Installing and sampling porous tension-cup lysimeters

Materials

- meter stick
- 2 mm sieve
- soil auger
- silica flour
- plastic bowl
- plastic spoon
- large plastic bag or small tarp
- lysimeters
- latex gloves
- field notebook
- sharpie
- pencil
- 1 L Nalgene water bottles filled with DI water
- lysimeter pump
- sample vials if sampling

Methods

Installation

Porous tension-cup lysimeters are commonly used to collect soil water for chemical analysis. Because the ceramic cup on the lysimeter is fragile, it is advised that foam be wrapped around the ceramic prior to transport. Typically lysimeters are installed as pairs - one shallow lysimeter in the A horizon and one deep lysimeter in the B horizon. Using a soil auger, auger down until you reach the desired depth, making sure that the deep lysimeter is not inserted into the saprolite layer - if the auger starts to make a "crunchy" sound and you notice a lot of rocks, you are probably in the saprolite layer. Soil from the auger should be carefully laid out by depth (shallow soils to deep soils) on the large plastic bag or small tarp so the soil can be easily put back in the hole based on the depth from which it originated. Once the proper depth is reached, take a few handfuls of soil from the lowest depth (be sure to wear latex gloves to prevent contamination) and sieve the soil through a 2 mm sieve to remove any rocks and large particles. Take this sieved soil and mix with silica flour (we use 200 mesh size crystalline silica from US Silica Company, Berkeley Springs, WV) and DI water using the spoon and plastic bowl until a dough-like pasty slurry is formed. Pour this slurry into the hole - there should be enough to cover the bottom of the hole and encase the ceramic cup of the lysimeter. Carefully place the lysimeter into the hole until the ceramic cup is completely encased in the slurry. Then, starting with the deepest soils, start placing soil from the tarp back into the hole, using an old meter stick to push and pack the soil around the sides of the lysimeter. It is important to make sure the soil is compacted tightly around the lysimeter so that overland flow or rainwater does not
leak down the sides of the lysimeter. Finally, in a field notebook, record the depth of the lysimeter (the easiest way is to note the overall length of the lysimeter and subtract the part of the lysimeter sticking out of the ground) and the date the lysimeter was installed. Using the lysimeter vacuum pump, place -30 centibars (0.3 bars) of negative pressure on the lysimeter. Water should be purged at least 2-3 times over a month before the soil water is ready to be collected for analysis. With flagging or lab tape, mark the tubing where the water will pour out so that you insert the lysimeter pump in the correct tubing. Also, it is a good idea to mark the ID of the lysimeter and its depth with a sharpie.

**Sampling**

Once the lysimeter has been purged 2-3 times, it is ready to be sampled. Take off both clamps - if the tubing is stiff, you might have to pressed the kinked part with your fingers until you hear air escape. Sometimes the line is frozen in the winter and you will need to use your hands or a hand warmer to thaw the line out before you can sample. Once both lines are open, place the hose of your lysimeter into the non-sample tube and use your other hand to hold the sample vial under the sample tube where the water will empty from the lysimeter. Pump until water comes out - be sure not to pump too many times or the rubber stopper may pop off. If using a 50 mL poly-propylene centrifuge, fill the vial somewhere between 40 & 45 mL - this ensures that there is space for the water to expand if the sample is placed in the freezer. Be sure to keep your fingers out of the sample vial and from touching the inside of the cap to avoid contaminating the sample. Once the sample is finished, continuing pumping until the lysimeter is completely purged of water. Next close the "sample" tube using the clamp and place the brass "vacuum" end of the lysimeter pump into the other tygon tubing. Pump until a vaccum of -30 centibars is reached and then clamp tube closed. Remove lysimeter and go to the next plots.

**Troubleshooting**

Take note if a sample had water or not. Often if the weather has been dry, there simply isn't enough moisture in the soil and the lysimeter will fail to sample. Otherwise, there are about 4 other reasons why a lysimeter won't sample:

1. If a lysimeter fails to have water over the course of 3 or more sample periods and the soil is relatively moist, it is worth checking to make sure the tube inside the lysimeter is still attached; sometimes the tube separates and needs to reattached.

2. If the lysimeter still does not sample and you can hear air being "inhaled" when you loosen the clamps and the weather has been wet (i.e., the lack of water in the lysimeter isn't because of lack of rain), the tension in the soil around the lysimeter might be compromised (i.e., the ceramic cup isn't in good contact with the soil). Take the lysimeter out and inspect the ceramic cup for cracks. If it looks OK, place back in the ground and follow the instructions for installing a lysimeter - you might need to make another hole.

3. If a lysimeter fails to sample and you don't hear air being "inhaled" when the clamps are loosened, then there is probably a leak. Check around the stopper and the around the holes where the tubing enters the lysimeter. It is a good idea to use silicone to seal around these areas. Place a vacuum on the lysimeter to see if it holds until the next round of sampling.

4. If the lysimeter still doesn't hold a vacuum after doing number 2 above, then the seal around the ceramic cup or the ceramic cup itself has been compromised and the lysimeter will need to be replaced.