed on a tube well near Bareilly and an analysis of the data gave the value of transmissivity $T = 1632 m^2/day$ for an aquifer is 68mt depth the average d_{10} size of the aquifer is 0.263m. Determine the hydrolic Conductivity k, from the pump test data from Allen Hazen formula and compare the two?

Solution:-

Given data

$T = 1632 m^2/day$

$b = 68mt$

$d = 0.263 mm$

$k = 850 d^2_{10}$

$$H.C = k = \frac{T}{b} = \frac{1632}{68}$$

$$= 24 m^2/day$$

By Allen Hazen formula

$$k = 850 d^2_{10} = 850 \times 0.263^2 = 58.79 m^2/day$$

The values obtained by the two methods Carry as well.

Problem - 15

15) A Pump-test was performed on a tube well near Bareilly and an analysis of the data. Gave the value of transmissivity $T = 1132\ m^2/day$ for an aquifer is 56mt depth the average d_{10} size of the aquifer is 0.102mm. Determine the hydrolic conductivity k, from the pump test data from Allen Hazen formula & Compare the two?

Solution:- Given data

$T = 1132\ m^2/day$

$b = 56mt$

$d = 0.102mt$

$k = 850 d_{10}^2$

$$H.C = k = \frac{T}{b} = \frac{1132}{56}$$

$$= 20.21 m^2/day$$

By Allen Hazen formula

$k = 850 d_{10}^2 = 850 \times 0.102^2 = 8.84 m^2/day$

The values obtained by the two methods carry as well.

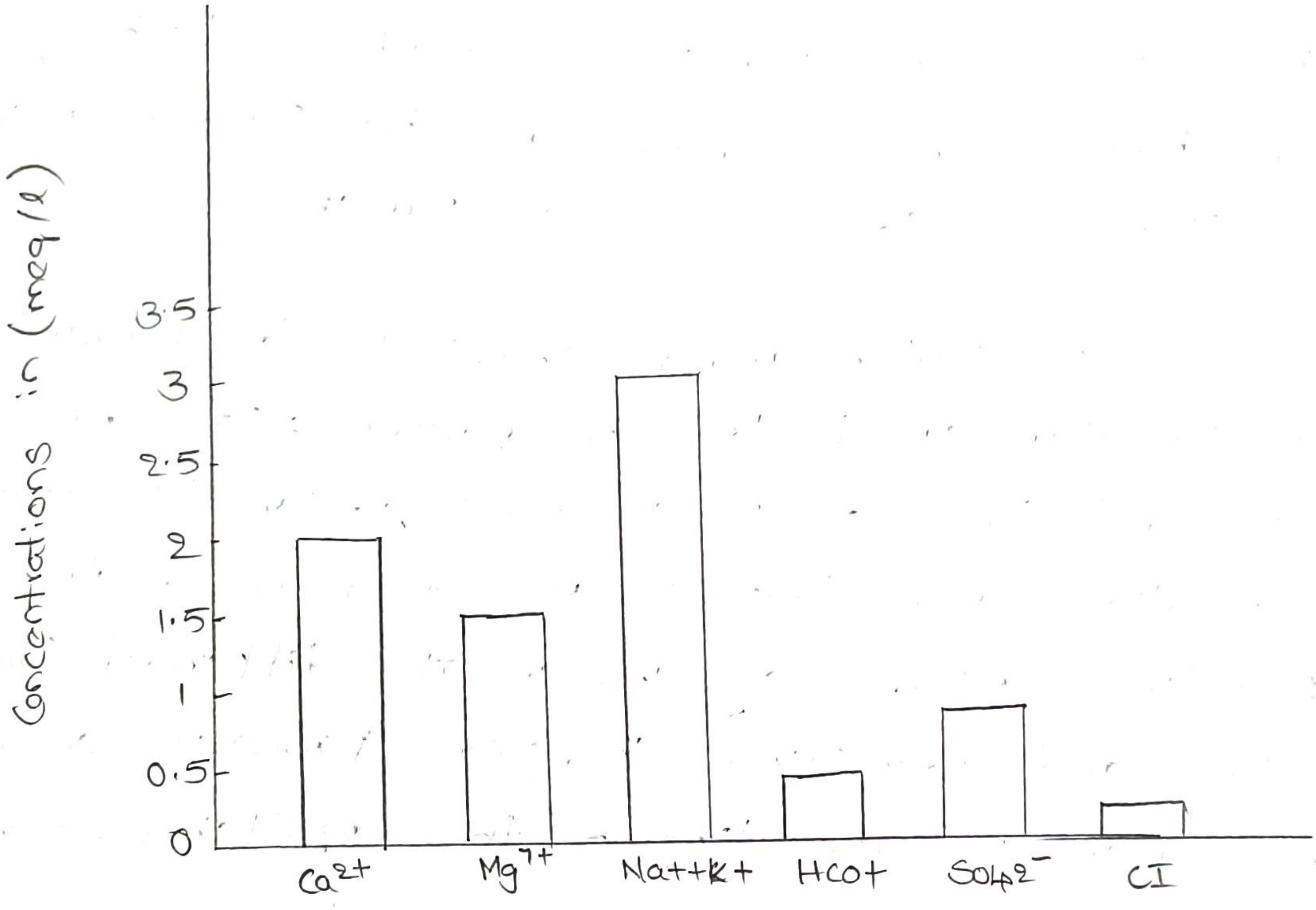
Graphical Presentation of the Ground water Quality data

To Convert the result of the chemical analysis into suitable for graphical representation, There are several varities of graphical techniques that have been devolped for the presentation of chemical components of water.

The water major chemical Constituents are usually used for the presentation, An important task of water investigation is the compilation and Graphs are also used in detecting mixing of water of different composition and identifing chemical process occuring as water passed through the aquifer system.

1. Bar charts
2. Pie charts
3. Stiff Diagrams
4. Scattered Plots
5. Schoeller Diagrams
6. Piper Diagram.

Sample A Bar chart



1. BAR CHARTS

* The bars are plotted with concentration values in milliequivalent per litre. It is widely used in portraying chemical quality.

* Each analysis appears as a vertical bar having a height proportional to the total concentration of anions or cation.

→ Vertical bars are widely used for showing the chemical quality of ground water.

→ The anlysis is shown as a vertical bar having height proportional to the total concentration of cation or anion, expressed in milliequivalent liters.

→ The concentration are divided horizantally to show the concentration of major ions or groups of closely related ions identified by different shading patterns.

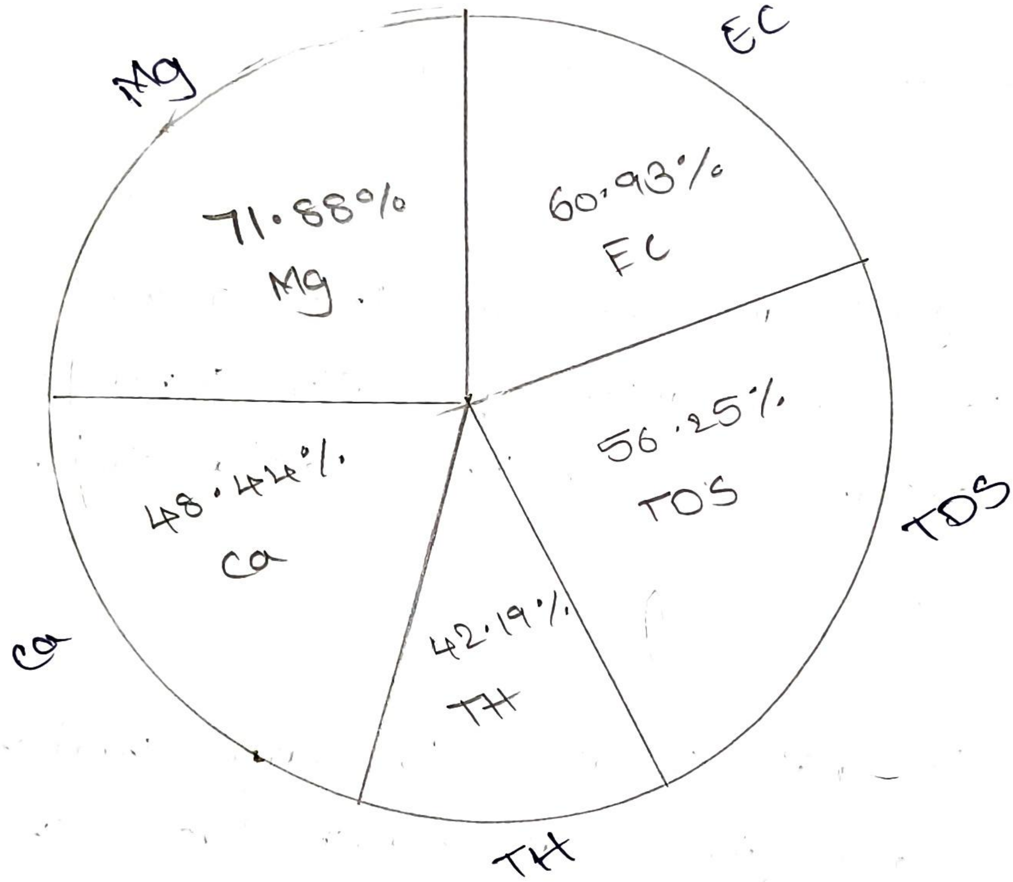
Bar charts show the similarities or difference between water from their concentration ranges and it also show clearly the Chemical constituent of total Cations are plotted to the left of vertical bar and anions to the right.

Advantages of BAR Charts

It gives an idea of the overall Concentration of cations and anions. visually strong. Can easily compare two or three data set.

Disadvantages of Bar charts

It is not suitable for large water Samples. It does not give Clear water type Characteristics use only with discreta data.


EC
60.93%
EC
Mg
71.88%
Mg
56.25%
TDS
TDS
48.424%
Ca
Ca
42.19%
TH
TH

2. PIE CHARTS

* Represent the total concentrations of major cations and anions of water sample by means of circle.

* The segments of the circle are indicative of the percentage composition in degree.

→ The diagrams of this types are probably most useful for indicating the composition of water on a geologic section or column.

→ The simplest way of representing ground water quality are the Pie-charts.

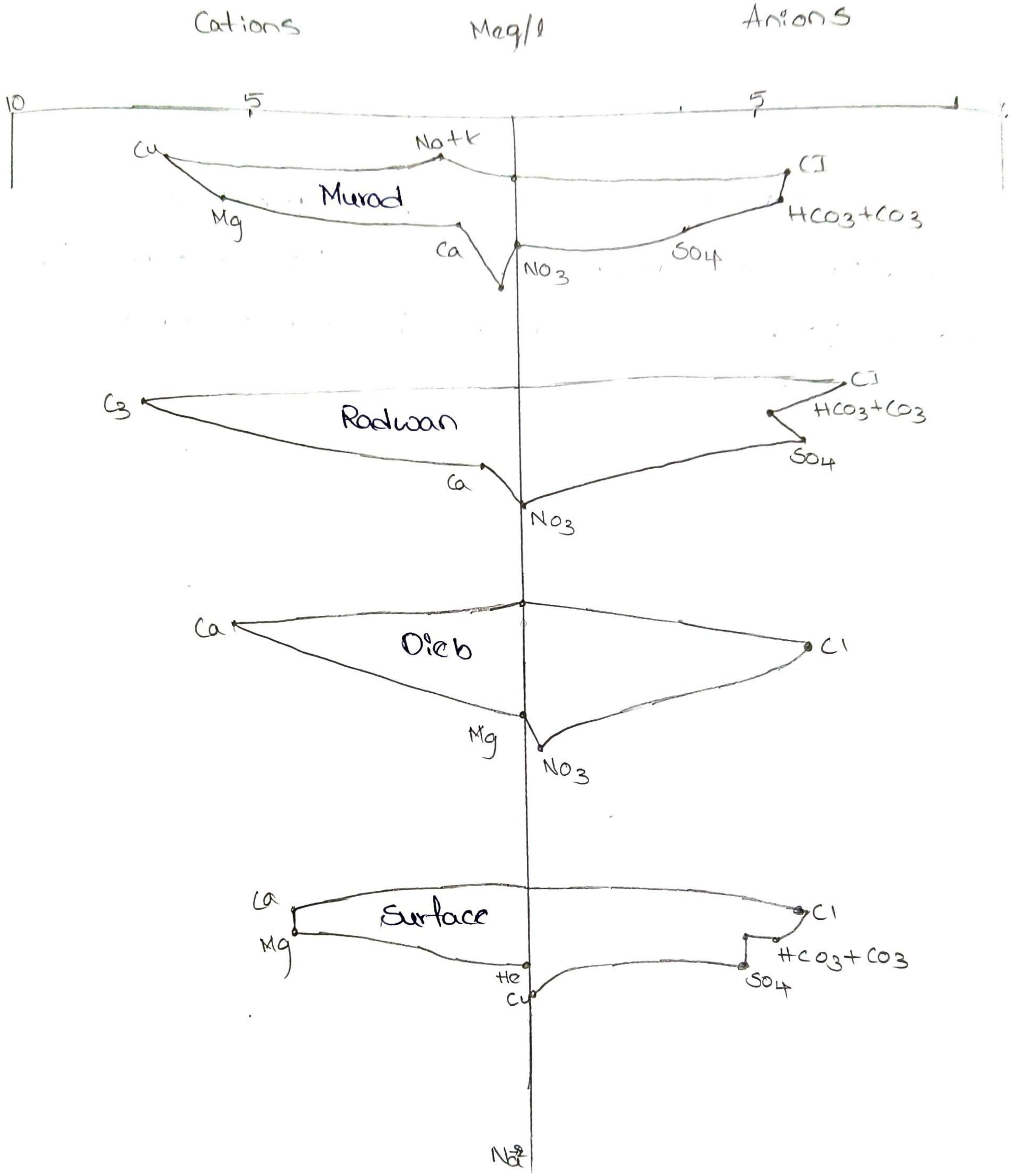
→ The diameter of the pie chart can be sealed according to the concentration of TDS.

Advantages of Pie charts

Visually appealing shows percent of total for each category. It Provides quick visual comparison of individual chemical analysis.

Disadvantages of Pie Charts

It is not suitable for large graphical Presentation of analysis. Hard to compare two data sets. use only with discreate data.


Cations
Meq/l
Anions
10
5
5
Ca
Na+k
Cl
Murad
Mg
HCO3+CO3
Ca
SO4
NO3
Ca
Cl
HCO3+CO3
Radwan
Ca
SO4
NO3
Ca
Oieb
Cl
Mg
NO3
Ca
Surface
Cl
Mg
HCO3+CO3
He
SO4
Cu
Na

3. STIFF DIAGRAM

* Stiff (1951) proposed another way of Presenting Chemical analysis data, in which he used four Parallel axes and one vertical axes for representing the chemical analysis.

* The procedure as proposed by Stiff (1951) is such that four cation concentrations are Plotted to the left of the vertical zero axis and four anions to the right, all value are in milli.equivalent Per liter.

→ Patter diagrams were first suggested by Stiff for representing chemical analysis.

→ Concentrations of cations are plotted to the left of a vertical zero axis and the anions to the right. All values are in meq/l.

→ The resulting point when connecting from an irregular polygonal pattern.

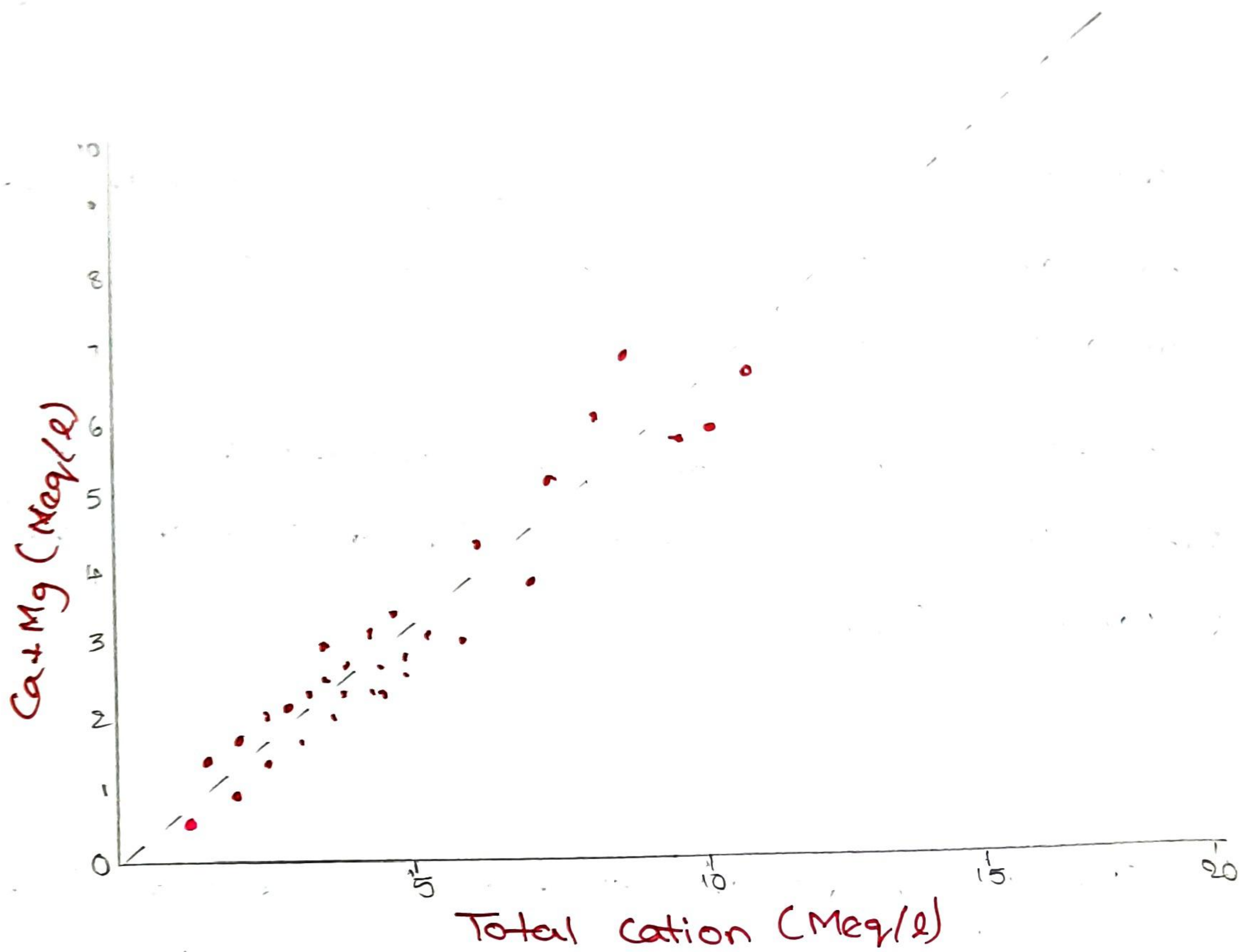
→ Water of similar quality define a distinctive Shape.

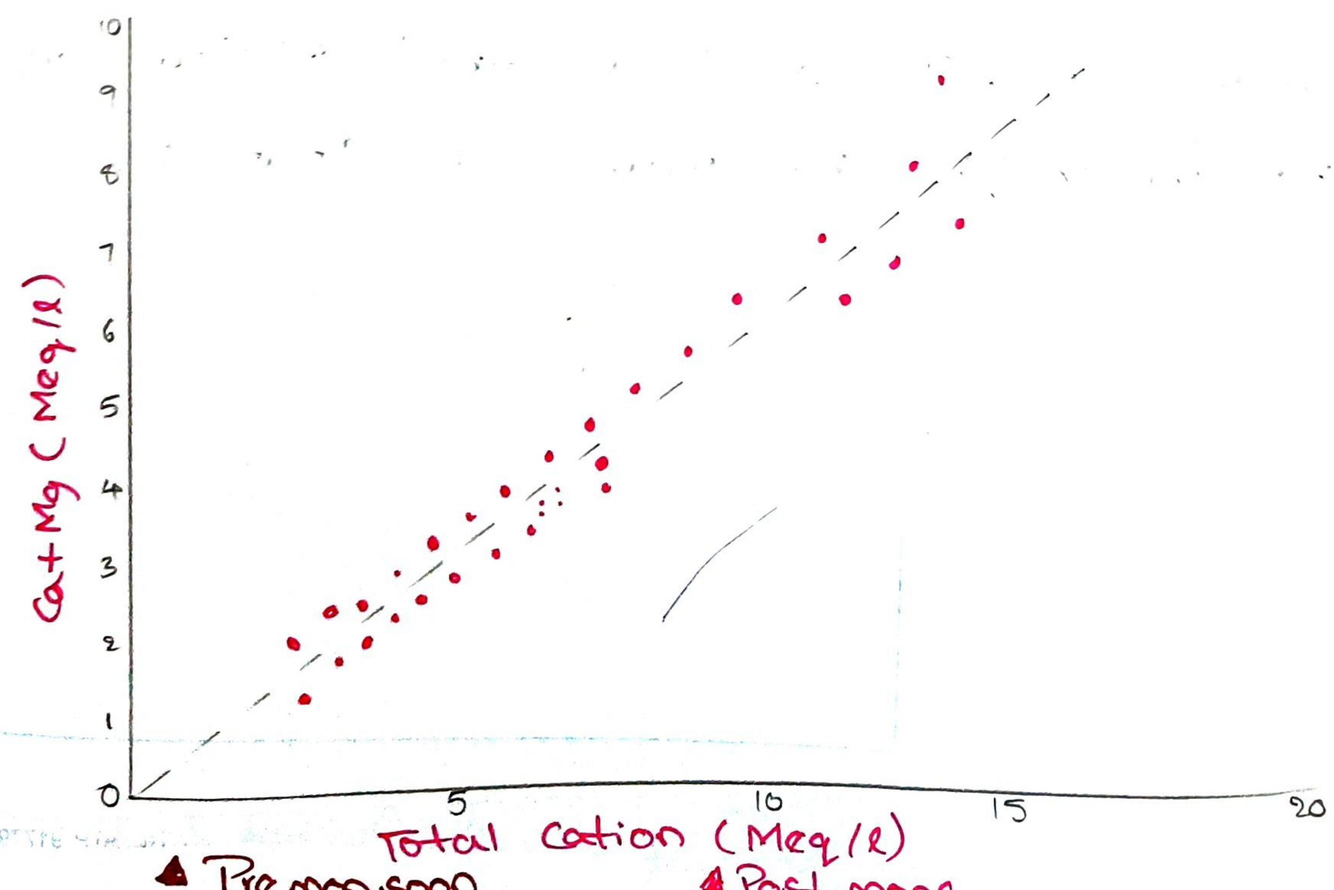
It is more applicable to ground water data that are interrelated than to miscellaneous surface water analysis.

Stiff water patterns are useful in making a rapid visual comparision between water from different sources.

Advantages of stiff diagrams

It is relatively simple to construct. It gives a clear pattern for ions of the same water type. It gives a direct picture of the water type by means of shapes.





▲ Pre monsoon ▲ Post monsoon

4. SCATTERED PLOTS

→ The scattered plot enables us to see the relationship between two variables at once. It can be used to determine the relationship between two set of data.

→ The measure of this relationship between any of these two variables is called correlation.

→ When we plot the values or points on the rectangular coordinate axes indicating x and y axes. The resulting picture is the scattered plot.

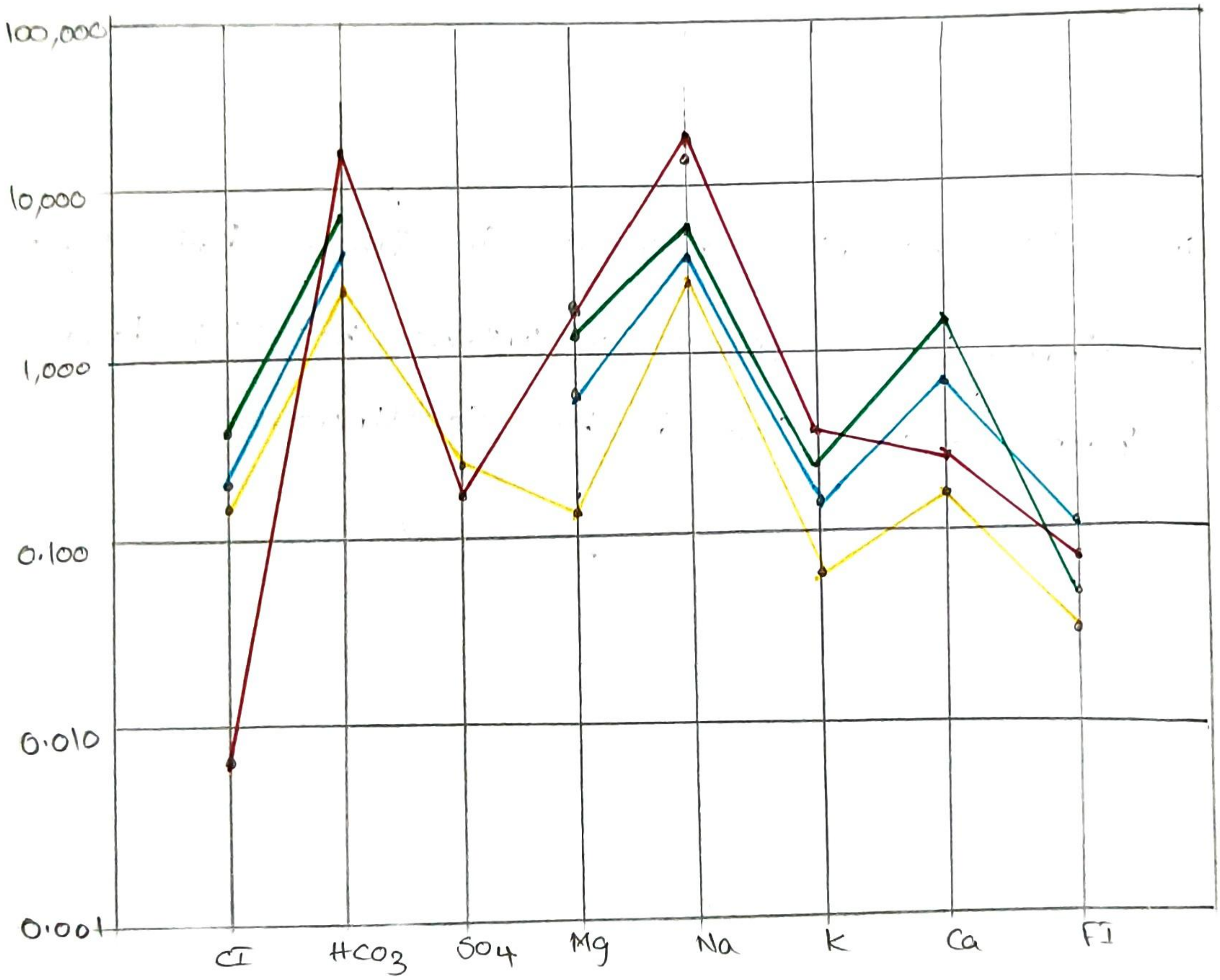
Advantages of scattered plots

Shows a trend in the data relationship.
Retains exact data values and sample size.
Shows minimum / maximum and outliers.

Disadvantages of scattered plots

Hard to visualize results in large data sets

Flat trand line gives inclusive results data on both axes should be continuous.



100,000
10,000
1,000
0.100
0.010
0.001
Cl
HCO3
SO4
Mg
Na
K
Ca
Fl

5. Schoeller Semilogarithmic Diagram

* Schoeller (1962) proposed the use of semi logarithmic graph paper to plot the concentration of anions and cations. The concentrations are plotted in milliequivalent per liter.

* That type of diagram allows us to make a visual comparision of the composition of different water. They are plotted on six equally spaced logarithmic scales in the arrangement.

* The points plotted are joined by straight line. This type of graph shows ~~not~~ only the absolute value of each ion ~~but~~ also the concentration differences among various ground water analysis.

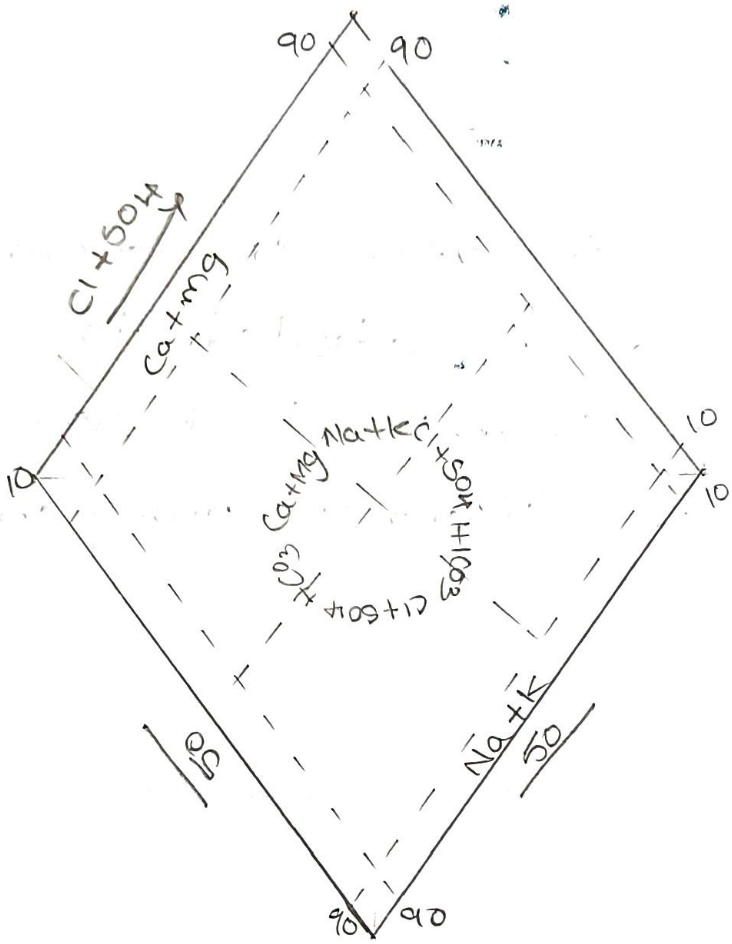
* Because of the logarithmic scale, a straight line joining the points A and B of two ions in a water sample is parllel to another straight line joining the point A and B of the same ions in both analysis is equal.

Advantages of schoeller diagram

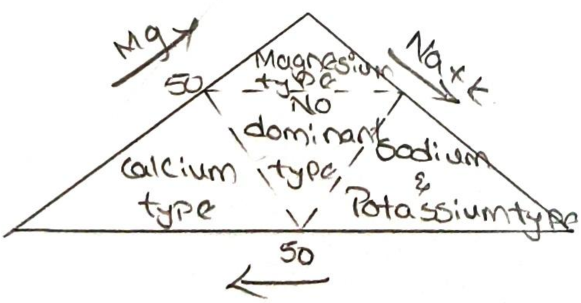
* It is widely used for comparing water analysis. It can be adapted to determine the degree of saturation in water. It shows the concentration difference among various water analysis.

Disadvantages of schoeller diagram

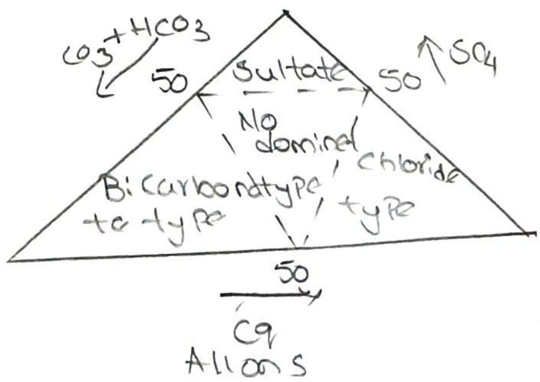
* It does not show the water type directly. Use only with continuous data.



90
90
Cl+SO4
Ca+mg
10
10
10
Na+K
Ca+mg
Cl+SO4
HCO3
Cl+SO4
CO3
Na+K
50
50
90
90



Mg
50
Magnesium type
Na+K
No dominant type
Calcium type
Sodium & Potassium type
50



CO3+HCO3
50
Sulfate
50
SO4
No dominant
Bicarbonate type
Chloride type
50
Ca
Anions

6. Piper Diagram

This method was devolped by Arthur M. Piper (1944). Diagram reveals similarities and differences among large number of ground water samples because those with similar qualities will tend to plot togather as groups.

The following are steps for plotting a Piper diagram.

Calculate the concentration of the analysed major ions (Na^+, k^+, Mg^{2+}, Ca^{2+}, Cl^-, HCO_3^-, CO_3^{2-}, and SO_4^{2-}) in milliequivalent per litre.

2. Calculate the percentage milliequivalent of anions.

→ The most commonly used diagram to interpret the results of water quality is the piper plot.

→ To plot an analysis on a piper plot an analysis on a piper plot, the cations and anions are first plotted separately in the triangles at the bottom left and right and the lines are drawn upward from the plotting position with in both the triangles until the meet with in the upper diamond.

By the use of Piper diagram chemical relationship among waters may be brought out in more definite terms than is possible with any other plotting graphical procedure. Pipe plotting is a very useful.

Advantages of Piper Diagram

It is most useful for representing and comparing water quality because it reveals the similarities and difference among water samples. It directly gives you the various water types. It can handle results of many samples of water with in the same graph.

Disadvantages of Piper Diagram

It is not good for a few data sets thats make it hard to be compared.