

2022 Sedimentology Spring Break field trip

Overview

On this field trip, we will explore some of the Paleozoic (540-252 million years ago [Ma]) sediments of upstate New York, focusing on the stratigraphy that hosts a positive carbon isotope ($\delta^{13}\text{C}$) excursion at the Silurian-Devonian transition (419 Ma), known as the Klonk Event [6]. We will also visit the late Cambrian **stromatolites** of Saratoga Springs, see the **Taconic Unconformity**, and look at **turbidites** deposited during the Ordovician.

Helderberg Group

The main focus of our Trip is the early Devonian Helderberg Group, which crops out in an L-shaped belt across New York State (Figure 1). The Helderberg Gp. is comprised of the Brayman Shale [4], Rondout Dolomite [6], Manlius, Coeymans, Kalkberg, and New Scotland Formations, which are further subdivided into various members [8]. Our stratigraphic and geochemical work will be concentrated on the Manlius, Coeymans, and Kalkberg Fms. in two localities: Cherry Valley and Catskill, NY. We will investigate the specific lithologies (types of rocks), sedimentary features, and fossils of each of these units in the field, and use our observations to reconstruct their depositional (paleo)environments.

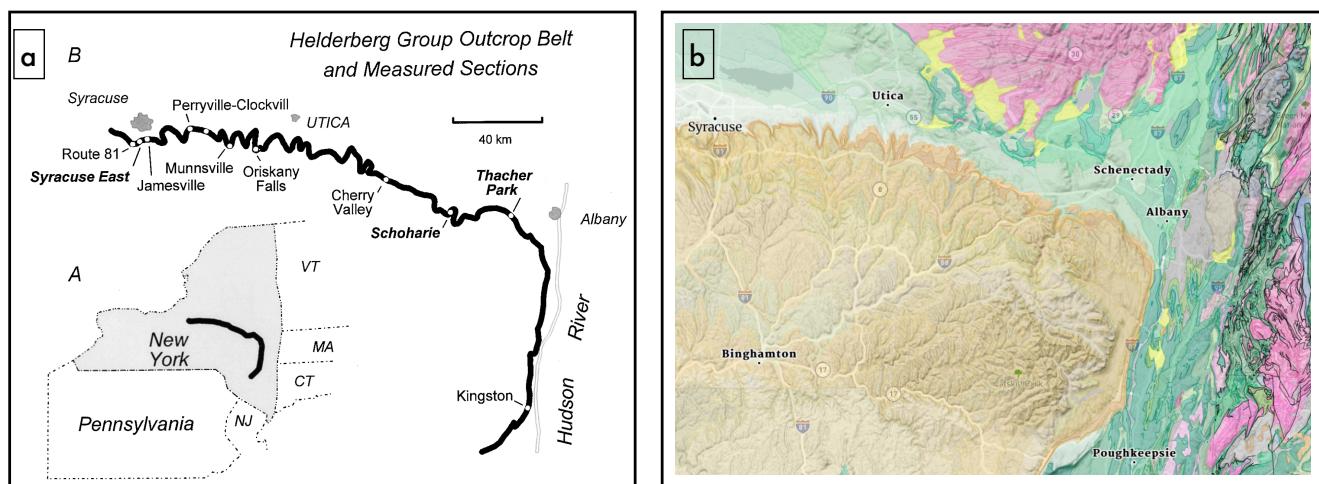


Figure 1: a: Overview map of the Helderberg Group [4]. b: Geologic map of the field trip area (from Macrostrat). Paleozoic sediments are in greens and browns.

Potential hazards and safety information

- Cars (ones we are in and ones we are near) pose the greatest safety risk on this trip. Always wear your seatbelt in the van, and always be cautious when observing road-side outcrops (we will see at least four). Wear bright colors (we have some safety vests) and stay as far away from the roadway as possible.
- When observing an outcrop, always look above you for loose rocks and **do not walk directly above someone on top of an outcrop**. If you dislodge a rock and others are below you, yell **ROCK!** to warn them.
- Warn others before hammering any rocks, and always ask to make sure the outcrop we are observing is okay to sample or hammer. It is a good idea to wear glasses or sunglasses while hammering to protect your eyes.
- Never stray from the group without letting someone (ideally Julia, Kristin, or Noah) know where you are going. We will provide multiple opportunities to use the restroom throughout the day to hopefully avoid having to go outdoors.

- In case of injury or illness, the closest hospital to where we are staying is Cobleskill regional hospital (178 Grandview Dr, Cobleskill, NY 12043).
- EAPS will cover all expenses for this trip.

Contact information

[redacted]

If you are concerned about safety or anything else while on the trip and do not feel comfortable talking to one of the instructors, please contact [redacted] EAPS Education Officer, at [redacted].

Itinerary

Monday, March 21: Stromatolites and Thacher Park

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|---------------|---|
| 8:15am | Arrive at the base of building 54 to load vans. |
| 8:30am | Depart MIT from the base of Building 54
Stop at at least one rest stop during our 3h15m drive |
| 12:30pm | Lunch in Saratoga Springs at Chipotle |
| 1:30pm | Stop 1: Late Cambrian stromatolites at Lester Park |
| 2:30pm | Drive to Thacher State Park (1hr drive) |
| 3:45pm | Stop 2: Walk the base of the Helderberg Group along Indian Ladder Trail (bathroom break) |
| 5:15pm | Drive to the Airbnb (40min drive) |
| 6:00pm | Settle in at Airbnb, dinner, evening lecture/overview of stratigraphy |

Tuesday, March 22: Cherry Valley Section

Today we'll measure our main section of the trip along road cuts of the Helderberg Group in Cherry Valley, NY. We'll be outside for most of the day.

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|----------|--|
| 7-7:30am | Get up and eat breakfast, pack lunch |
| 8:30am | Leave Airbnb for ~45min drive to sections, stop for a bathroom break in Cherry Valley |
| 9:30am | Stop 3: Measure sections!
We will have opportunities to drive to the nearest gas station for bathroom breaks throughout the day. |
| 5:00pm | Drive back to the Airbnb |
| 6:00pm | Make dinner and recap the day |

Wednesday, March 23: Catskill Section and Ordovician turbidites

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|----------|---|
| 7-7:30am | Get up and eat breakfast, pack lunch |
| 8:30am | Leave Airbnb for ~1hr drive |
| 9:30am | Stop 4: Turbidites
Look for Bouma sequences in the Ordovician strata. |
| 10:00am | Drive to section along Hwy 23 (15 min drive + bathroom break) |
| 10:30am | Stop 5: Measure section of the Helderberg Group.
(or whenever the weather gets bad...) Drive back to the Airbnb |
| 5:00pm | Make dinner and recap the day |

Thursday, March 24: Howe Caverns and drive home

On the last day of our trip, the weather looks bad, so we'll head to Howe Caverns.

- 7:30-8am Wake up, pack up, and eat breakfast
- 9:30am Leave AirBnB for Howe Cavern (20 min drive)
- 10:00am **Stop 5:** Fun tour at Howe Cavern (closes at 1pm)
(roughly...) Stop for lunch and drive back to Cambridge (3.5hr drive)

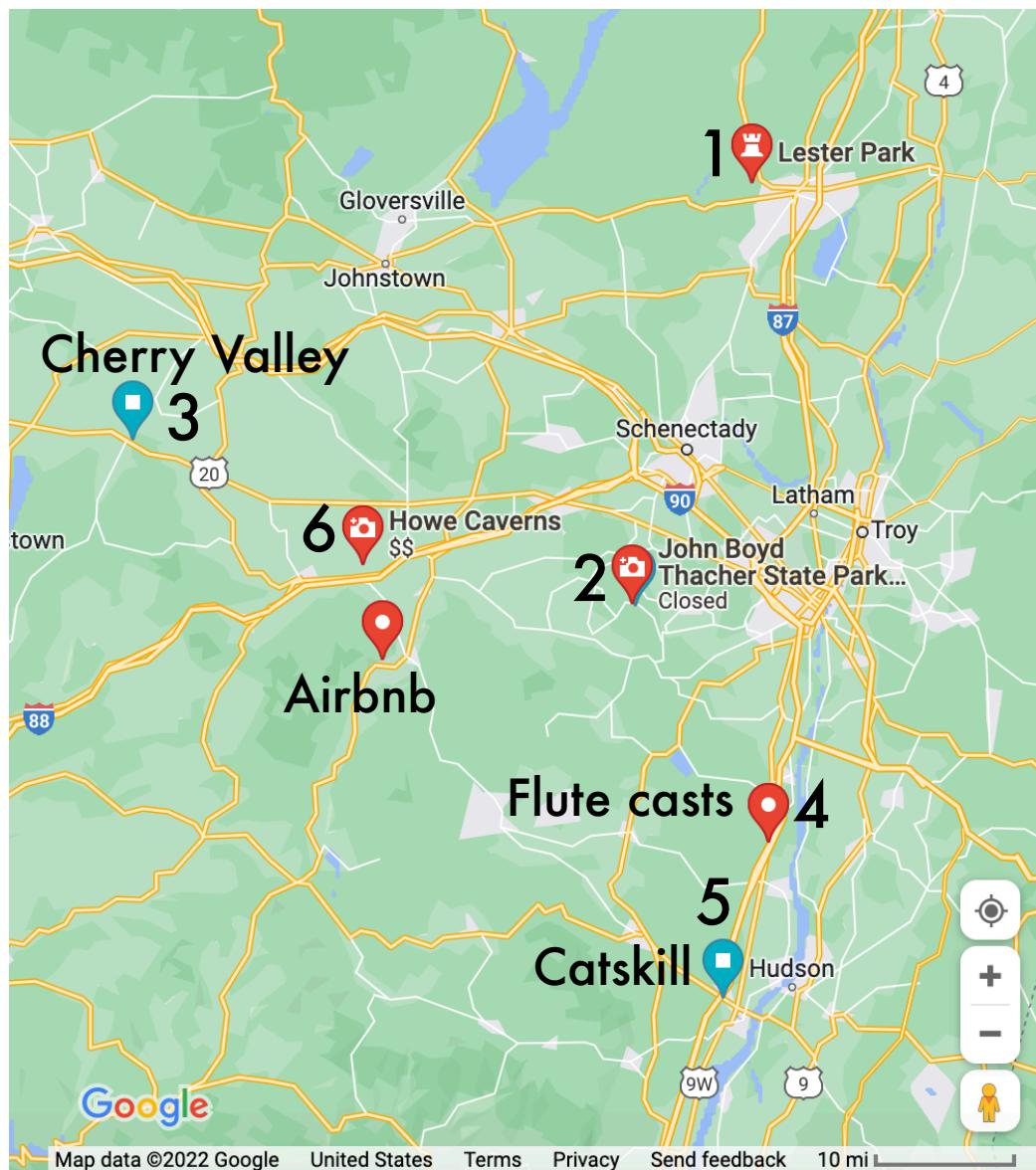


Figure 2: Map of the region we're exploring on this field trip.

Making field observations

“Sedimentary Rocks in the Field” chapter 2 covers many of the observations we could and should make while in the field. At each stop we make during this field trip, you should at least make a full set of basic observations:

- Overview sketch and photo of outcrop (always add a scale bar to photos!)
- Strike/dip (orientation of the outcrop in space)
- Description(s) of facies present, including:
 - lithology/composition
 - grain size
 - fossils
 - structures/other features

You can then supplement this base set of observations with information specific to the question(s) of interest at a given outcrop. Some ideas are provided for each stop. As you observe, it is good to be mindful of the scale at which you are making observations – an overview sketch is helpful, but if you are really interested in the fossil assemblages present, it probably makes sense to just spend a few minutes on the overview sketch and more time sketching/studying/finding fossils. Conversely, you might be interested in lateral changes along the outcrop (along strike). In this case, maybe you’d spend more time “zoomed out” at the meter-scale, only “zooming in” to characterize facies.

After collecting observations, we’ll piece together the depositional environment(s) of the sedimentary strata we observe. This field guide is meant to give you a little bit of background information about each stop without giving too much away :)

Stop 1: Late Cambrian Stromatolites in Saratoga Springs

We'll use this stop to see an iconic example of stromatolites and to practice observing carbonate rocks in the field.

Stromatolites are layered structures formed as microbial mats either precipitate CaCO_3 or trap and bind sediment. Stromatolites can take on a variety of morphologies, depending on environmental conditions, including current direction/velocity, amount/rate of sediment influx, and the microbial ecosystem. The Saratoga Springs stromatolites that we'll see were first described by geologists in the early 19th century and are the first stromatolites to have been given a taxonomic name, *Cryptozoon*. The Hoyt Limestone, which hosts these iconic stromatolites, is Late Cambrian-Early Ordovician in age (~484Ma). *To discuss: how do we know the age of these rocks?*

Oral traditions from the local Native peoples extend back thousands of years before Western, colonial geologists first described *Cryptozoon*. In the Algonkian tradition “these stone formations are identified...as the remains of a rich garden that was planted by ancient ancestors. But after these people fought with their neighbors, the stories say, then the sky spirits devastated their village and turned the crops to stone, to teach the people not to make war” [2].

Due to the Native and Western historical significance of this outcrop, **do not hammer, acidify, or otherwise damage these rocks.**

While we're there...

Some ideas to think about (and write about in your field notebook!) while we're at the Hoyt stromatolites. (Please include the base set of observations in your field notebook.)

- What direction should we go to see younger strata?
- How high (approximately) above the seafloor did these stromatolites grow?
- Sketch a ~ 1x1m area of stromatolitic outcrop
- If we see a vertical section of outcrop, what is the *stacking pattern* of the strata surrounding and including the stromatolites (i.e., what is below and above?)
- What is the fill between individual stromatolites?
- What type of depositional environment is represented by these rocks?

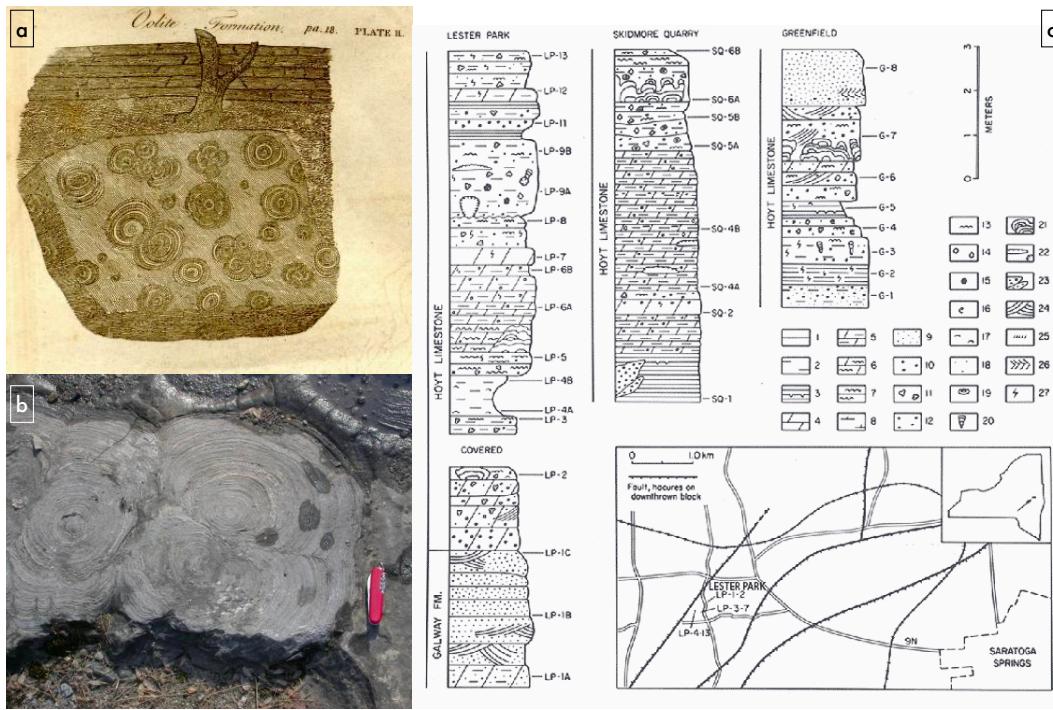


Figure 3: a: Sketch of the “concretions” (stromatolites) from [11]. b: photo of stromatolites from NY parks. c: stratigraphic sections of Lester park outcrops by NY Parks. <http://www.nysm.nysed.gov/research-collections/geology/resources/lester-park>

Further reading

- Recently, some authors have argued that *Cryptozoon* is actually a keratose sponge-microbialite consortium and not just a microbial mat [7].
- If you want to go way back... the first paper published about the Hoyt Stromatolites appeared in the 1825 volume of the American Journal of Science [11]. You can read it [here](#).
- And if you’re curious to know more about stromatolites, these are two more recent review papers [1, 9].
- For a Native perspective on landscapes, check out [3].

Stop 2: Thacher State Park

This stop marks the start of our three-day tour of the Helderberg Group. We hope to be able to walk to the base of Indian Ladder Trail, but this may be closed for winter (see Figure 4). Thacher State Park sits on the Helderberg escarpment, which forms a 200m cliff of early Devonian limestone – the rocks we’re studying. At the base of the exposure here, we should be able to find a small bit of the upper Rondout Dolomite, which is then overlain by the Manlius Limestone, followed by the Coeymans Formation on top of the escarpment (we may not see this). Our goal today is to get acquainted with these rocks before we start measuring sections tomorrow.

While we’re there...

- Describe and compare the Rondout Dolomite and the Manlius Limestone.
- What facies are present within the Manlius? How many can you identify? Practice “lumping,” describing the unit in as few facies as possible, and “splitting,” breaking down the unit into as many distinct facies as you can identify and describe. Which feels more natural? In what setting(s) might one approach be preferable to the other?
- What is your favorite part about this outcrop?

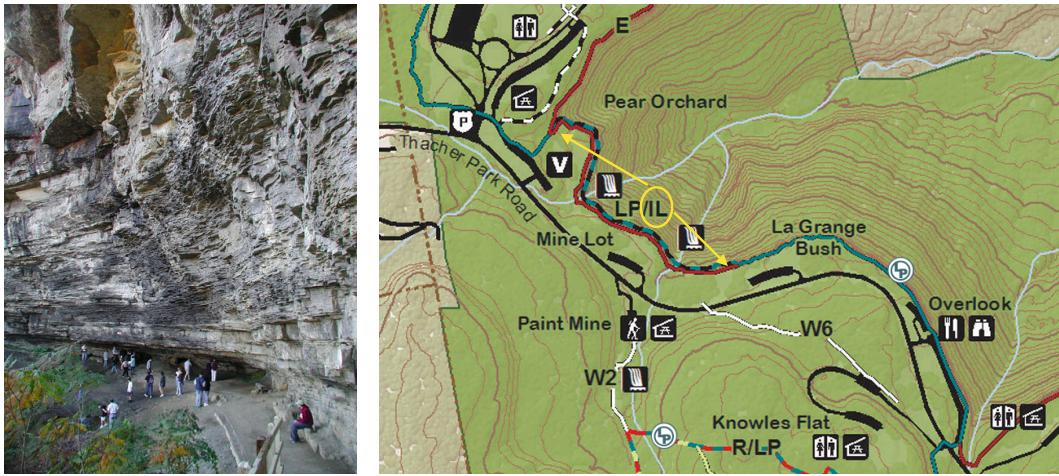


Figure 4: The Helderberg Group and map of Indian Ladder trail at Thacher State Park.

Further reading

- Our field trip is inspired by [6], who measured a section at Thacher State Park.
- This chapter by [5] provides a great overview of the Helderberg Group at Thacher.

Stop 3: Cherry Valley sections of the Helderberg Group

Today we will measure stratigraphic section(s) of the Rondout, Manlius, Coeymans, and Kalkberg Formations, following the work of [6]. We have a few goals today, including: to learn how to (or practice) measure a section, to compare the Helderberg Group in Cherry Valley to the equivalent rocks we saw yesterday at Thacher (~ 100 km SE), to collect samples for isotopic and petrographic analysis back in the lab. We will observe, measure, and collect concurrently.

Stop 4: Turbidites

We will briefly stop to see the Ordovician-aged turbidites of the Austin Glen Formation, starting with a beautiful exposure of flute casts at a road-side stop (be very careful on this busy road!). Flute casts (Figure 6) are formed by turbidity currents scouring the bed of sediment over which they flow. Their morphology tells us the direction of paleoflow. We will work this out in the field :)

While we're there...

- Sketch a flute cast
- Which way is stratigraphic up?
- Measure the direction of paleoflow using Kristin's Brunton compass or FieldMove
- How does the sediment in which the flute casts are preserved compare to the over/underlying rocks?

Stop 5: Catskill sections

The main focus of this final stop is to measure another section of the Helderberg Group, but we will also see the Taconic Unconformity and some more of the Austin Glen Formation. We will determine measuring/sampling strategies based on what we accomplished on Tuesday. The weather might turn bad in the late afternoon – we'll keep an eye on it and wrap up before the precipitation starts.

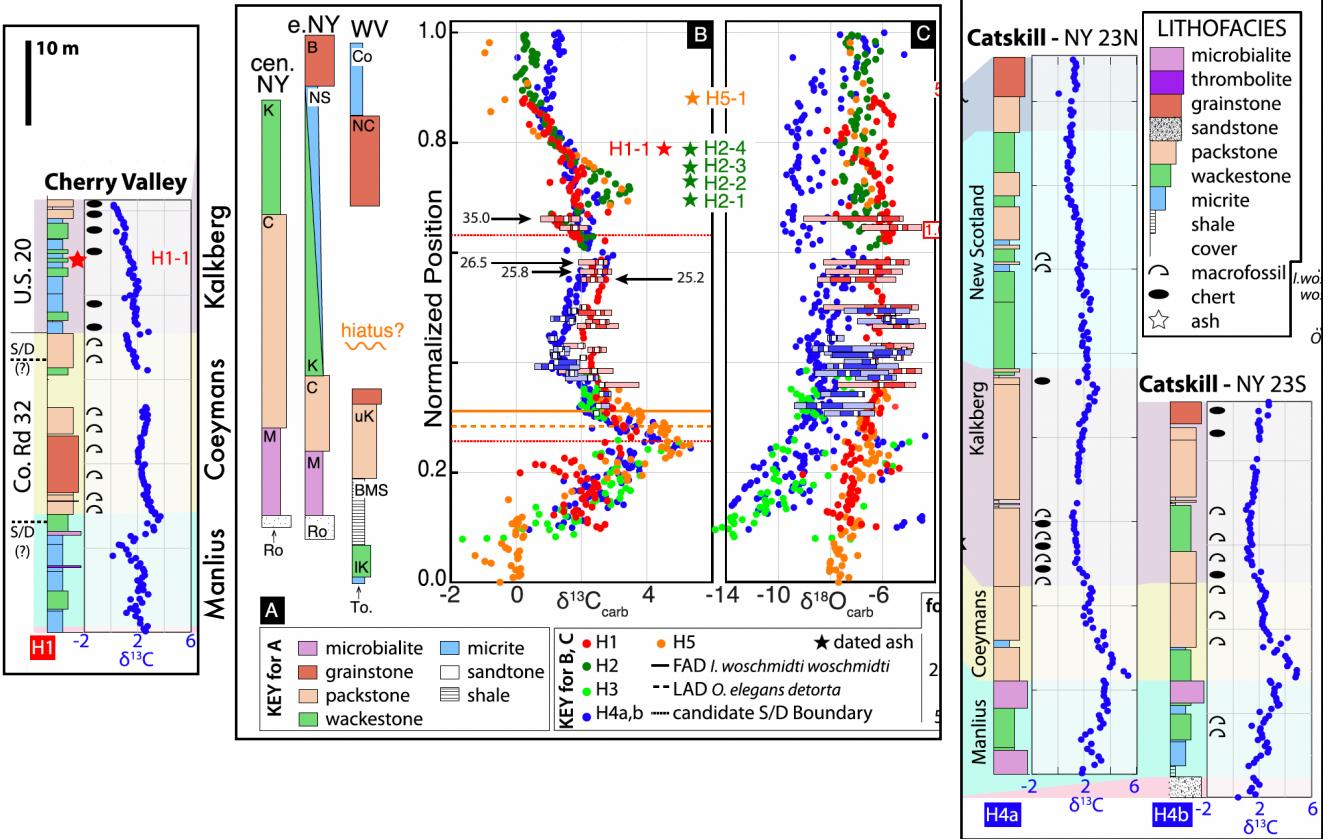


Figure 5: Sections from [6] that we'll visit. Note the differences in $\delta^{18}\text{O}$ between H1 (Cherry Valley) and H4 (Catskill) and the positive carbon isotope excursion (panel B). Both project teams will explore these data when we get back to MIT.

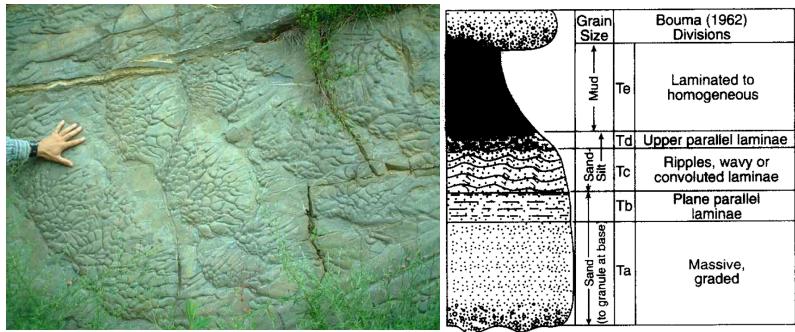


Figure 6: Left: Flute casts in the Austin Glen turbidites (photo: Wendy Franklin). Right: diagram of a Bouma sequence from [10].

References

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- [3] Bruchac, M. M. (2014). Earthshapers and Placemakers : Algonkian Indian Stories and the Landscape. *Algonkian*

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- [4] Diedrich, N. W. and Wilkinson, B. H. (1999). Depositional Cyclicity in the Lower Devonian Helderberg Group of New York State. *The Journal of Geology*, 107(6):643–658.
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