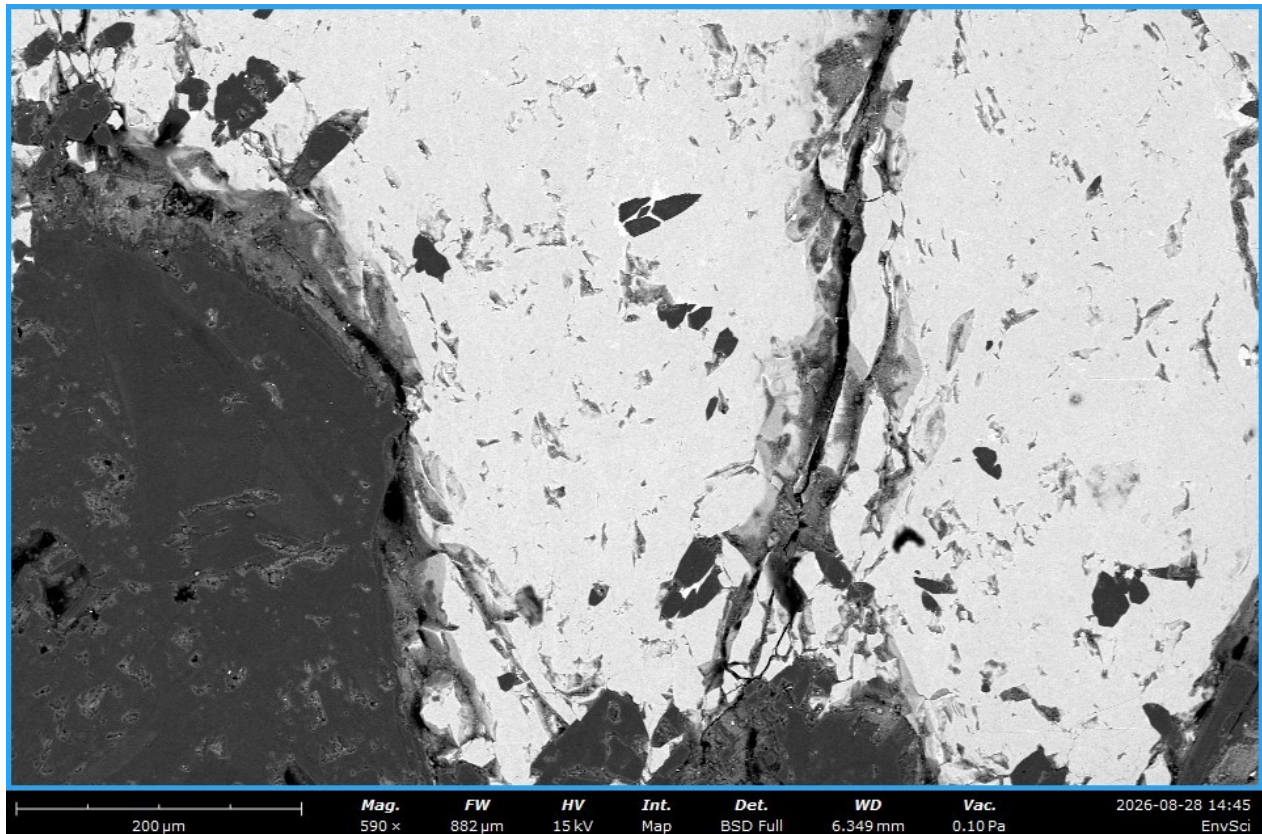


SCIENTIFIC EXPLORATION

at the University of Pittsburgh at Bradford

SEM/EDS, engineering, and learning how to investigate



A fractured geode region imaged during the second SEM session on August 28, 2026. I chose geode regions like this because irregular boundaries and cracks often gave me the most interesting questions to test.

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SCHOOL	NEST+M High School, New York City
EXPERIENCE	August 24-29, 2026 main project work through August 28

1. How this experience began

My week at the University of Pittsburgh at Bradford began informally. My uncle, who is a professor at the university, invited me to stay nearby and gave me the chance to visit campus, sit in on science classes, meet professors, and work on projects. Through him I met Dr. Frantescu, who agreed to show me the scanning electron microscope (SEM) and let me analyze samples with him. After the first session, I asked Dr. Frantescu myself if I could come back for a second session. He agreed, and by then the experience had become much more self-directed and internship-like.

What made the week valuable was not only access to advanced equipment. I was given room to explore. I could ask questions, choose some of the samples and regions I wanted to examine, build an engineering project from an idea, and work through math that was above what I had formally learned. That freedom changed how I approached difficult problems. Instead of only trying to find the expected answer, I became more willing to notice my own assumptions, try an unusual path, and test whether it worked.

AT A GLANCE

5 days	2 SEM sessions	28 SEM images	10 EDS projects	1 engineering build
Aug. 24-29	about 1-2 h each	11 day 1 + 17 day 2	retained Geode analyses	Arduino + LiDAR + LED

Purpose of this report

This is not meant to present me as an expert after five days. It documents what I actually did, what I became confident doing, what I observed in the data, and where my understanding still has limits. The SEM/EDS work is the main technical project, but the larger story is how the week changed the way I investigate unfamiliar problems.

2. Learning the SEM and EDS workflow

2.1 From demonstration to independent operation

During my first SEM session, Dr. Frantescu showed me the instrument controls and explained the basic science behind what I was seeing. I personally helped place, position, trim, and secure samples on mounts using adhesive/carbon tape. I then learned to load samples, move around the specimen, change magnification, focus, adjust image settings, choose areas to examine, capture images, and make measurements. At first Dr. Frantescu pointed out which areas were likely to be useful. By the second half of the first session I was operating much more independently, and by the second session I felt comfortable handling the basic imaging workflow myself.

One part I did not perform independently was the conductive coating of biological material. Dr. Frantescu handled that step because I did not know the correct coating amount. I remember the coating being extremely thin, but I did not record the thickness myself, so I do not report a specific value here. What I did understand was the purpose: nonconductive samples can be difficult to image

cleanly, and a conductive coating helps reduce that problem. Seeing unusually bright or flashing regions during later imaging made that idea much more concrete for me.

My understanding of the exact electron physics is still incomplete. I learned the general idea that the electron beam interacts with the sample and the instrument turns detected signals into an image, but I would not claim to understand all of the detector physics or the mathematics behind image formation. That is one of the areas I would like to learn more deeply.

2.2 First-session observations: biological structures

The first retained SEM dataset was collected on August 25. Two biological samples I remember clearly were a flower bud and a tick positioned with its underside facing upward. One of the most memorable images was a pollen particle whose surface looked covered in sharp projections. At normal scale, pollen looks like dust. Under the SEM, the individual particles looked structured and almost architectural.

Dr. Frantescu also explained the folded or marked structure on the underside of the tick. As I understood his explanation, those surface features are related to the tick body being able to expand after feeding. I include that as something I learned from him, not as a conclusion I independently established from the image.

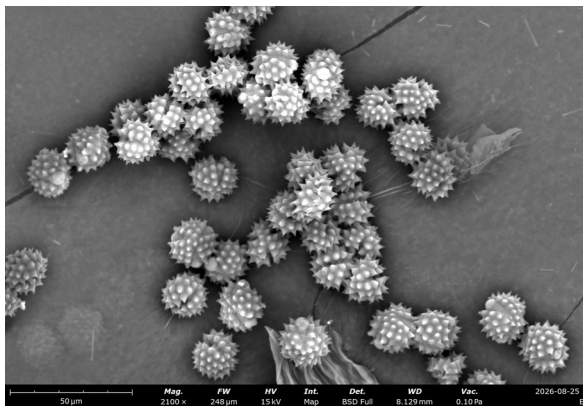


Figure 1A. EnvSci_221: spiny spherical particles that I remember as one of the clearest pollen examples from the first session.



Figure 1B. EnvSci_226: the tick imaged from the underside. Dr. Frantescu used this specimen to explain how biological form can connect to function.

2.3 Why the geode became my main investigation

The geode was a sample I chose because it looked complicated enough that there was always another region to investigate. At first I used obvious brightness differences to choose EDS locations. That became repetitive, so I started looking for less obvious clues: branching cracks, small divots, crystals that looked different from their surroundings, and changes in apparent height or depth. Those areas were often more interesting because they gave me a reason to ask whether something different might be underneath or embedded in the surface.

Dr. Frantescu and I both selected EDS locations. Sometimes he chose an area he wanted analyzed, and sometimes I chose my own. On the first day I was comfortable identifying elements and

comparing amounts, but I still benefited from his help interpreting the larger meaning. By the second session I felt much more confident reading the elemental results and using them to decide where to look next.

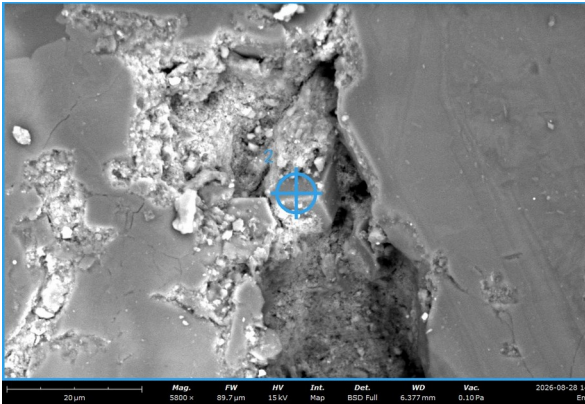


Figure 2A. Geode 1: a rough, recessed region with a selected analysis point. Areas like this helped move me from looking at obvious contrast to looking for irregular structure.

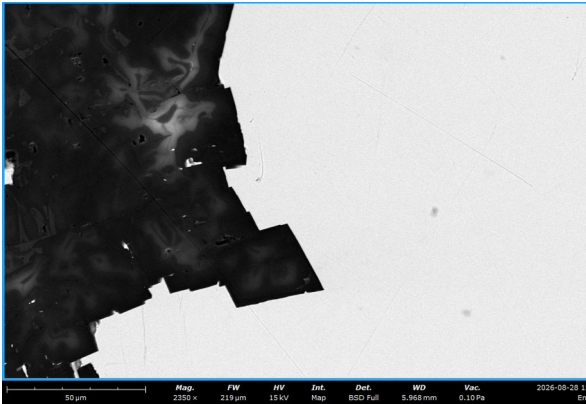


Figure 2B. Geode 8: one of the retained EDS map regions. The export reported antimony and sulfur among the strongest weight-percentage signals.

3. Findings from the geode analyses

The strongest data-supported finding was not the identity of one mineral. It was that different small regions of the geode could have very different reported elemental compositions. That matched what interested me visually: a crack, boundary, or distinct crystal could represent a change that was not obvious from the larger specimen alone.

Selected retained EDS results

Dataset	Largest reported weight signals	What stood out to me
Geode 2	Si 40.1%, Al 28.8%, Fe 17.2%, Mg 6.0%	A strong Si/Al/Fe region; oxygen was disabled in this line-scan quantification.
Geode 4	O 23.5%, S 21.2%, Fe 20.9%, Cu 17.5%	Several major elements shared the signal rather than one element dominating.
Geode 5	Sn 56.3%, Si 13.8%, Cr 9.8%, C 8.4%	Tin was the largest reported signal; oxygen was disabled in this map quantification.
Geode 8	Sb 41.5%, S 21.9%, O 18.1%, C 11.4%	Antimony was the largest reported weight signal.

Dataset	Largest reported weight signals	What stood out to me
Geode 10	Sb 35.8%, S 22.0%, O 21.7%, Si 11.1%	A second retained region with a large antimony signal.

Table 1. Representative weight-percentage values from the retained EDS exports. These are local, semiquantitative analyses of selected regions, not the bulk composition of the whole geode.

3.1 What I learned from those results

A result like Geode 8 or Geode 10 was interesting to me because the EDS result gave evidence that a visually different region was also compositionally different. I remember finding antimony in some of the unusual regions, and that memory is supported by the retained exports. I also remember seeing a possible palladium detection during exploratory work, but palladium does not appear in the EDS summary files I retained. Because I cannot verify it from the saved data, I do not treat it as a formal finding in this report.

I also noticed what seemed like a relationship between the size of some crystals or particles and their composition. I did not record a systematic set of paired size and EDS measurements, so I cannot call that a measured correlation. For me it is better described as a pattern I noticed and would want to test in a future session.

I learned that EDS results also require judgment. During the sessions, I became less confident in an identification when an analysis was very short or when the target crystal was recessed inside a hole and poorly exposed. Even when software assigns element labels, the geometry of the target and the quality of the scan matter. This was one reason I became more careful about treating the instrument output as evidence to interpret rather than an automatic answer.

My main scientific takeaway

The most important thing I learned was a process: notice an irregularity, ask why it might be different, choose a way to test it, compare the result with what you expected, and then decide what to investigate next. The geode gave me a place to practice that cycle repeatedly.

4. Engineering project: turning code into a physical system

The week was not limited to microscopy. I had never done an engineering project before, but I was able to get parts from a lab and decided to build a small alarm-like system. I designed a box, used an Arduino connected to a LiDAR sensor and an LED, and wrote the logic so the LED would change color depending on the speed of an approaching object. I came up with the idea, selected the components, wired the system, wrote the code, debugged it, designed the enclosure in CAD, and assembled the final box.

My uncle helped me debug one specific software problem: the LiDAR sensor was sending feedback quickly enough that the terminal could crash, so we reduced the feedback rate. That problem was a good introduction to engineering because the solution was not just “write the correct code.” I had to

be patient, change one part of the system, test it again, and keep going until the hardware and software worked together.

LiDAR sensor	Arduino	Approach logic	LED output
measures distance repeatedly	reads the measurements	estimates how quickly an object is closing	changes color as the warning state changes

Figure 3. The basic logic of my first engineering build. The project made me more interested in doing work that combines coding with physical systems.

5. Math, classes, and learning in a university environment

I also attended science classes, talked with other professors, and worked on calculus during the week. The biggest difference from high school was the freedom to follow my own curiosity. I was using real equipment and solving open-ended problems instead of always following a predetermined procedure.

One calculus problem stayed with me because I was stuck and could not see a standard path to the answer. I tried representing the objects in the diagram as formulas and realized that subtracting the circle's diameter could give me the length of one side of a square, which then let me calculate the square's area. What mattered to me was not only that the method worked. I had almost rejected that kind of approach because it did not look like the typical solution. The experience made me more willing to try an idea before deciding it is wrong.

That same mindset appeared in the SEM work. Once I was allowed to choose my own regions, I stopped waiting for someone to tell me what was important. I started forming my own questions. I became more interested in small anomalies, especially the ones that did not immediately make sense, because those were often the places where I could learn the most.

6. Reflection: learning the language underneath knowledge

"I came in aware of knowledge, and I left aware of the language that knowledge is composed of."

My clearest way of describing what changed during the week

Before this experience, I thought more about knowledge as information: facts, formulas, and answers that I could learn. During the week I became much more aware of the process underneath that information. I had to notice my assumptions, decide which patterns mattered, form an idea, test it, and sometimes change my approach when the first one did not work.

That is what I mean by the "language" knowledge is composed of. If I understand more ways to reach an answer, I have more paths available when I face something unfamiliar. I also become more capable of creating something new instead of only repeating something I have already learned.

The week also made me more confident in my own ability to learn unfamiliar technical material. I picked up the basic SEM workflow quickly, built my first engineering system, and found that I could work through problems above what I had formally studied. At the same time, I became more comfortable admitting what I do not know. I can operate the SEM workflow I was taught, but I have only used the instrument for two sessions and there are advanced functions I have not learned. I can use SEM and EDS evidence to make material identifications, but I do not have the pattern knowledge and geological experience of a trained geologist. I see those limits as directions for further learning, not as reasons to avoid difficult problems.

The biggest change was becoming less afraid of being wrong. When I am aware of my own assumptions and biases, I can question them instead of automatically letting them narrow my options. I still want evidence before I accept an idea, but I am more willing to trust my intuition enough to test the idea in the first place. That makes me more creative, more persistent, and more curious.

7. Limitations and what I would do next

Limitation	Why it matters
Limited time on the SEM	I used the SEM during two sessions of roughly one to two hours each. I became comfortable with the workflow I was taught, but that is not the same as expert knowledge of the instrument.
Incomplete record of preparation details	Dr. Frantescu performed the conductive coating of biological material. I remember it as extremely thin, but I did not independently record the coating thickness, so I leave that number out.
EDS is local evidence	Each EDS result represents a selected spot, line, or mapped region. It should not be treated as the composition of the entire geode.
Some observations were exploratory	The possible size/composition relationship was not recorded as a controlled dataset, so it remains a hypothesis rather than a demonstrated correlation.
Not every memory is in the retained files	I remember a possible palladium detection, but it is not present in the EDS summary exports I kept. I therefore exclude it from my formal results.
My mineral knowledge is still developing	I became confident combining image appearance with EDS results, but an experienced geologist would recognize mineralogical patterns and context that I may miss.

If I had another SEM session, I would return to geode and mineral samples, learn more advanced SEM functions, and make the investigation more systematic. I would choose repeated locations using the same criteria, record particle or crystal size alongside each EDS measurement, and test whether

the patterns I noticed are repeatable. That would turn an exploratory observation into a question that could be evaluated more rigorously.

8. Closing thoughts

This week showed me that complexity can teach more than the answer to one problem. A difficult problem forces me to examine how I am thinking, and that process can transfer to other fields. The same habits helped me with microscopy, engineering, and calculus: notice what is unusual, stay open to more than one approach, test the idea, and revise it when the evidence disagrees. That is the part of the experience I expect to carry forward into future science and engineering work.

A note to Dr. Frantescu

Dr. Frantescu, thank you for taking the time to explain the SEM instead of only showing me how to operate it, for trusting me enough to let me investigate my own questions, and for welcoming me back when I asked for a second session. I am also very grateful that you were willing to support my future college and science opportunities with a recommendation. I was told you were interested in seeing what I eventually sent you, and I hope this report shows not only what I observed, but how much I learned from the way you approached science with curiosity.

Appendix A. Retained SEM/EDS data

The retained files keep the two SEM sessions separate. The first set contains 11 SEM TIFF images. The second set contains 17 SEM TIFF images plus 10 Geode analysis projects with maps, spectra, and quantitative exports. The image overlays on the examples used in this report show 15 kV acquisition and preserve the original scale bars.

Session	Date	Dataset	Retained contents
Day 1	Aug. 25, 2026	semdata	11 SEM TIFF images: EnvSci_219 through EnvSci_229.
Day 2	Aug. 28, 2026	EnvSci_230	17 SEM TIFF images: EnvSci_230 through EnvSci_246.
Day 2	Aug. 28, 2026	Geode 1-10	10 SEM/EDS project folders with images plus map, spot, or line-scan analyses.

Table A1. Dataset inventory used for the SEM/EDS portions of this report.

Appendix B. Full EDS summary

Dataset	Largest reported weight-percentage signals
Geode 1	O 51.3, Si 12.8, Al 11.3, Fe 7.2
Geode 2	Si 40.1, Al 28.8, Fe 17.2, Mg 6.0 (oxygen disabled in retained quantification)
Geode 3	O 49.4, Si 13.9, Al 12.6, Fe 8.6
Geode 4	O 23.5, S 21.2, Fe 20.9, Cu 17.5
Geode 5	Sn 56.3, Si 13.8, Cr 9.8, C 8.4 (oxygen disabled in retained quantification)
Geode 6	O 48.1, Sn 32.5, Si 9.5, Al 4.4
Geode 7	O 44.1, Sn 29.5, B 12.2, Si 7.2
Geode 8	Sb 41.5, S 21.9, O 18.1, C 11.4
Geode 9	O 54.7, Ca 14.4, C 11.8, Si 8.9
Geode 10	Sb 35.8, S 22.0, O 21.7, Si 11.1