Every Rock Tells a Story—A Field Trip in the Italian Alps

Anne Haws
Senior year in MCAS, Geological Sciences major with a minor in Ancient Civilizations, and member of the Arts and Sciences Honors Program

Intro: "This is one of the reasons I find geology so exciting; we are able to explore and understand the forces and processes that shaped our world long before humans existed."

When faced with a mountain range like the seemingly immortal Alps, the same mountains that Hannibal crossed with a herd of elephants over two thousand years ago, it is easy to forget that, as Julie Andrews once sang, the hills are indeed alive. We often describe someone who accomplishes a seemingly impossible task as one who moves mountains, and something ancient is said to be as old as the hills, suggesting that these features are fixed, while humanity continuously changes and evolves - and as far as human history goes, this appears to be true. But in the grand scheme of things, it's all about perspective, and the Earth is just as dynamic a system as a human being or a human society, albeit on much longer timescales. As a Geological Sciences major, I am humbled by my studies because, whether I am actively cognizant of it or not, I am reminded each day how fleeting the human lifespan is in the context of Earth's four billion year history. We can't actively observe the rising of a mountain range or the disappearance of the ocean floor beneath the continental crust at a subduction zone with generations of human observations, let alone an individual lifetime. Processes such as these, however, are recorded by the rocks they form, and geologists have physical and chemical tools that can be used to read the stories that these rocks have documented for us. As my senior thesis advisor, Professor Ethan Baxter, often says, "Every rock tells a story."

This is one of the reasons I find geology so exciting; we are able to explore and understand the forces and processes that shaped our world long before humans existed. Being able to help unravel a part of that story is partly why I am hoping to pursue a career in geologic research, and why I elected to write a senior thesis this coming year. When Ethan offered me the opportunity to spend a week in the Italian Alps and collect rock samples for my thesis, I couldn't possibly say no - I knew that being able to see these rocks in person would be an unparalleled experience. The Alps offer us an opportunity to study a slice of that four billion year history, the subduction of one tectonic plate beneath another approximately 33 million years ago. During this process, the denser oceanic crust of one plate, which formed about 160 million years ago, was forced beneath the less dense continental crust of another plate and down into the mantle, bringing water and other materials with it. (Picture 1) The subducted rocks were subjected to extremely high pressures, and although these rocks are not often exhumed, or brought back to the surface, the Alps are home to exhumed subduction zone rocks. This gives us the materials necessary to study subduction from a geochemical perspective. A collaborative, NSF-funded subduction zone project called E-FIRE, which stands for ExTerra Field Institute and Research Endeavor, was created to study these rocks; this is the group that I am now working with. The primary goals of the project include exploring the cycling of chemical compounds and fluids in subduction zones, as well as the timing of those events, and involves collaboration with a European group called ZIP (Zooming In between Plates).

Although there are multiple ways in which these questions can be approached, our group at Boston College is interested using thermodynamics to constrain the pressure and temperature conditions under which these rocks formed, and geochronology, which uses the decay of a radioactive parent element to a stable daughter element within a mineral to determine how much time has passed since

the mineral formed. Geochronology can give us a sense of not only when these processes occurred, but how long they took, which is an important part of understanding how they work.

The focus of my thesis, a small facet of the larger E-FIRE project, is the study of rocks called rodingites, which form when oceanic crust is chemically altered by the flow of calcium-rich fluid; these rodingites are then subducted alongside the rest of the oceanic crust. What makes them unique and particularly interesting to study is their mineralogy. As oceanic crust is subducted, it is hydrated, which changes most of it into a mineral called serpentine; the rocks themselves are then called serpentinite. Although serpentine can be very pretty, it is not particularly useful from a chemical standpoint. The minerals in a rodingite, including garnet, which can be used as a geochronometer, are much more conducive to geochemical studies. Therefore, rodingites may be able to help us understand their own subduction story as well as that of the neighboring serpentinites, which is what I will be studying this coming year.

Over the course of our week in Italy, we visited a variety of locations in the Western Alps and Apennines; Chiavari is a town near our Apennines field sites, while Sassello and Saluzzo are close to where we worked in the Alps. (Picture 2) Each day began with an Italian breakfast, which is rather sparse relative to what most Americans eat in the morning. That said, I really enjoyed it; instead of bacon, eggs, and pancakes, we had toast, yogurt, and jam, as well as pastries, cakes, and tarts. After saying goodbye to Larry the dog, guardian of the bed and breakfast we stayed at, we would head out for the day in a caravan of cars filled with hiking gear, sledgehammers, and empty bags for the samples we would collect. (Picture 3) Each morning, we visited a few sites we were interested in sampling. Some sites were roadcuts, which meant that we only had to pull over and get out of the car, but others involved lots of climbing and bushwhacking, and even wading through a river. (Pictures 4, 5) After arriving, we would spend a few hours exploring, taking notes, and sampling the rocks before moving on. (Picture 6) In true Italian fashion, we had excellent lunches every afternoon, including some of the best cheeses and cured meats I've ever had, as well as espresso (Picture 7). This was true no matter how deep in the middle of nowhere we seemed to be; the priority Italians place on good food is something I have come to respect even more than I already did. After visiting another site or two in the afternoon, we would return to the bed and breakfast around eight o'clock and clean up before dinner. Each day was long and exhausting, but also a lot of fun, and it was definitely worth it to be able to see where the rocks I will be working with for the next year came from.

In addition to the opportunity to study such fascinating rocks, this trip also gave me the chance to join a group of scientists representing multiple countries and academic institutions and travel to a place I had never visited before. Although by no means representative of the entire E-FIRE group, we worked with scientists from Virginia Tech, the University of Genoa, and the University of Pavia over the course of the trip. (Pictures 8, 9) Although I certainly learned a lot just from being a part of the group, one of the highlights was the opportunity to meet and talk with Professor Marco Scambelluri from the University of Genoa. He is an accomplished metamorphic petrologist as well as an expert in local geology, so having the opportunity to learn about the Alps from him while physically being there was a particularly edifying experience. He took the time to make sure that we undergrads understood the geology of the sites we visited and why we had chosen them. For example, we visited a place in the Alps called Erro Tobio, where the process of serpentinization can actually be seen; the rocks there represent a gradient ranging from peridotites, which are unhydrated mantle rocks, to serpentinites, and it is possible to walk from one to the other. Marco took the time to give us a lecture in the field, walking us from rock to rock as we talked about the process of serpentinization.
(Picture 10)

I also learned quite a bit about being Italian from Marco. I usually try not to put too much stock in stereotypes, such as the famous generalization that Italians talk with their hands. This does appear to be true, but I never knew that some of these hand signals have literal meanings, and how involved they can be. One day, I heard Marco talking about how we Americans didn't understand all his signals - apparently, moving one hand and suggesting that we leave is just that, a suggestion, but moving two hands and saying the same thing is an insistence, regardless of verbiage. Additionally, moving one's hand by one's hip and suggesting we go really means that we need to go eat. Marco also had some other hand signals whose meanings were less specific and were used in a wider variety of situations, and I quickly found that his gestures often conveyed more than words could.

As an Ancient Civilizations minor, the Alps have inevitably come up in my Classics courses; Julius Caesar mentions troop movements across the Alps in his *De Bello Gallico*, in which he chronicles his conquest of Gaul, and a Roman history course would be incomplete without a discussion of Hannibal traversing the Alps with a herd of elephants. It is all very well to read about these things, or to look at pictures and maps, but to physically be in the Alps is a different experience entirely. Having to bushwhack, wade through rivers, and scramble up and down steep slopes to reach isolated sampling locations helped me understand how difficult travel is without modern transportation systems, and how impressive these historical figures really were. Although we didn't make any stops specifically geared toward history, I still feel as though my study of the Classics was enhanced simply by being there.

As well as being an extremely beneficial academic experience for me, this trip also gave me the opportunity to spend a lot of time outside and enjoy some of the most beautiful landscapes I have ever seen. As a member of the Arts and Sciences Honors Program, I have had the opportunity to study human thought from antiquity to the present over the past three years, and one recurring theme is the question of how humans fit into and ought to interact with the natural world. While we were at Erro Tobio, I had a few minutes to sit alone with my thoughts, and my mind wandered to this topic. (Picture 11) I started thinking about how remarkably crafted a system the Earth is, and returned to the question of humanity's place in relation to nature. On one hand, humans have superimposed their own manmade order upon an already functioning system that seems like it could work without us, often to the point where we begin to harm it as well as ourselves. On the other, it is worth remembering that, regardless of who we are, where we come from, and where we may be going, we are all here because a rocky planet in the corner of a galaxy met the necessary conditions to harbor life. We are all subject to nature's processes, whether they are beautiful or destructive. We're all part of the same dynamic, natural system, whether we choose to accept it or chafe against it. As far as the Earth is concerned, we're all much more alike than we are different. And at the end of the day, millennium, or epoch, depending on the temporal perspective one wants to take, I think this is one of the most important lessons that the Earth has to teach us.

Pictures:

1. Diagram of a subduction zone. (This is public domain, but I don't know if it's something we need to document in a particular way, so here is the link to where I got it from: https://commons.wikimedia.org/wiki/File:Active_Margin.svg)
2. Map of the places we visited (I took a screenshot from Google Earth and modified it, if that's ok)
3. Annie Haws (MCAS '19) with Larry the dog. (photo from Ethan Baxter)
4. Dr. Paul Starr (Postdoc, Boston College), Annie Haws (MCAS '19), and Sarah Marvin (MCAS '19) climbing up from a site in the Apennines. (photo from Ethan Baxter)

5. Dr. Paul Starr (Postdoc, Boston College) and Annie Haws (MCAS '19) climbing up to a site in the Alps. (photo from Ethan Baxter)
6. Annie Haws (MCAS '19) taking a sample in the Apennines. (photo from Ethan Baxter)
7. Lunch after spending the morning at Erro Tobio. (photo from Annie Haws)
8. The BC group overlooking the Mediterranean Sea: Dr. Paul Starr (Postdoc), Annie Haws (MCAS '19), Sarah Marvin (MCAS '19), and Prof. Ethan Baxter. (Photo from Ethan Baxter)
9. A part of the larger group hiking up from the sampling site in the Alps: Prof. Donato Belmonte (University of Genoa), Prof. Marco Scambelluri (University of Genoa), Dr. Mattia Gilio (Postdoc, University of Pavia), Sarah Marvin (MCAS '19), Hugo Van Schrojenstein Lantman (PhD student, University of Pavia), Annie Haws (MCAS '19), Dr. Paul Starr (Postdoc, Boston College), and Dr. Besim Dragovic (Postdoc, Virginia Tech). (Photo from Ethan Baxter)
10. Prof. Marco Scambelluri (University of Genoa) talking to Annie Haws (MCAS '19) and Sarah Marvin (MCAS '19) about the serpentinization process. (Photo from Ethan Baxter)
11. Annie Haws (MCAS '19) at Erro Tobio. (Photo from Ethan Baxter)