Hydrogeochemistry Class Demonstrations

1. Mineral dissolution rates (can also be used for a soils or mineralogy course)

This class demonstration communicates the role of particle size and surface area in influencing mineral dissolution rates. A quickly dissolving mineral (halite) is used to demonstrate this concept. The specific conductance of the water that the halite dissolves into is used to measure dissolution over time.

Materials:

   a. Coarse salt (~3-5 g)
   b. Mortar and pestle
   c. Weigh boats
   d. Balance
   e. Deionized water (2 L)
   f. 2 L beakers (2)
   g. Stir plate and stir bar
   h. Electrical conductivity meter (can be purchased for ~$30 on Amazon)

Set up:

   a. Discuss concepts of surface area, mineral dissolution, and specific conductance
   b. Explain the experiment, and then hypothesize what the results will be.

Instructions:

   a. Grind half of the coarse salt into a fine powder using the mortar and pestle
   b. Weigh 1 g of each coarse salt and fine salt
   c. Fill two beakers each with 1 L of deionized water
   d. Measure the electrical conductivity of water in each beaker using an EC meter. It should be ~0 μm cm^{-1}.
   e. Place one beaker of water onto a stir plate and set the water to mix gently but thoroughly
   f. Keeping the EC meter in the water, add the coarse salt to the water
   g. Record electrical conductivity every 5 seconds (for 30 seconds) and then every 10 seconds until readings stay constant
   h. Repeat the experiment with the finely ground salt.
   i. Plot the results of the demonstration as EC versus time (see below) to visualize the differences in dissolution.
   j. This activity can be extended to covert EC into mg/L NaCl by converting EC to TDS and assuming all TDS represents Na$^+$ and Cl$^-$ ions. Then, dissolution rates (mg/s or mmol/s) can be calculated as the slope of the linear portion of each line.
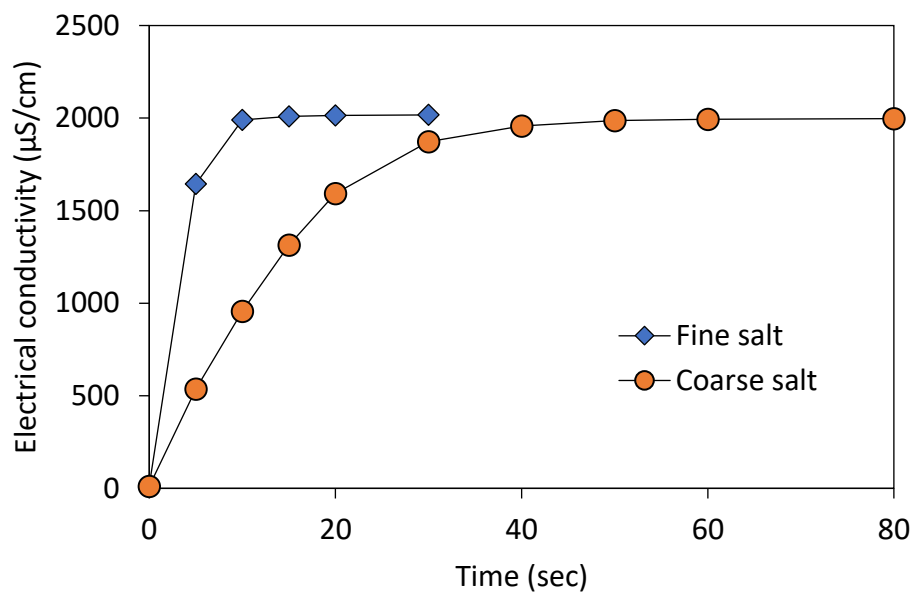
Notes:

a. Students can do this activity in small groups or participate in a demonstrate by having volunteers perform the experiment and/or record EC.

2. Alkalinity

This activity demonstrates how carbonate species influence the pH of water.

Materials:

    a. SodaStream or other water carbonation method
    b. Tums or equivalent calcium carbonate tablets (finely ground)
    c. Deionized water (2 L)
    d. 2 L beakers (2)
    e. pH meter

Set up:

    a. Discuss concepts of alkalinity and pH. Hypothesize how adding CO_2 gas through carbonation (similar to soda) or CO_3^{2-} through antacids will alter pH.

Instructions:

    a. Measure the pH of the deionized water
    b. Carbonate 1 L of water with the soda stream, and then remeasure pH.
        a. *pH should decrease as the water becomes more acidic.*
    c. Add the ground antacid tablets to the other 1 L of water and then remeasure pH.
        a. *pH should incrase as the water becomes more alkaline.*

Notes:

    a. Students can bring in their own water to measure pH (and alkalinity, if there is capability for that) to understand how