How do we check correctness of analyses?

1. Compare Measured TDS and Calculated TDS

<table>
<thead>
<tr>
<th>Solute</th>
<th>Measured Conc (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca$^{2+}$</td>
<td>92.0</td>
</tr>
<tr>
<td>Mg$^{2+}$</td>
<td>34.0</td>
</tr>
<tr>
<td>Na$^+$</td>
<td>8.2</td>
</tr>
<tr>
<td>K$^+$</td>
<td>1.4</td>
</tr>
<tr>
<td>Fe(III)</td>
<td>0.1</td>
</tr>
<tr>
<td>HCO$_3^-$</td>
<td>325.0</td>
</tr>
<tr>
<td>SO$_4^{2-}$</td>
<td>84.0</td>
</tr>
<tr>
<td>Cl$^-$</td>
<td>9.6</td>
</tr>
<tr>
<td>NO$_3^-$</td>
<td>13.0</td>
</tr>
</tbody>
</table>

NOTE:
When calculating TDS we group the mass of some items and call it Alkalinity

\[
\text{Alkalinity} = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] + [\text{OH}^-] - [\text{H}^+]
\]

We will talk more about Alkalinity in the next lecture

2. Calculate Charge Balance

Check Correctness of Analysis: Calculate TDS

\[
\text{Calculated TDS} = 0.6 \times \text{Alkalinity} + \text{Na} + \text{K} + \text{Ca} + \text{Mg} + \text{Cl} + \text{SO}_4^2- + \text{SiO}_2 + \text{NO}_3^- + \text{N} + \text{F}
\]

Alkalinity = \([\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] + [\text{OH}^-] - [\text{H}^+]) = 325

Calculated TDS = 567.2 mg/L

Measured value in this case 603.5 mg/L

What is the ratio? Is it acceptable?

\[
\text{ratio} = 1.06 \quad \text{is acceptable}
\]
### Summary checking correctness of analysis

1. **Check Calculated vs Measured TDS**

   \[
   \frac{\text{measured TDS}}{\text{calculated TDS}} = \frac{603.5}{567.2} = 1.06
   \]

   Between 1 and 1.2, so it's OK!

2. **Check Anion-Cation (Charge) Balance**

   \[
   \frac{\sum \text{cations} - \sum \text{anions}}{\sum \text{cations} + \sum \text{anions}} = \frac{7.79 - 7.56}{7.79 + 7.56} = 0.0145
   \]

   The cation/anion imbalance for the data is 1.5% < 5% so it's OK!
Plotting on a Piper Diagram

Ca 40 ppm  
Mg 15 ppm  
Na 120 ppm  
K 20 ppm  
HCO₃⁻ 2.8 meq/L  
SO₄²⁻ 234 ppm  
Cl 45 ppm  

Convert to Equivalents / L  
Divide by formula weight  
Multiply by charge  

Ca 1.996×10⁻³  
Mg 1.234×10⁻³  
Na 5.222×10⁻³  
K 0.51×10⁻³  

So 4 234  ppm  
Cl 45  ppm  

Sum Na+K  
Normalize Ca Mg Na+K to 100%  
Normalize HCO₃⁻ SO₄²⁻ Cl to 100%  

Ca 22.3%  
HCO₃⁻ 31.3%  
Mg 13.7%  
SO₄²⁻ 54.5%  
Na+K 64.0%  
Cl 14.2%  

Mg 13.7%  

When plotting many samples sometimes we make the symbol size proportional to TDS.

**Plot on a Piper Diagram distributed in class**

Ca 131 ppm  
Mg 44 ppm  
Na 43 ppm  
K 7 ppm  
HCO₃⁻ 200 ppm  
SO₄²⁻ 431 ppm  
Cl 19 ppm  

Bicarb=Carb Chloride Sulfate  

Ca 53.6  16.8  29.7  
K + Na 70.2  4.2  25.6  
Mg  

Plotted point is approximate given ppt drawing limitations.

THIS IS THE WILD ROSE SAMPLE FROM THE DEATH VALLEY DATA SET.

CATIONS  

Na+K HCO₃⁻ +CO₃⁻ Cl  

Ca 22.3%  
Mg 13.7%  
Cl 14.2%  

ANIONS  

SO₄²⁻ 54.5%  

Calcium (Ca)  

Magnesium (Mg)  

Sodium (Na)  

Potassium (K)  

Bicarbonate (HCO₃⁻)  

Carbonate (CO₃²⁻)  

Chloride (Cl)  

Sulfate (SO₄²⁻)
The sample data that you just plotted on the paper Piper diagram in class is one of the Death Valley samples, Wildrose Spring. Compare your plotted point to the one that Rockware plots.

Consider the Data with respect to the maps on the next two slides. (note: we will discuss these again in an upcoming class)

HOMEWORK:
Make an interesting observation using Rockworks on one of these data sets. You must attach the associated Rockworks diagram and explain how it supports your observation.