Enjoy making observations and being frustrated? If you answered “yes”, a career in geoscience is for you!

Becca Walker

Geologists observe and interpret. Observe and interpret. Observe and interpret. In my teaching at a large, urban community college, I find myself repeating this phrase over and over in the classroom, in the field, and in the context of assignments. Although I encounter a handful of science majors in the introductory-level courses that I teach, the majority of my students are non-science majors who enroll in my courses to satisfy a general education requirement. For a variety of reasons, including promoting scientific literacy; reducing misconceptions about how the scientific process works; and providing potential geoscience majors with an accurate portrayal of what geoscientists do; conveying the nature of geoscience research and “how we know what we know” is an important part of my curriculum. Below, I’ve provided three examples of my approach to teaching the methods of geoscience.

Geoscience method #1: Observing and interpreting

It took me roughly two years of teaching to realize that most of my students struggle to distinguish observations from interpretations. This distinction is so crucial in understanding how to think like a geologist that “observations and interpretations” is a recurring theme in all of my courses. For example, my physical geology class begins with a non-geologic photo (usually an embarrassing photo of me) and a request for observations. Many students offer interpretations at this stage, so a discussion of observations vs. interpretations ensues. Once they understand the difference between the data and the story using a non-geologic example, we move on to talk about how detailed small and large-scale observations allow geoscientists to unravel a geologic history.

The culmination of their work with observations and interpretations is in the field. Prior to their field trip, students in most of my courses analyze an outcrop during class with the help of a YouTube video on outcrop analysis, a color photo of an outcrop and a representative hand sample, and a hypothetical example of a field notebook entry that I provide. Ideally, they are comfortable with the “observe and interpret” procedure before going out in the field. Once we get to the field area, I add one extra step: sketching. In my experience, giving students time to make detailed, labeled sketches, <u>think</u> about the significance of what they are observing and sketching, and later, making sure that every label (observation) is tied to an interpretation is hugely beneficial.

Geoscience method #2: Evaluating multiple lines of evidence to identify patterns

How do geoscientists forecast volcanic eruptions? Which oceanographic data were used to support the idea that plates move? How do geologists recognize faults in the field? Our understanding of the Earth system comes from identifying patterns, and although this is a fundamental concept that I address verbally with my students, I believe that the best way to illustrate this geoscience method is to have students discover the patterns for themselves. So far, the most effective way that I have found to accomplish this self-directed pattern recognition is a variation on the jigsaw method. For example, the activity that I have contributed to the resource collection for this workshop is a short in-class exercise on the lines of evidence for plate tectonics, a concept about which we have not talked, nor even named. Briefly, each student is given either an A, B, or C preparation exercise with instructions. The A prep asks students to read and prepare to discuss the “continental shapes” aspect of continental drift and observe a map showing the age of the oceanic crust. The B prep asks students to read and prepare to discuss the “rocks and fossils” aspect of continental drift and observe a marine sediment thickness map. The C prep asks students to read and prepare to discuss the “glacial deposits” aspect of continental drift and study figures of physiographic features of the ocean floor. During the next class meeting, students break into groups of 3 with an A representative, B representative, and C representative. Together, they look for patterns among their data and come up with some ideas about why they observed the patterns. It’s an effective, non-lecture introduction to plate tectonics, gets them thinking about how the idea was developed, and provides practice with looking at multiple data sets simultaneously.

Geoscience method #3: Not knowing what you will find before you find it

The geologic history of the Earth is a story, and one of the principal challenges that I face in teaching the methods of geoscience is conveying to my students that at the onset of a geoscience research endeavor, scientists don’t know where the story is going. In class discussions and conversations, I consistently encounter the misconception that real science is neat and linear, starts with a hypothesis and ends with a conclusion (with a cookbook experiment and some perfectly reproducible data in between), and that somehow, the scientist knows what his/her results will be before doing the work. This view of the scientific process is an inaccurate depiction of the iterative and dynamic nature of our understanding of Earth processes, and it is a misconception that I work hard to address in all of my courses.

This idea about the methods of geoscience was plainly evident this semester when a colleague and I began supervising 8 of our students on an independent study project. The students on this team have taken close to all, if not all, of the courses that we offer in our department. They were ready for a challenge. Together, we came up with a skeleton for a project investigating changes in channel shape and sediment characteristics of a fluvial system in Orange County between its source and the beach. I can’t think of another time in my career when I have seen so many jaws drop as I have over the course of this project. Most of these dropped jaws have been related to the realization that the professors don’t have the “right answer”. Some examples:

1) *[The first recon day. Students and professors stand in Trabuco Creek, observing the stream channel.]*
Professor: What are some of the characteristics of this channel that you want to measure?
Students: Well, what should we measure?
Professor: I’m not sure, that’s why I’m asking you.
[Students’ jaws drop. End scene.]

2) *[A couple of weeks into the project. Student and professors meet in a faculty office.]*
Student: We have three stream profiles done from different locations and have taken sediment samples at the sites.
Professor: Great. Did you see any differences in your profiles?
Student: Yes.
Professor: Then the next step is to think about what these differences are telling you geologically.
Student: What they’re telling me?
[Student’s jaw drops. End scene.]

I met with the independent study team today and watched them continue to chew on identifying their objectives for their next trip to the study area. They wanted me to tell them what their focus “should” be. I shrugged my shoulders and asked them what they thought was most important, based on the geology they had observed in prior trips to the field area. I was incredibly proud when, instead of their jaws dropping, they gave me a list of ideas. They are learning one of the most important geoscience methods: establishing a plan for observing and collecting data in the face of uncertainty.