*Special Thanks to Marianne Dunne of the Cambridge Public School District

Soils As Electrical Systems

This learning activity was designed by Dr. Larry P. Wilding of Texas A&M University

Materials Needed:

- 60 grams (1/4 cup) of clayey soil
- One 500 mL (pint) glass or plastic beaker or jar
- One 6 volt dry-charge lantern battery with two screw top terminals at the top of the battery (e.g. Everready Classic Lantern Battery)
- Two pieces of 12 gauge, plastic insulated, multiple strand, twisted copper wire about 50 cm (20 inches) in length

Procedure:

- Place 60 grams of the clayey soil in the 500 mL glass or plastic jar.
- Add 500 mL of tap water to the above container with soil
- Stir or shake the container for several minutes until the soil is completely mixed with the water.
- Let the suspended soil materials in the container settle for 10 minutes.
- On each end of the electric wires, remove the insulation and strip back to expose the bare wire for about 5 cm (2 inches) at the end of the wires.
- Connect one end of each wire to the terminals of the battery and screw the terminal cap tight to fix the wire to the terminal.
- Place each of the other ends of the electrical wires in the clay suspension about 5 cm (2 inches) below the top of the water line in the beaker holding the clay slurry. Make sure the bare ends of the two wires are spaced about 5 cm (2 inches apart) and do not touch each other. Mark or note which of the two wires is connected to the anode (positive end of the battery) and which is connected to the cathode (negative end of the battery).
- Leave the wire electrodes in the clay slurry for about 10 to 15 minutes and then pull them out to see what happened.

*Special Thanks to Marianne Dunne of the Cambridge Public School District

Observations and Interpretations:

1. Before the wire electrodes are removed from the clay slurry, predict what you will find when the electrodes are removed.

Which electrode do you think will have attracted the clay to accumulate about the bare wire? Why?

2. What general principle is being observed here? Anions (e.g. clay minerals) go to the anode (positive electrode) and cations (e.g. most plant nutrients-Ca, Mg, Na, K, etc.) go to the cathode (negatively charged electrode).

Hence, most plant nutrients (cations) in soils bond to clay surfaces.

3. If, instead of a clay suspension, suppose that the Methylene Blue dye solution had been used.

In that case which electrode would you have predicted that the dye would have been plated out on--cathode or anode?

4. The demonstration here is the same principle used in electrolysis for resilvering a mirror.

Silver chloride is used as the plating material. The mirror is placed in a solution of silver chloride. Cations of silver and anions of chloride form the silver chloride solution. An electric current is introduced into the solution such that the mirror is made the cathode. Hence, silver cations plate out on the mirror by the process of electrolysis.

5. This demonstration also confirms the electrical principle that LIKES REPEL AND UNLIKES ATTRACT.
6. This demonstration confirms the fact that SOILS ARE ELECTRICAL CHEMICAL SYSTEMS that provide remarkable potential to attract and hold plant nutrients. The more positive charge associated with the nutrient the tighter the adsorption to the soil. Also, the greater the clay and organic colloid content of the soil the greater the storage bank that hold nutrients available to plants.
7. The demonstration also supports the remarkable chemical buffering and filtering qualities of soils for cationic pollutants. Most soils also possess some anionic buffering potential but this is less effective than the cationic sorptive capacity. This is why the potential for nitrate pollution from water transport through soil systems is much greater than pollution from metal cations moving through soil systems. However, pollutants absorbed to soil colloidal surfaces can be major concerns to water quality when soil sediments are eroded into fresh water stream and aquifer bodies.