GEL4250 Groundwater (Hydrogeology)

Manitou Springs Water Chemistry Graphical Analysis Assignment

ASSIGNMENT GRADING RUBRIC

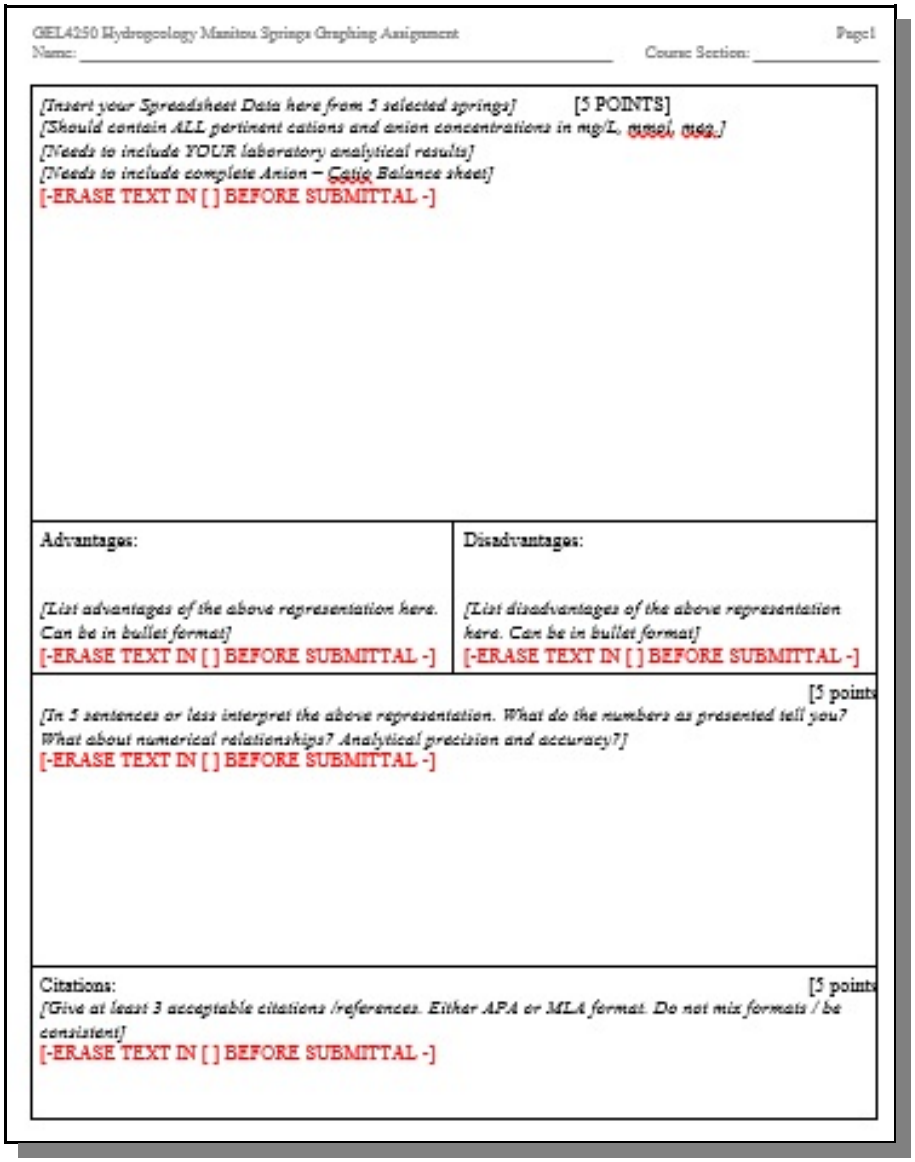
Grade:

Name:_____ Section: _____

The Project consists of 6 individual pages. Each page is subdivided into 5 panels and graded on a 5points/panel, 25 points/page grading system as indicate below. These raw points received will be added to derive at your final score.

Raw Point Distribution:	□ □ □ □ □ Panel:	6 pts (A+), 5pts(A), 4pts (B), 3.5pts (C), 3pts (D), <3pts (F)
	□ Extra credit for outstanding work	-1pt for every uncertainty, error, or incomplete; -1 to -3pts for quality BELOW other students

Note: A+ summa cum laude (26pts) is only given for very exceptional & outstanding performance rarely seen!
A magna cum laude (25pts) is reserved for excellent work without any necessary improvement !



GEL4250 Hydrogeology Manitou Springs Graphing Assignment Page1
Name: _____ Course Section: _____

[Insert your Spreadsheet Data here from 5 selected springs] [5 POINTS]
[Should contain ALL pertinent cations and anion concentrations in mg/L, meq/L, meq.]
[Needs to include YOUR laboratory analytical results]
[Needs to include complete Anion – Cation Balance sheet]
[-ERASE TEXT IN [ ] BEFORE SUBMITTAL -]

Advantages:	Disadvantages:
[List advantages of the above representation here. Can be in bullet format] [-ERASE TEXT IN [ ] BEFORE SUBMITTAL -]	*[List disadvantages of the above representation here. Can be in bullet format]* [-ERASE TEXT IN [ ] BEFORE SUBMITTAL -]

[5 points
[In 5 sentences or less interpret the above representation. What do the numbers as presented tell you? What about numerical relationships? Analytical precision and accuracy?]
[-ERASE TEXT IN [ ] BEFORE SUBMITTAL -]

Citations: [5 points
[Give at least 3 acceptable citations /references. Either APA or MLA format. Do not mix formats / be consistent]
[-ERASE TEXT IN [ ] BEFORE SUBMITTAL -]

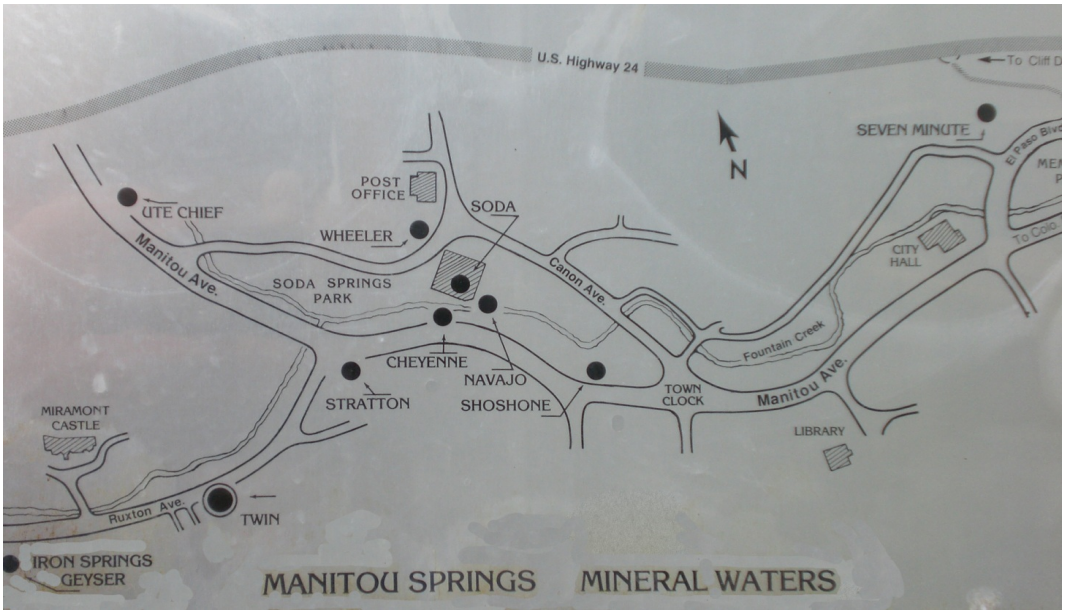
This is a generic page showing the grading and grade distribution for each panel. Please download the complete template for the assignment for details.

Please populate the Data / Graph Fields with ELECTRONICALLY PREPARED COPIES ONLY. NO hand drawn graphs please.

Most graphical manipulation can be accomplished by becoming familiar with and using the graphing functions in MS Excel or equivalent spreadsheet software.

Note: Having a working knowledge of Excel is a prerequisite for this class. So please do NOT ask me how to do this. There are plenty of tutoring websites available and I have neither time nor desire to help you learn such basic essential skills.

Manitou Springs Water Chemistry Graphical Analysis Assignment



For this project you will travel in a group to the town of Manitou Springs to sample, analyze, study & interpret the unique natural mineral waters of the area.

You will be assigned one of the 8 working mineral springs as a group. Please make sure your contact information is correct in case group members need to contact you!:

Spring	Group Members & Contact Information
Twin Spring	
Seven Minute Spring	
Stratton Spring	
Ute Chief Spring	
Cheyenne Spring	
Shoshone Spring	
Navajo Spring	
Wheeler Spring	
Iron Spring	
Soda Spring	Not running and no indicators that it will be restored at all.

Field Data Collection

Measurement & Data Collection for assigned Mineral Spring

Field Measurements Template:

Spring Name:	Location:	Geology:	Date:
Temperature: °C	Conductivity:	pH:	eh:
Organoleptic Assessment:			
Flow Rate Measurement:			
Sampling Technician w/ contact information:			

Organoleptic Testing: Odor & Taste test. Have a bottle of distilled water ready for taste comparison. Make sure you have not eaten any highly flavored or sweet foods right before the test. Take a swig of distilled water and observe taste carefully. Then follow with a sample of Mineral Spring water. Describe any odor or taste as accurately as possible. Salty taste may stem from high concentrations of Na and/or Cl, while a bitter taste may be the result of elevated $MgSO_4$. Sweet tasting water is often the product of bicarbonate ions with very little else. Tangy flavor is due to acidity such as produced by carbonic acid (natural carbonation). High concentrations of Iron have a distinct iron (almost blood like) taste, yuk!

Field Sampling Bottles

Fill three bottles with mineral water from your spring. Two bottles will be used for your own analytical service, one bottle will be diluted and acidified upon your return for 72 chemical element ICP analysis described below.
All sampling bottels are to be rinsed three to for times with the sampling water before being filled to the brim and tightly closed. ALL bottles are to be transported in a cooler with ice or ice-packs out of light and stored in a refrigerator until analysis. The maximum storage time before testing is summarized below:

Compound	Preservation	Maximum Holding Time
Alkalinity	cool, 4°C	14 days
Boron, Hardness, Metals	HNO_3 pH<2	6 months
Bromide, Chloride, Fluoride	None	28 days
pH	None	Immediately
Nitrate	cool, 4°C	48 hrs
Sulfate, Phosphorous, Conductivity	cool, 4°C	28 days

AFTER FIELD SAMPLING YOU MUST DO ALL THE LISTED IN-HOUSE LABORATORY TESTS WITHIN 48 HOURS. PLAN YOUR SAMPLING TRIPS AND ANALYTICAL TIMES ACCORDINGLY!

Water Analysis

IN-HOUSE LABORATORY TESTING PERFORMED BY YOU

NOTE: YOU MAY WORK IN GROUPS. HOWEVER, THE WRITE-UP AND COMPILATION IS NOT A GROUP PROJECT AND MUST BE SOLELY YOUR WORK!

ANION TESTING

SO_4-test: To test for sulfate use any professional laboratory spectrometer equipment. Follow instructions explicitly and keep equipment clean. Calculate S from SO_4 measurements.

HCO_3-test: To test for bicarbonate use the exact titration procedure learned in a previous lab exercise. See attached. E-mail results to Dr.K fro inclusion in the raw data matrix.

NO_3-test: To test for nitrates, use an UV/VIS spectrometer. Measurement of UV absorption at 220 nm enables rapid determination of nitrate. In order to combat interference by dissolved organic matter, which also absorbs at 220 nm but does not absorb at 275 nm, use a second measurement made at 275 nm for correction.

Cl-test: To test for chloride either use a calibrated probe or spectrometer measurements as per instruction.

CATION TESTING

Ca, K, Na, Mg-test: To test for calcium, potassium, sodium, and magnesium cations you will use an AAS (Atomic Absorption Spectrometer). Please contact the Lab Coordinator for time and place.

Selected cations-test: To test for other selected cations you will also use an AAS (Atomic Absorption Spectrometer) depending on the availability of analytical lamps. Please contact the Lab Coordinator for time and place.

ALL ANALYTICAL RESULTS NEED TO BE SHARED WITH EVERYBODY IN THE COURSE IN A TIMELY MANNER! PLEASE DISTRIBUTE ELECTRONICALLY IMMEDIATELY AFTER ANALYSIS!

BICARBONATE IN WATER

MATERIALS:
Titration burette, 200mL beaker / Erlenmeyer flask, Cooper-Indicator, 50mL 0.1n HCl, Vessel with $CaCO_3$ chips for waste disposal

PROCEDURE:
Place 100.00mL water sample into flask. Add 5 drops Cooper indicator. Your water sample should turn blue.

Fill titration burette with 0.1n HCl. Carefully drop HCl from burette into flask. Shake flask continuously. When color changes from blue to clear or onion-skin color is achieved, immediately stop adding HCl.

NOTES:
Depending on the amount of HCO_3^- present, you may go faster at first, but at the end it is one drop at a time. Your point of color change MUST BE EXACT.

RESULTS:
Carefully record mL of HCl used. Then use the equation below to calculate HCO_3^- in mg/L:

$$\text{-----}\frac{mg}{L}_{HCO_3} = \left(\frac{\text{----}mL_{0.1nHCl} \times 0.1n_{HCl} \times 1000\frac{mmol}{mol}}{100.00mL_{H_2O}} - 0.005\frac{mmol}{L} \right) \times 61\frac{mg}{mmol\,HCO_3}$$

Note:
n = m = mol/L; 0.005mmol/L = acid correction factor due to H_2CO_3

CLEAN-UP:
Dump flask contents into vessel with $CaCO_3$ chips. Rinse flask with tap water and discard rinse into $CaCO_3$ chipped vessel. Use dish soap & bottle brush to clean flask. Rinse thoroughly with tap water, discard rinse into sink. Do a final rinse with DI water, discard rinse into sink. Dry outside with paper towels, put away to dry.

Empty left over burette contents into vessel with $CaCO_3$ chips. Rinse thoroughly with DI water and discard into same vessel. Dry outside with paper towels, put away to dry.

Put stands, clamps and other materials away. Wipe down work area with paper towels.

Making a 0.1nHCl solution from concentrated 37% HCl!
8.33cm^3 of 37% HCl in 991.67cm^3 DI water. (37% HCl = 12M HCl = 12N HCl; 8.33$cm^3_{37\%HCl}$=0.1N_{HCl}*1000cm^3/12N_{HCl})
Making Bicarbonate Titration Indicator after Cooper
Dissolve 0.02g methyl red and 0.10gbromocresol green in 100mL 95% alcohol.

DILUTION & ACIDIFICATION PROCEDURE

MATERIALS:
Water samples, DI water, 20mL 1:1HNO_3, 2× 100mL mixing vessels, Scale, 100mL Graduate cylinder, 2× Shipping Vessels, Labeling Stickers, cleaning solution & bottle brushes. Vessel with $CaCO_3$ chips for waste disposal.
***Note:* Refrigerate ALL liquids used for 1 hr before proceeding.**

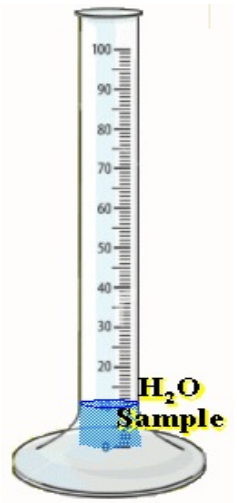
PRE-CLEANING:
All sampling and measuring vessels must be ABSOLUTELY CLEAN. Simple rinsing with DI water will NOT be sufficient. You will have to clean ALL your vessels used, including the sampling bottles carefully with soap and bottle brush. Remember, our analysis using an ICP-MS will pick up any level of trace contamination.

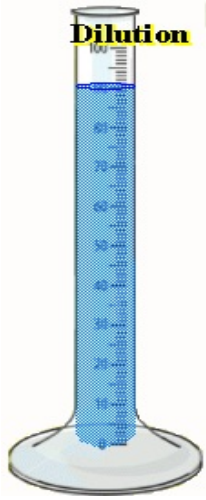
PROCEDURE:
Take two 100mL mixing bottles. Label one of the bottles with your Group & Sample Label we will call "SAMPLE". The other bottle should be labeled with your group and an acronym for blank we will call "BLANK".

For the bottle labeled BLANK, fill with exactly 90.00mL of distilled or DI water. Then add exactly 10.00mL of 1:1 HNO3. Because all measurements need to be exact, you may want to use a scale instead of a graduate cylinder. Since all liquids are refrigerated (~4°C), they are at the perfect density for using a scale without adjusting for temperature volume expansion.

Next, fill the SAMPLE mixing bottle with exactly 10.00mL of your water sample. Add exactly 80.00mL of distilled or DI water. Then add exactly 10.00mL of 1:1 HNO_3. Again, because all measurements need to be exact, you may want to use a scale instead of a graduate cylinder.

***Note:** If you do the BLANK first, you can use the measuring vessels again for the SAMPLE without re-cleaning your vessels.*





NOTES:
For GROUP use initials of Members
Example for Labels: YEAR-GROUP-SPRING (e.g.; 2011-JDSGBB-TWIN)
Example for "Blank" Label: YEAR-GROUP-BL (e.g.; 2011-JDSGBB-BL)
Remember, because we diluted the sample by a factor of 10, we have to multiply test results from returned analysis by 10 to convert values back to original concentration. A spreadsheet is very helpful for this calculation.

SHIPPING:
Transfer "SAMPLE" and "BLANK" to shipping bottles and label. Write VERY legibly (better yet type / print on sticky label). Close both bottles very, very tight. Turn over and check for leaks. Bottles are now ready for shipping and may be kept in the refrigerator until the mailing date.

CLEAN-UP:
Acidified leftovers should be dumped into vessel with $CaCO_3$ chips. Rinse all glassware with tap water and discard rinse into $CaCO_3$ chipped vessel as well. Use dish soap & bottle brush to clean mixing vessels. Rinse thoroughly with tap water, discard rinse into sink. Do a final rinse with DI water, discard rinse into sink. Dry outside with paper towels, put away to dry.

Wipe down work area with paper towels. Put equipment away.

NITRATE IN WATER

MATERIALS:
Spectrophotometer with cuvette that transmits UV light.
Nitrate-free water (Di-Water); stock nitrate solution; intermediate nitrate solution; hydrochloric acid solution, HCl, 1 N.

PROCEDURE:
Sample Pretreatment: To 50 mL clear sample add 1 mL HCl (1N) solution and mix thoroughly.

Preparation of standard curve: Prepare calibration standards in the range of 0 to 7 mg NO_3^--N/L by diluting to 50 mL the following volumes of intermediate nitrate solution: 0, 1.00, 2.00, 4.00, 7.00, 35.0 mL. Treat standards in same manner as samples.

Spectrophotometric measurement: Read absorbance using distilled deionized water as the reference. Use a wavelength of 220 nm to obtain reading and a wavelength of 275 nm to determine interference due to dissolved organic matter.

NOTES:
Use this technique only for screening samples that have low organic matter contents, i.e., uncontaminated natural waters and potable water supplies. The calibration curve follows Beer's law up to 11 mg /L.
Presence of dissolved organic matter, surfactants, NO_2^- and Cr^{6+} interfere.

RESULTS:
For samples and standards, subtract two times the absorbance reading at 275 nm from the reading at 220 nm to obtain absorbance due to NO_3^- . Construct a standard curve by plotting absorbance due to NO_3^- against NO_3^- -N concentration of standard. Using corrected sample absorbances, obtain sample concentrations directly from standard curve.

Note:
If correction value is more than 10% of the reading at 220 nm, do not use this method.

CLEAN-UP:
Turn off and store instrument or replace dust cover.

Dilute samples with tap water and pour down the drain. Clean all cuvetes and vessels thoroughly with soap and water. Do a final rinse with DI water, discard rinse into sink. Dry outside with paper towels, put away to dry.

Put materials away. Wipe down work area with paper towels.

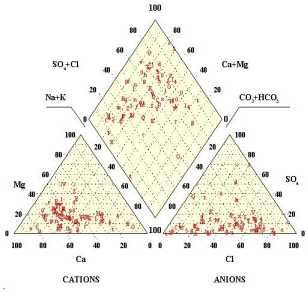
Stock nitrate solution: Dry potassium nitrate (KNO_3) in an oven at 105°C for 24 h. Dissolve 0.7218 g in water and dilute to 1000 mL; 1.00 mL = 100µg NO_3-N.
Intermediate nitrate solution: Dilute 100 mL stock nitrate solution to 1000 mL with water, 1.00 mL = 10.0µg NO_3-N.

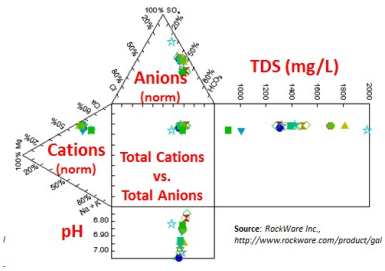
Manitou Springs Water Chemistry Graphical Analysis Assignment

You will need to report your findings in various ways. Please look at the template for greater details. Here is a collection of information concerning database spreadsheets and graphs.

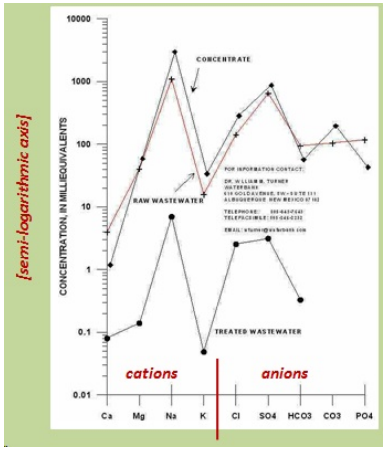
Creating Analysis Computational Spreadsheet:
see Fetter (2001) Ch. 9 p. 382 Figure 9.16 "Format of EXCEL spreadsheet to make basic geochemical calculations"
Use this sample to create your own spreadsheet. HOWEVER, include additional Cations / Anions as reported by geochemical laboratory. Do a Cation - Anion balance.

Piper Diagram:
Review Fetter (2001) Ch.9 Section 9.14.1 p. 374 - 376 "Piper Diagram"
Use the procedure to create the piper diagram for ALL SAMPLES. Obtain needed data from other Mineral Spring Groups. A blank piper diagram is attached. You may also play around with the free USGS software called GW chart, available at
http://water.usgs.gov/nrp/gwsoftware/GW_Chart/GW_Chart.html .

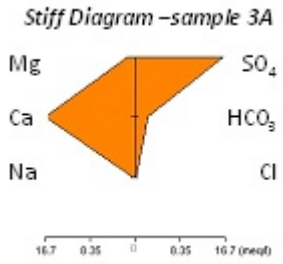




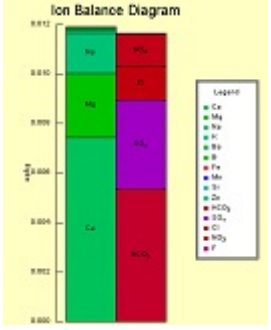
Durov Diagram:
The intersection of lines extended from the two sample points on the triangle to the central rectangle gives a point that represents the major-ion compositions on a percentage basis. From this point, lines extending to the adjacent scaled rectangles provide for representations of the analyses in terms of two parameters selected from various possibilities, such as total major-ion concentrations, total dissolved solids, ionic strength, specific conductance, hardness, total dissolved inorganic carbon, or pH.



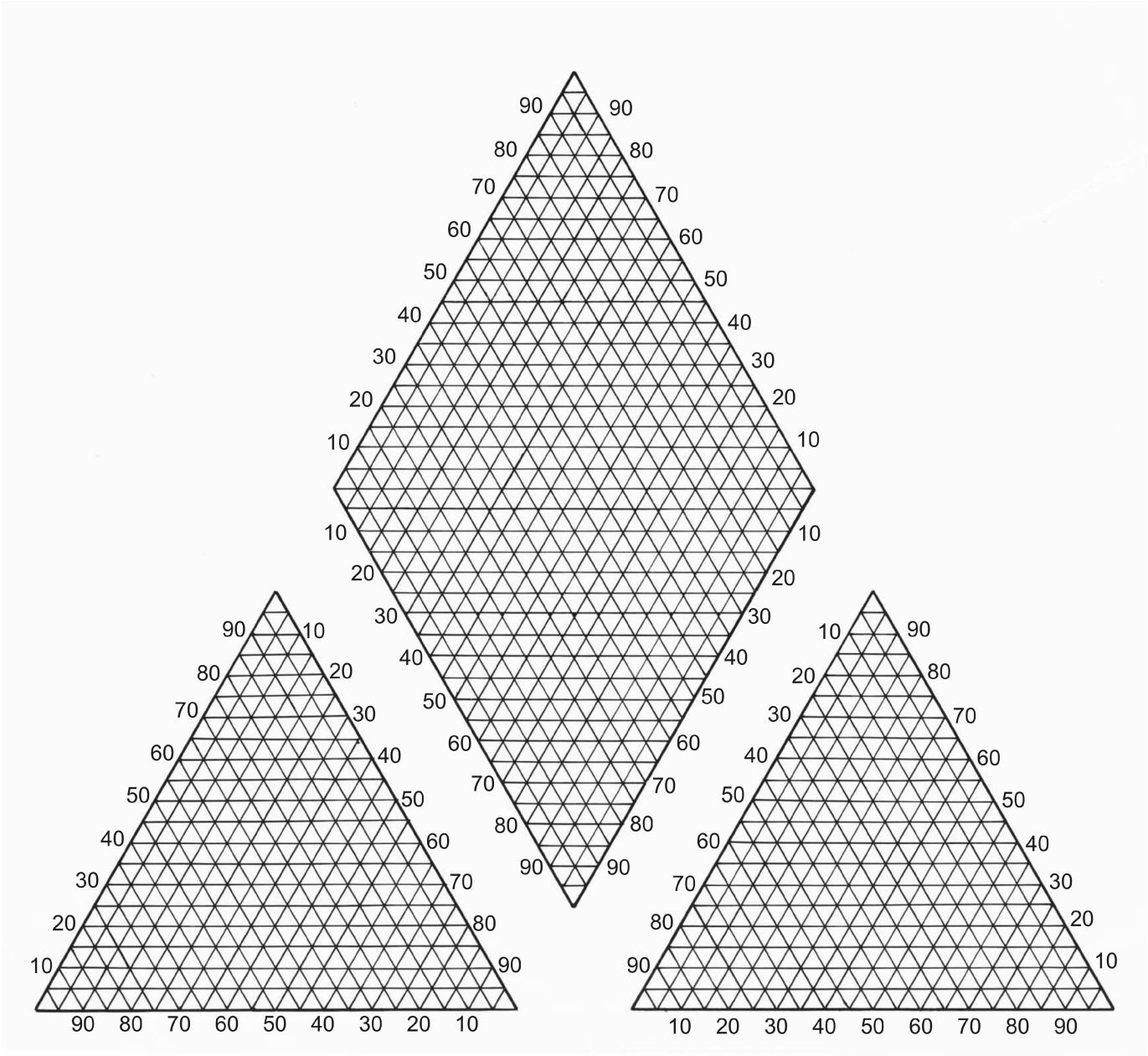
Schoeller Diagram:
A Schoeller Diagram is a semi-logarithmic diagram of the concentrations of the main ionic constituents in water (SO_4, HCO_3, Cl, Mg, Ca, Na/K) in milliequivalents per L of solution (meq/L). Concentrations of each ion in each sample are represented by points on six equally spaced lines and points are connected by a line. The diagram gives absolute concentration, but the line also gives the ratio between two ions in the same sample.
If a line joining two points representing ionic concentrations in a single sample is parallel to another line joining a second set of concentrations from another sample, the ratio of those ions in those samples are equal. Hence equal slope = equal ratios!



Stiff Diagram:
A polygonal shape is created from three or four parallel horizontal axes extending on either side of a vertical zero axis. Cations are plotted in milliequivalents per liter on the left side of the zero axis, one to each horizontal axis, and anions are plotted on the right side. Stiff patterns are useful in making a rapid visual comparison between water from different sources.
Depending on the scope of the investigation, additional plot pairs may be added or exchanged, such as: Fe - NO_3, K - NO_3, Fe - CO_3



Ion Balance Diagram:
Ion Balance diagrams are stacked bar graphs with the left stack representing the Cations, the right parallel stack are Anions. Plot concentration is millieqivalents perliter (meq/L). If both stacks have about the same height or are equal, the cations and anions are more or less balanced.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