**EAS 2200 – The Earth System**
**Lab #3: Enfield Glen**

## INSTRUCTOR'S NOTES

### DESCRIPTION

Ithaca NY is currently located in a tranquil mid-continental geologic setting. But Ithaca's past was anything but tranquil. Would you believe that we once sat beneath a mile-thick sheet of ice? Or on the bottom of the ocean? In a zone of high seismic activity? Or volcanic eruptions? Its all true. On this field trip to Enfield Glen, in Upper Treman State Park, we will make measurements and observations that allow us to reconstruct some of the events in the geologic past of this locality. Was New York always on the east coast of North America? Come on, let's find out!

Keywords: fluvial processes, glacial landforms, delta deposition, orogeny, paleogeography

This activity is a 2.5 hour field trip in which students search through strata of the Upper Devonian Catskill Delta for paleocurrent indicators that allow them to infer paleogeographic differences between Devonian and modern time. Through measurement of paleocurrent indicators, joint surfaces, and observation of local landforms, students construct the paleogeographic history of the NY Finger Lakes region.

This is one of the early field trips in the first required class for SES majors. In upstate NY our access to the field is seasonally controlled. In the fall all the field trips have to fit into the first six weeks of the semester, in spring the reverse. As this site is within a State Park that closes in winter, the spring trip is usually run at an entirely different site that opens earlier in the season. The paleocurrent features that form the basis of this trip can be observed almost anywhere within the Devonian deltaic deposits that extend from NY to the southern Appalachians. When we move the trip to different locations we tailor the rest of the discussion to suit that site (e.g. swap out the interglacial gorge story for whatever is most appropriate at the new site). This trip can be adapted to different grade levels; we have run it with Girl Scout troops, lower-division non-majors classes, and upper division courses.

### PRIOR TO THE TRIP

I often use a "Pre-lab Assignment" to get students thinking about the trip before they begin. My favorite pre-lab assignments are those that ask the students to formulate a hypothesis that we will then test in the lab. Sometimes these are true hypotheses, but when students have little background they are just guesses, which is fine too. For this trip I ask them to suggest where the ancient Acadian mountains might have been located. On a good day the various members of the group will propose each of the 4 points of the compass, giving us lots of possibilities to test.

There are three key concepts that have to be communicated prior to the start of the trip. I usually do this on-site at a picnic shelter adjacent to the trailhead.

1 The pulsed deposition of sandstone and shale
2 How paleocurrent indicators work and what they look like
3 How/why joints form

(1) The Catskill Delta sediments are turbidite deposits comprised of interbedded sandstone and shale. In order to understand this, I bring several plastic graduated cylinders (200-500ml) and a bag of poorly-sorted sand to the trailhead. We fill the cylinders with creek water and distribute them among the group. I then ask someone to dump a pulse of sediment into the cylinders. We wait a few minutes, chatting about sediment transport by rivers, and then repeat the sediment pulse. Two very well-defined graded beds have formed in each cylinder, with the sandstone at the bottom and silt on top. We relate this to the deposition of sediment on the delta.
(2) In order to understand paleocurrent indicators and recognize them in the field I bring hand samples with me (actually they are rather large slabs appx. 1x2ft across). These samples contain easily-recognizable examples of sole marks and ripple marks. We discuss how these features form, how they indicate paleocurrent, and make sure the students understand that while the ripple marks will be visible on the top of the sedimentary layers, the sole marks are only visible on the bottom. It is especially important that the students understand the asymmetry of the sole marks, as these are the best unidirectional paleocurrent indicators that we will find.
(3) As for the joints, I ask the students to make a drawing of a block (of any material) and to imagine hitting it from above with a large mallet. In what direction will it break? If they were to squeeze the block tight and then release it, in what direction will the release joints form? With a little discussion, the students are ready to go.

If the class is young or inexperienced one other aspect of this trip needs attention prior to hiking into the gorge; we make sure that the students understand how to use a Brunton compass. Since all of our surfaces are either horizontal or vertical we are spared having to explain dip, and need only focus on the azimuth of a plane or line. We do this at the first outcrop we encounter. As the trip progresses the Prof and TA follow along after the students and make sure everyone is working properly with their compasses.

EQUIPMENT

Brunton compasses (1 per pair of students)
Rock samples showing ripplemarks and sole marks
Graduated cylinders (2-4, 250ml)
Bag of poorly-sorted sand
Protractors (1 per student)
"Portable Powerpoint Binders"
10x24" white board and dry erase markers
Don't forget to reserve the van…

"PORTABLE POWERPOINT BINDERS (PPPTS)"

Pppts are ring binders that contain helpful grahics. I prepare one binder per pair of students. Graphics (usually in color) are slotted into plastic sheet protectors and placed in 1" flexible plastic ring binders. The Pppts allow me to bring along images and photos that I think will help the students understand what they are seeing "in real life" in the field. Sometimes I include historical photos, satellite images, DEMs, line drawings, photos of similar processes in other places, etc. This allows me to provide lots of images in the field without filling the individual lab handouts with bulky (expensive, tree-killing) color graphics, and without relying on a single image that I somehow have to hold up and show everyone. The Pppts are re-used from year to year, and sometimes the same graphics are slotted into different binders in the same year on different trips.

## LEARNING GOALS

This activity is about reading the pages of Earth history written in the rock record. It includes analysis of both sedimentary rock sequences and glacial landforms. The "Aha! Moment" comes when students realize that Ithaca's landscape, while "gorges," contains an even more fascinating and profound history that can be revealed by a few simple measurements and a little bit of cogent interpretation.

Students will:

- Locate themselves on a topographic map
- Learn to recognize geologically significant features within a mass of gray sedimentary rock (e.g. ripples and sole marks)
- Use a Brunton compass to make measurements of strike (joint planes) and trend (sole marks).
- Plot directional data in support of paleogeographic analysis.
- Synthesize the data they collect and the features they observe in order to interpret the paleogeographic history of the Ithaca area.
- Communicate their results in written form to a non-technical audience.

## PACE AND TIMING

The site is 30 minutes from our campus. The introductory discussion usually takes about 15 minutes, and I leave 15 minutes for a summary discussion. This gives us an hour in the field. The students work in pairs, and I let them go at their own pace, giving them a rendezvous point and time where/when we will all meet for the follow-up discussion. If students are lagging I hurry them up, and if they don't seem to be finding any paleocurrent features I make sure that they do so. As might be expected, some students pore over every sand grain while others bolt to the finish and wonder what's taking so long. I usually have a graduate TA who can help make sure everyone is on task. In the summary discussion I try to make sure that everyone has enough data to work with, and that they didn't plot it backwards, etc., etc.