EPSCoR soil monitoring network as classroom: preliminary data on the biogeochemistry of soils and streams

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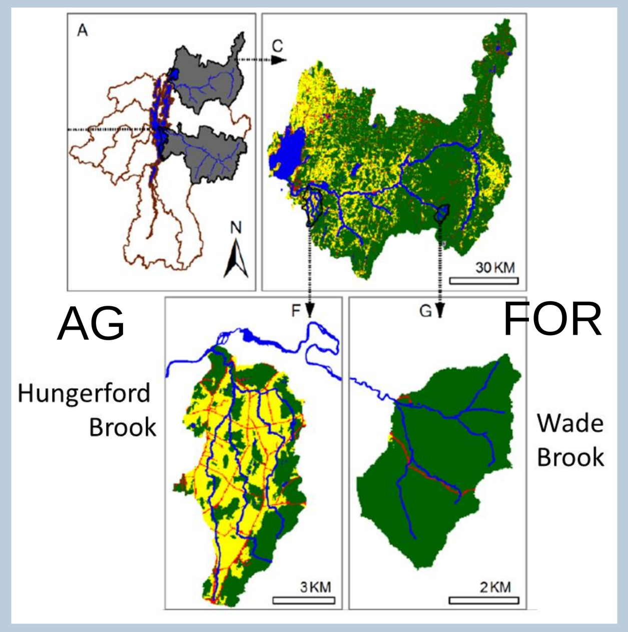
Environmental Geochemistry lab (GEOL135)

- The goal of the lab part of GEOL 135 was to complete a small research project using the soil monitoring network precisely and safely.
- Students completed a research project as a group of up to 3 students.
- They chose from a list of research projects, performed literature searches, developed hypotheses, collected samples in the field, collected data in the lab, analyzed data and synthesized findings to test hypotheses.
- At the end of the semester each group presented their preliminary results. Some of them are shown here.


Left: Kyle McCarthy and Ari Libenson take field notes. Right: Melinda Quock takes auger samples.

The BREE soil monitoring network



- The soil monitoring network of the EPSCoR basin resilience to extreme events (BREE) has 2 locations located in the Missisquoi watershed.
- Location 1 is located in the forested Wade Brook sub-watershed (FOR).
- Location 2 is the agriculturally dominated Hungerford brook sub-watershed (AG).

- Each of these locations (AG and FOR) host extensive sub surface installations (pictures below) in transects across dry and wet areas to investigate hypotheses such as:
- "wet sites are hydrologically better "connected", have a stronger downstream impacts and are therefore less resilient".

Installation of the FOR wet site in summer 2016. Subsurface sensors such as O_2, CO_2 and redox provide continuous information.

BREE postdoc Erin Seybold and PhD student Brittany Lancellotti explain field site design and installations.

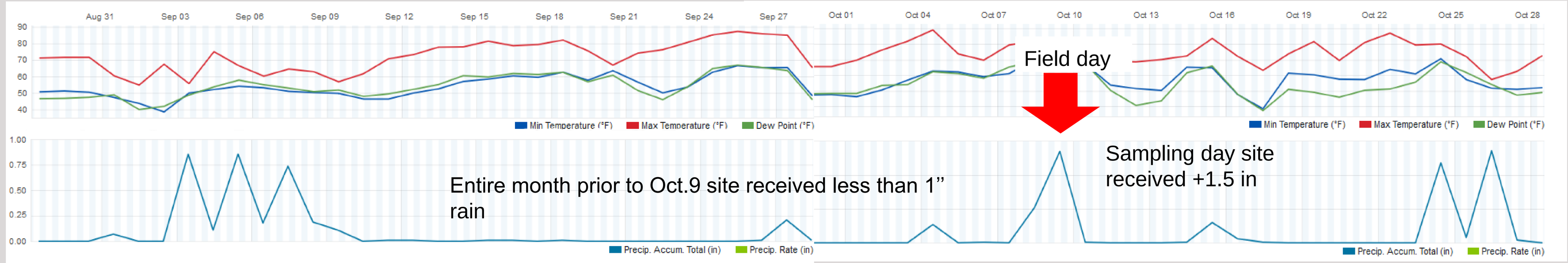
GEOL 135 projects

Students chose from the following **5 general themes:**
1) wetland (clay) mineralogy, 2) soil aggregate stability, 3) dissolved metals, 4) soil water vs. stream water carbon, and 5) stream water carbon in AG vs. FOR settings.
They performed literature research, developed testable hypotheses, a research and a sampling plan.

Field and lab work

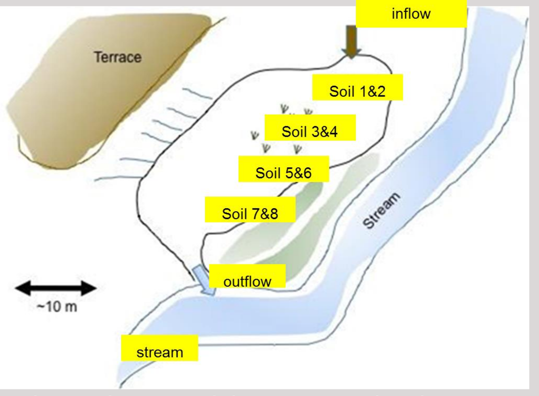
Our field work was conducted during the first significant hydrological event in a month (10/09/2017, below). Since extreme events are the focus of BREE, the rain was quite welcome, however, as stated in field notes by Alex Collins, "the refreshing torrential downpour created slight difficulty in keeping samples, notebooks, and selves dry and uncontaminated…"

Alex Collins and Tim Quesnell take soil samples

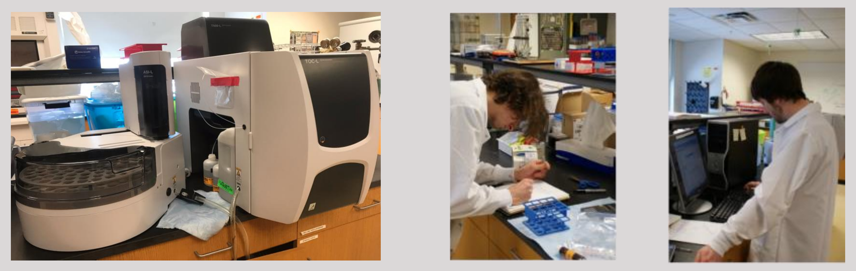


Data for Montgomery, VT from wunderground.com, retrieved by Tim Quesnell.

Sampling plans depended on the questions and hypotheses. For example one group hypothesized that wetland soil solution composition would change along a transect through the wetland due to soil flushing. They compared inflow water composition with soil solution and wetland effluent (right).



Schematic map of the FOR wetland



Typical instrumentation and lab work in Environmental Geochemistry

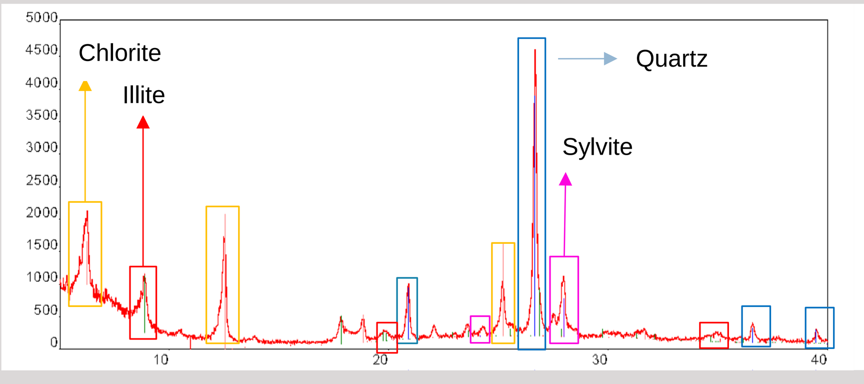
Lab procedures and analyses depended on the research questions.

- (Clay)-mineralogy was assessed with X-ray diffractometry.
- Aqueous soil extracts were used as proxies for soil solution.
- Dissolved metal content was determined with an ICP-OES
- Dissolved carbon and nitrogen concentration were analyzed with a Shimadzu carbon analyzer
- Dissolved organic matter character was determined with fluorescence spectrometry.

Preliminary results mineralogy

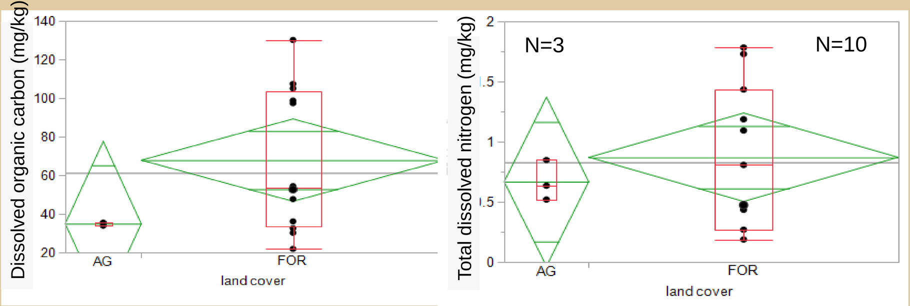
Sample locations AG

X-ray diffraction confirms chlorite and illite as main clay minerals in the gleyed soils (example right).
Smectite confirmation is ongoing. Nutrients present in whitmorite ($Fe^{2+}Fe^{3+}{}_2(PO_4)_2(OH)_2 \cdot 4H_2O$) and sylvite (KCl).



Example diffractogram of wetland clay layer (wet AG).

Preliminary results soils

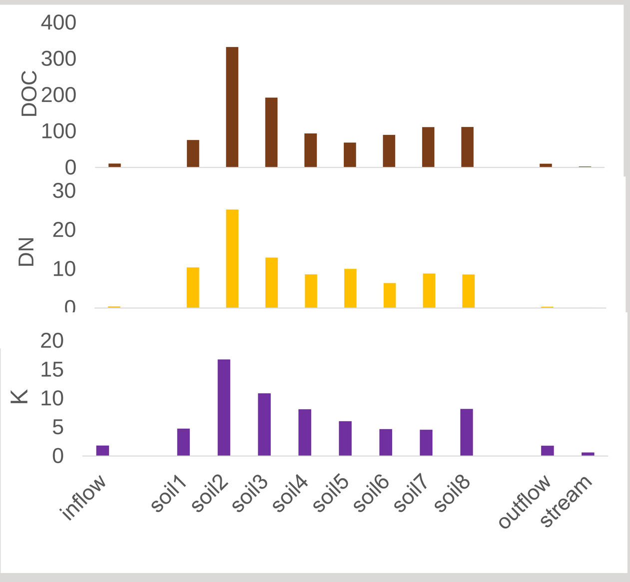


Boxplot of dissolved organic carbon and total nitrogen in aqueous soil extracts.

Amount of water extractable carbon and nitrogen in 0-15cm soil samples were more variable in the forest system than in AG. The differences between FOR and AG samples were not significant for soil extracts.

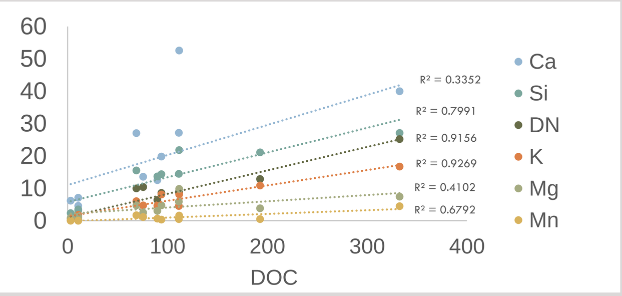
Sophie Ryan and Brenna Anderson take wetland samples

Preliminary results soils vs. streams



Dissolved organic carbon, total nitrogen and potassium along the wetland transect. Inflow, outflow and stream are given in mg/L, soil extract concentrations are given in mg/kg.

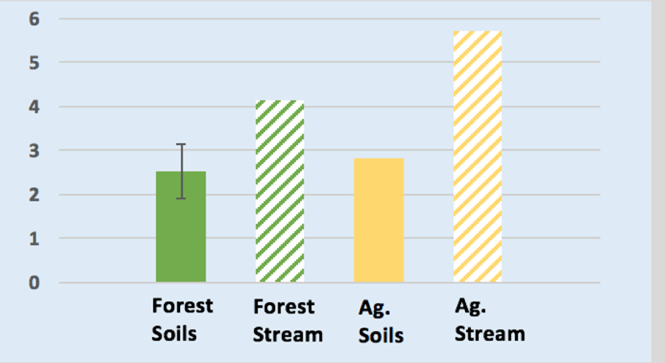
Left: inflow and outflow concentrations are similar and soil extracts along the wetland are variable (see "field and lab work" for a map).
Below: TN and most metals correlate with DOC in stream and soil extracts.



Linear correlation of all tested metals and TN with DOC.

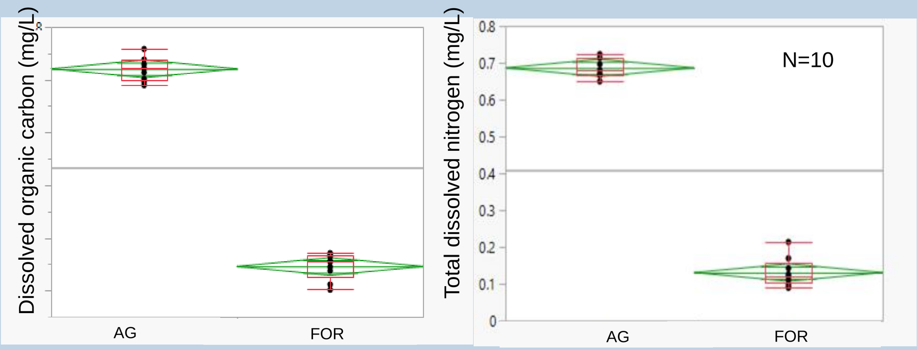
Alex Collins and Tim Quesnell inspect samples.

As expected, soil solutions were always much more concentrated than stream water samples (data not shown). Dissolved organic matter characteristics were also different. For example, the E2/E3 ratio, a measure for molecular size, indicated greater molecular size in soils vs. stream samples.



E2/E3 ratio is inversely related to DOM molecular size.

Preliminary results stream water



Boxplot and ANOVA of stream water dissolved organic carbon and total nitrogen.

Dissolved organic carbon and total nitrogen concentrations were significantly higher in the AG stream.
AG DOM had relatively more terrestrial vs microbial DOM (data not shown).

Annelise Couderc takes stream water samples

Thanks!

Thanks to all students of GEOL 135 for a great semester!

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BREE Basin Resilience to Extreme Events in the Lake Champlain Basin