Penn in the Alps
August 2017

Penn
University of Pennsylvania

In August 2017, fourteen undergraduates traveled to the European Alps equipped with hiking boots, a Zurich hotel address, and a reading of *Physical Geology Today*. One even had the physical copy of the textbook. This was the second year University of Pennsylvania professor of geology Reto Gieré has led the twelve-day course, Penn in the Alps, to teach students in diverse majors how to observe and discuss natural phenomena and civilizational history outside of a college classroom. The Alps, which are world famous for their geological sites and cheeses, couldn't have been a more ideal setting to introduce us to natural processes, which drive the world and the society in which we live, wherever we happened to be from.

Before meeting in Switzerland, each student spent the earlier part of the summer writing a research paper on an assigned topic pertaining to the Alpine environment we were about to experience firsthand. In the midst of our day-long hikes (occasionally augmented by inquisitive alpine cattle) listened to each other present his or her research topic on mountain peaks, along the banks of turquoise-colored glacial lakes, and in front of 13th century stone castles.

Although we might suggest reading this report at an elevation of 2,600 meters for a completely authentic experience, the papers compiled herein may be read in the comfort of one's own home. Also included are diaries and photographs documenting each day we spent learning as geologists, mountaineering in the Swiss and Italian Alps.

Madison Bell-Rosof

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Trip Leaders

Reto Gieré was born in Switzerland and has lived all over the world, from Freiburg, Germany to Indiana, USA. He is the Department Chair of Earth and Environmental Science at Penn.

Justin Kulp is a candidate in the Masters of Environmental Studies program, a full-time Philly firefighter, and an enthusiastic van driver.

Student Authors

Walter Dawydiak is a junior from Long Island studying Environmental Science. He is an avid sailor and student of nature.

Kathryn Schoenauer enjoys going on long runs through Italian towns before hiking mountains in the afternoon. She runs track for Penn.

Joe Brau likes physics and Planet Earth and is a middle-of-the-pack hiker.

Anurag Makineni is a Penn senior from San Jose, California, studying Mechanical Engineering and Robotics!

Nayadis Couce recently submatriculated into the Master of Public Health program at Penn. In her free time, she loves to bike, hike, and read.

Carrie Wang dreams of napping on top of a mountain in the middle of the Swiss Alps.

Abby McGuckin is an Urban Studies Major exploring the rural parts of Europe this summer. She finds time in these remote spaces important in shaping her academic studies.

Jane Boszik enjoys car napping, dipping pretty much anything in Nutella, and trying to be a good trail mom. After graduation, she intends to move to a remote area of the Italian Alps and live out the rest of her days as a shepherd.

Gabrielle Davis is from Philly but goes to school at Middlebury College where there are more cows. It's a good place to study environmental chem.

Eric Yeh likes to drink glacial water. He is an engineering student at the University of Illinois at Urbana-Champaign.

Alys Ferragamo is a senior studying Cognitive Science. After Penn she intends to move to Montespluga and eat gnocchi everyday.

Katherine Chan is from Hong Kong and is a member of the Class of 2020. She is concentrating in Real Estate in the Wharton School and minoring in History.

Josh Lauder is a Palo Alto-born student studying Science, Technology, Society & Communications (STSC). He's passionate about experiential learning, video/photography, connecting (with) people, tech/entrepreneurship, philanthropy, and writing bios of himself.

Madison Bell-Rosof found an edelweiss first. She eventually found her passport, too. She studies environmental science and English.

Diaries

Day 1: August 9th

August 9th was the first day of the program and the day that most arrived in Zürich. Since most students arrived in the morning and the program didn't officially begin until 2 pm, we had a few hours to explore the city of Zürich before our tour later that day. Our hotel, Hotel California, is located in Zürich's old city and this is where I spent most of my time exploring. This area is composed of a mazelike network of cobblestone streets and alleys which are mostly limited to pedestrian traffic. The area is interspersed with picturesque squares and streets lined with shops, cafes, and restaurants. Later on in the day, we would learn about the development of the city as well as Switzerland as a country.

Switzerland is separated into 26 cantons, similar to states in the US. Each of these cantons have their own official languages, largely based on their geography and proximity to border countries such as Italy and France. The entire country has four official languages including German (largely Swiss German), French, Italian, and Romansh. The federal government is based in Bern and is led by the seven members of the Swiss Federal Council. Two members from this council are chosen to serve one-year terms as President and Vice President, although these designations mostly proffer ceremonial power. Switzerland is a direct democracy, meaning that if enough citizens support a legislative change, a referendum may be called and it can be voted on. A prominent example of this direct democracy in action is the 2013 referendum to dissolve the Swiss military which only garnered 27% support in the polls.

Figure 1: A pedestrian street with Grossmünster towers in background.

In the afternoon, our group met up for the first time and headed out into the city (Fig. 1) for an introduction to the course and a tour of some of Zürich's notable sights. We stopped along the water for an introduction to the city itself. Zürich, Switzerland's most populous city, is located at the northern boundary of Lake Zürich (Fig. 2), where it flows into the Limmat River (Fig. 2.5), a tributary to the Rhine. Although the city borders are confined to this area, Zürich's urban sprawl surrounds all of the relatively large Lake Zürich. Zürich is home to 400,000 residents, 32% of which are foreigners without citizenship. This high number of expats can be attributed to both the living standards that foreigners seek out as well as the difficulty for noncitizens to gain citizenship. Many of these foreigners are classified as permanent residents which means they live and work in Zürich but don't enjoy the full benefits of citizenship. Workers in Switzerland on the whole generally have higher salaries and low taxes, contributing to the country's consistent position at the top of world quality of life rankings. For tourists, though, Zürich and other Swiss cities can seem surprisingly expensive. Price differences for anything from restaurants to hotels between cities in the United States and in Zürich are exaggerated further by the strength of the Swiss Franc over the US dollar.

Figure 2: View looking out over Lake Zürich with the famous Zürich Opera House (white building at center).

Zürich gained importance and wealth early on due to its position along important trade and transportation routes through the Alps. Modern-day Zürich is a financial and technology hub for the country where international companies have headquarters due to favorable tax rates. Switzerland has become wealthy off its exports. It lacks many of the environmental issues of other countries because there has never been much industry or manufacturing. Most of the country's wealth comes from trade, technology, and financial services. It also derives most of its power from "clean" energy, with over half of electricity generation coming from hydropower and well over a third being generated in nuclear power plants. Coal- or oil-fired power plants do not exist in Switzerland, which has helped in limiting pollution.

Figure 2.5: The Limmat River flowing from Lake Zürich. The towers of the Fraumünster and St. Peterskirche can be seen.

The geography of Zürich has been sculpted by glacial action, as is the case with many localities throughout the Alps. Around 10,000 years ago, following the last major glacial period, the 25-mile-long, 470-foot deep Lake Zürich was carved out. Terminal moraines, glacial deposits of sediment and rocks carried by the ice, formed Zürich's hills that rise up around the Limmat River. These important glacial formations influenced the settlement of Zürich and other major cities in Switzerland such as Geneva and Lucerne, all of which are situated around glacial lakes.

Zürich has been continuously inhabited since the Bronze Age. The Romans established a settlement here in 15 BCE which evolved into a tax collection post for trade moving through the area. The Romans also built military fortifications here to protect the site from invasion. Roman control lasted until around 400 CE when the Alemannic tribes invaded and took over the area and built a new Carolingian castle on the old Roman site, extending Charlemagne's Carolingian Empire into Switzerland.

In the late 13th century, the Swiss Confederacy was formed to establish a degree of unity between the fledgling cantons. Zürich joined in 1351, forming the Helvetic Confederacy.

This Confederacy became for a short time the Helvetic Republic when Napoleon's armies conquered Switzerland while on their way to attack Austria. Within twenty years, Switzerland returned to the political system of unified but distinct governing cantons set up in the Helvetic Confederacy. According to Reto, most Swiss cantons have always been fiercely independent and have strongly resisted central leadership. This was demonstrated when Rudolf Brun led the guilds of 14th century Zürich to reject leadership by a regional or church leader and instead allow the common people to run society. Through this revolution, more power was put in the hands of the lay people. These guild houses, once centers for craftspeople, are now mostly high-end restaurants.

After hearing about the history of Zürich and Switzerland, we made our way to the first site of the day, the Fraumünster, or Women's Minster, Church. The Fraumünster is one of several churches in the city, two of which we visited later on in our tour. This church was originally a convent for women and was run by an abbess. The church has several stained-glass windows, five of which were created by the famous 20th century artist Marc Chagall. These five windows depict several religious scenes in a less traditional manner than is often seen in church windows (Fig. 3).


Figure 3

From the Fraumünster we headed to the Wasserkirche, or Water Church, named for its proximity to the Limmat River. Originally, the church was actually on a tiny island within the river but was connected with the main bank in the 19th century. The Wasserkirche features prominently in an important local legend. In this legend the siblings Felix and Regula, now patron saints of Zürich, were decapitated at the site of the Wasserkirche by the Romans. Following their execution, the pair picked up their heads and carried them a short walk up the hill before saying a prayer and finally dying. The legend follows that Charlemagne, an avid hunter, spotted a beautiful stag in the woods of Cologne, Germany, which he tracked all the way to Zürich. When the stag reached the site of the graves of Felix and Regula, it got down on its knees, as did Charlemagne's hunting dogs and horse. Charlemagne took this as a sign from God and commissioned the building of the Grossmünster church in around 800 CE.

The Grossmünster is the last and largest church we visited (Fig. 10). It sits atop one of the glacial moraine hills overlooking the old city. The Grossmünster served as the medieval center of town and has always been a symbol of Zürich. In the early 16th century, Huldrych Zwingli began the Reformation in Switzerland in the Grossmünster. We had the chance to tour both the nave and the crypt museum where a 15th century statue of Charlemagne stands as a reminder of the church's origins.

After leaving the Grossmünster, we spent some time strolling through the quiet backstreets of the old city. We stopped to take a look at two businesses that survive as remnants of earlier times (Fig. 4). Conditorei Schober is an extremely popular and pricey café with a beautiful centu-ry-old interior that draws many in from the street to take a look. H. Schwarzenbach is a shop that sells an incredible variety of fruits, spices, coffees, and the like. It advertises "colonial wares", and is a historic relic to the colonial days when these trade shops held high importance.

After visiting the churches and touring the city, we were given a chance to buy our lunches for the next few days. Since our food couldn't be refrigerated it had to hold up through a few days of traveling. Most students selected items such as hard cheese, bread, and apples. Others vied for more adventurous options such as octopus carpaccio and salmon tartare. Either way, everyone seemed to enjoy their meals later on the trails. After our first experience shopping for food in Switzerland, we headed back to the hotel for a couple hours to settle in and relax.

For dinner, we went to Tibits, an upscale vegetarian buffet with a surprising array of options ranging from Thai veggie meatballs to spiced chickpea tagine. It was a delicious and filling meal and a great chance for everyone to spend some time getting to know each other after such a whirlwind day.

Figure 4

There were several interesting anecdotes from our day in Zürich. For example, many believe that the American Amish have Dutch origins but they actually originally come from Switzerland and only are associated with Holland because they passed through there on their way to the US. They speak a dialect of Swiss German. Another interesting fact is that Switzerland is the only country other than Vatican City to have a square flag. Also, Swiss German is distinctly different from High German, or the main dialect spoken in Germany. Thus, when German tourists come to visit Switzerland, they have much trouble communicating. Additionally, speakers of High German have an extremely difficult time learning Swiss German. As Reto puts it, "It's almost impossible." Speakers of Swiss German do not have such difficulty of picking up another dialect.

Wally Dawydiak

Day 2: August 10th

Leaving Zurich

The day started early with a delicious breakfast at the Hotel California. For many, our Hotel California breakfast marked the start of a two-week streak of bread, Nutella and coffee for breakfast. Afterwards, the group went upstairs to grab our luggage and carry it downstairs. There was a wide variety of suitcase sizes spanning from Abby's backpack to small carry-on suitcases to my ginormous green luggage. Luckily, the vans were incredibly spacious. We piled our luggage, backpacks, hiking boots, Josh's drone and ourselves all in the vans to leave Zurich on the rainy morning. I climbed into Reto's van along with Joe, Jane, Nayi, Carrie, Wally and Gabby. These van arrangements would soon become our travel cohort for the next two weeks. With only some bias, I can say that Reto's van definitely became known as the best van.

As we drove out of Zurich, we were surrounded by amazing views. One perk of being in Reto's van was the opportunity to have a lesson during the drives. As we passed Lake Zurich Reto explained the formation of the lake was due to a glacier. Because the lake was formed by a glacier, it is extremely deep. Reto pointed out the U-shaped valley surrounding the lake which is often characteristic of a glacial lake. Reto also gave explanations of the many houses and buildings we saw surrounding the lake. He said while one may assume the houses and buildings are all part of the city of Zurich, they are actually separate towns and their own entities. We continued on for about an hour and stopped at Heidiland, the nicest rest stop I have ever seen, for a restroom and snack break. Reto explained that we had to pay one Swiss Franc to use the restroom. This was extremely different from the rest stops in America that we were used to, it wasn't filled with long lines and the smells of McDonalds.

Flims, Switzerland

We continued the drive through the Swiss Alps. They grew narrower and frankly scarier as we approached our next stop. Reto and Justin both drove vans with manual transmissions, making it easier to control the vehicle on mountain roads like the ones we were on. We then stopped in Flims, Switzerland to do a small walk to get a greater view of the mountains, river and valleys (Fig. 5). It was a bit chilly, but we would soon learn that layers are key when hiking. We gathered and looked down at the part of the Rhine River called the Rhine gorge. Along the river we were able to see a railway. Reto explained that this is the Panorama express.

Figure 5

As we looked over across the scene, Reto pointed out the white rock in which the Rhine River carved a canyon. This strange attribute is due to a landslide that occurred approximately 9,500 years ago, this time marks the end of the Ice Age. We know the age of the landslide because the event destroyed all vegetation, ancient trees are found in rocks from the landslide and scientists are able to use carbon dating to identify a period in time when the landslide occurred. Reto explained the concept of permafrost through the context of this specific landslide. When the ice disappeared at the end of the ice age, the sides of the valley that were once held together by the glacier and the permafrost started sliding, leading to a massive landslide. Approximately 10–11 km3 of rock fell in the landslide creating geographical changes to the terrain. After the event, a large lake developed because the river had nowhere to go. However, the lake is no longer here. Reto also explained the power of the Rhine River. The river has eroded 400m of rock and the river has a gray color due to the sediment. The rock in the valley is a soft rock so it is fairly easy for a river to dig through.

Not only did Reto discuss the geographical implications of this area but he also talked about the cultural influences this geography has had. The area became a natural barrier that separated two different cultures. Above the barrier are Romansch speaking people and below the barrier are German speaking people. Because people could not get up and down this area, two different languages flourished although in extremely close proximity.

Hike to the Rhine River

After our stop, we prepared for our hike down to the Rhine River. Because it rained that morning, the trail was fairly slippery. Not all of us had our hiking legs yet and many of us slipped down the trail on our way down. We would soon become much more comfortable with the idea of slipping and falling while hiking in the next two weeks as it would happen to all of us. On the way down to the river Alys got stung by a bee but took it like a champ and did not even let out a scream. Once at the bottom of the river we were able to explore along the river bank (Fig. 6). Reto asked us to collect rocks to discuss during lunch.

Figure 6

As we explored the river, Reto pointed out the rocks that are being carried by the water. We were able to identify the rocks that have been carried by their roundness and diversity of the rocks. The rocks on the other side of the river were larger, and blocky because they are too large to be moved by the river. These rocks occur because we know that cliffs are always in motion. Rocks often fall from the surrounding cliffs and land in the river. After collecting our rocks, we ate lunch by the side of the river and looked at what we found. Reto gave us a brief overview of the types of rocks, how they are formed and we learned the other basic foundations of geology. Most importantly we learned that rocks are made of minerals, and minerals are made of elements. We discussed some of the differences between metamorphic rocks, igneous rocks and sedimentary rocks. As we discussed the similarities and differences we enjoyed our first lunch of bread, fruits, vegetables and cheeses that we bought back in Zurich. After lunch we worked our way back up the valley towards the van. For many of us, I think this is when we realized that the study abroad trip we signed up for might be a little more than just a few walks and pretty views. While some of us thought this hike was difficult, it was much smaller

than the hikes we would endure in the next few days.

Zillis

After we all made it back to the vans we piled in and headed to Zillis. In Zillis, Wally gave his presentation on the Church of St. Martin (Figure 4). Wally went into detail on the importance of the church in historical trade routes. For many travelers and traders, this church was a place of safety and comfort after experiencing treacherous conditions on the mountain paths and passes. The church is known as the "Sistine of the Alps" due to its incredible ceiling. Unfortunately, because of restoration work in progress, we were unable to see the ceiling in its entirety. The ceiling consists of 153 panels divided into seventeen rows and nine columns. Each panel on the ceiling features a biblical scene and groupings of tiles tell a variety of stories (Fig. 7). The four corners of the ceiling contain angels representing the connections between the world and the unknown to remind people that judgment day is approaching.

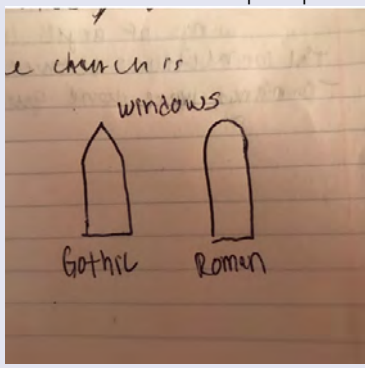

Figure 6.5

Wally continued to explain the importance of restoration and architecture in the church. The church has gone through many restorations starting in 500 CE. The ceiling was then added in 1130 CE. Many people began to pass through the town of Zillis as trade increased. The 1st Crusade also brought a lot of people through the area. During this time period, there was a strong clash between church and state, this clash led to The Concordat of Worms. This proclamation gave most of the power back to the church and because of this the church was able to acquire more land, build and renovate churches as shown by the Church of Zillis. Wally showed us that by looking at the diverse architectural elements we could determine the time period in which different sections of the church were built (for example, Romanesque vs. Gothic arches; see Fig. 6.5).

After exploring the church, we were able to walk through the museum in Zillis. In the museum we watched a video that gave an in depth overview of the history of the village, the church and the gorge. The Viamala was a trail, and later a road, that was built for travelers near the area of Zillis. Unfortunately, the path was extremely dangerous thus Zillis became a place of refuge before and after crossing the path. The video discussed the importance of the ceiling as it represents



Figure 7

the story of Christian salvation. The individual paintings were completed quickly and cheaply. The museum had a lot to offer and helped us all gain a deeper understanding of the cultural importance of the region.


Figure 8

Viamala Gorge

We made our final stop at The Viamala Gorge (Fig. 8) – a ravine with a significant amount of history. This path was the most treacherous but fastest route between Switzerland and Italy. Prior to completion of the Wildener Bridge, many travelers and traders were not able to make it through this gorge. The gorge was extremely jagged and steep, it was no surprise the road was named Viamala.

Reto explained that the creation of the gorge could have occurred in a few different ways. Some say it was formed partially by a glacier because of the large boulders and debris present at the bottom. Others say that the steepness of the gorge could have only been formed by a stream. Perhaps it was a subglacial stream that started to carve the gorge already during the ice age? It was incredible to see the Rhine running through the gorge and surreal to imagine trying to cross this path during the Middle Ages like the Romans did.

Montespluga

After admiring the gorge, we got back in the vans and headed towards our final destination Montespluga. We arrived and there was an incredible fog over the mountains (Fig. 9). Many of us were able to explore the little town before having the first of many amazing Italian dinners. At dinner we had delicious pasta and local wine. Many of us were exhausted from our first big day and ready to get to bed.


Figure 9

Kathryn Shoenauer

Day 3: August 11th

Preface: This day was a physical and emotional rollercoaster where the physical peak was our emotional depth.

A beautiful, clear morning in Montespluga welcomed us to a day of hiking and travel as we broke fast at the Hotel Vittoria. After eating assorted croissants and jams, a few of us went for morning walks around the beautifully quaint buildings and scenery in Montespluga. Personally, looking out onto the stretch of field just South of the town was one of the more stunning experiences of the early part of this trip. Discussing the mountains surrounding this pasture, Prof. Gieré noted the mountains were composed of metamorphic gneiss and that the reason the water of the Lake of Montespluga was greenish was due to the presence of mica.

After a short van ride to the start of our trail, greeting cattle along the way (Fig. 10), we briefly discussed a dam built in 1931 that cut off the Lake of Montespluga and overlooked the valley we were preparing to enter, the Valle Cardinello. The trail along this valley, a subsection of the Via Spluga, was once a central point of travel through the Alps as it was a short (yet dangerous) passage through the mountains. This path was also noted to have been carved out by hand. Further discussing the trail that we were preparing to hike, Prof. Gieré said that the path we were to travel had been traversed many times by the Romans and even at some point by the French army of Napoleon Bonaparte!

Figure 10: An alpha cow (left) greeted us at the start of our journey, mooing to her beta cows (right) to get them to move down the hill.

Climbing downhill, over an electric fence and scattered cow pies, we got a beautiful display of the valley below. The mountains surrounding us were somewhat lush with grasses and trees with scattered cliffs and rock fall. We heard high-pitched warning chirps on the way down, getting our first experience of the alpine groundhog cousin, the marmot. These chirps signaled to the other marmots of potential danger, so once we heard them, we knew it would be difficult to spot them for a while.

Hiking further down, we had been progressively noticing the wide temperature differences between the edges and centers of the valley. This early test in layering was really only a warmup for what was to come. Crossing wooden bridges and walking through the depths of the valley, we eventually reached a waterfall where Kathryn Schoenauer would present to us about the history of infrastructure in and crossing through the Alps.

Kathryn described all the ways in which various types of technology have been used to make transportation possible through the Alps. She noted that infrastructure in the Alps has had important cultural, military, and economical effects on Alpine history. From Hannibal's disputed crossing in 218 BCE to the use of cable cars bringing increased tourism in the mid-twentieth century, Kathryn talked about the wide ranges of paths, roads, and rails created to make travel accessible in the Alps. After her presentation, Reto told us the story of Devil's bridge (named for a supposed deal with the devil to keep it up) and about a recently constructed 57 km tunnel to create a path from Zurich to Milan in 2.5 hours. He noted the process of having to bore tunnels from both sides, as well as one shaft down the middle (with the help of South African gold miners) to build a boring machine in the center.

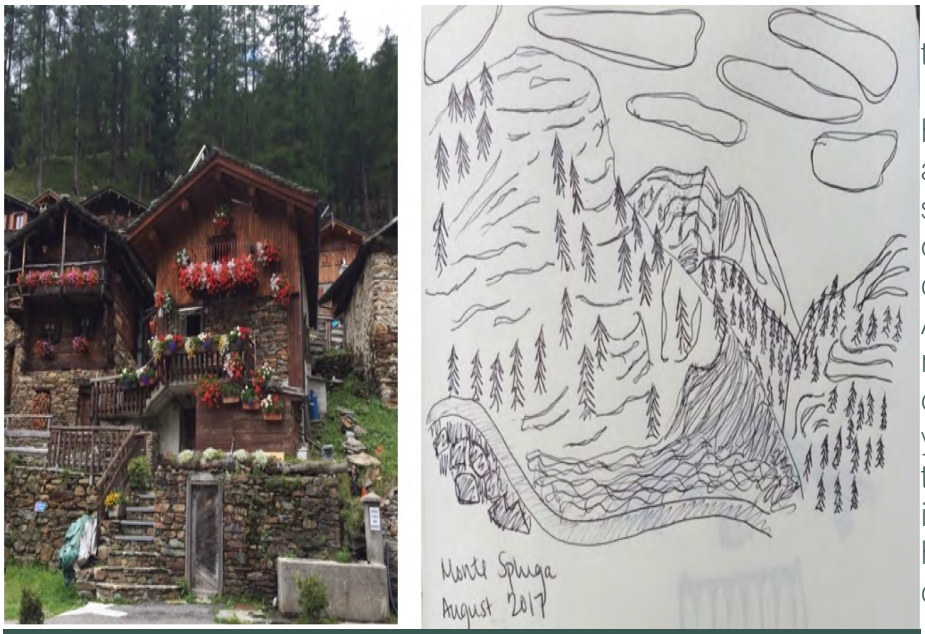

Figure 11: (left) The village of Rasdeglia , (right) A beautiful drawing of the valley by Abby McGuckin

From there, we had a pleasant walk to the small village of Rasdeglia (Fig. 11), a series of scattered wooden houses on the hillside, where we ate our breads and cheeses and sat down to listen to Abby McGuckin's presentation on the history of human settlement in the Alps. Abby discussed the history of humans (including the Neanderthals) occupying the area nearly 40,000 years ago, and the effects that each tool age had on lifestyle and farming in the region. The main focus of her presentation was the discussion of transhumance in the Alps. This was the seasonal roaming of animals (livestock) from valleys to high mountains depending on the temperature. Abby also talked about the change in crops and the importance of cows, a relatively recent development, on the livelihood and economy of the Alps.

After Abby's presentation, and all lunches and lunch desserts were eaten, our warm hearts and happy minds were greeted with an ominous set of clouds. Although the majority were cautiously optimistic, many put on rain jackets and we started the trek back. Josh did not have a raincoat, but he did have a mango.

In an effort to go see some cottages at the top of a steep hill, Reto led us through an alternate path than the one we took down. This path became pretty loose and vertical, so Justin very fortuitously led Carrie and Gabby the "long way" up the path we originally took. As we continued to climb, the rain began to pick up and we entered a marmot territory of steeper climbs and scattered holes. We also saw a herd of sheep walking at an elevation that was way higher than ours, which was a little demoralizing. Despite some exhaustion, spirits were still relatively high (Fig. 12).

Reaching the cottages at the initial summit of our own journey (Fig. 12), the rain began to come down heavily. Many of us ducked under the arching roof of one cottage while water came down faster and harder. After redistributing layers and waterproofing valuables, Reto told us it was time to forge through the rain back to the van.

"We followed Hannibal blindly" – Madison Bell-Rosof

"We followed Hannibal blindly" – Madison Bell-Rosof



Figure 12: (left) Abby and Madison hiking in the rain, (right) quick cottage stop as the rain begins to pick up

It's difficult to say how long we had been hiking before the whole group had become fully confident that we were lost, off the trail. The path we followed back had become marker-less. We had to climb over trees, duck through brush, and hang on to rocks as our path became more and more laterally steep. Reto had decided that we would attempt to follow the valley to meet the trail closer to the bridge. At some point in this mess, we saw Justin at eye-level directly across the valley. Anxious and tired, some of the group had reached physical limits and emotional lows.

In trying to cut to the bridge, we eventually reached a steep, open, grassy area. With all the rain and nothing to hold onto, Reto decided to turn around and search upwards for the trail we had lost at the cottage. Fortunately, within a few minutes we discovered the red and white trail marker. We all silently marched down and across the bridge and climbed back up to the vans. We arrived at the vans cold, wet, and tired, greeted Gabby and Carrie, and removed our soaked outer layers. In the precipitation, we noticed that the caps of the mountains surrounding the valley were then completely covered in snow. I shoved M&Ms in my face and our group slowly recuperated on the winding drive down to Chiavenna.

"Then we hiked back and got lost and it rained a lot and we scaled the mountain and we eventually got back to the van." – everything I had written in my journal on the second half of this day.

In somber spirits, we unloaded in Chiavenna (Fig. 13) in search of warmth and dryness. With warm showers and changes of clothes, we rebounded by exploring the historic town, stopping at gelaterias, stores and piazzas. We joined together for a really pleasant and filling Italian dinner.

The first half of this day gave us a glimpse of natural Alpine beauty. The second half of this day brought us closer together. Overall it was an important and memorable experience.

Joe Brau


Figure 13: The river flowing through Chiavenna

Day 4: August 12th

Morning in Chiavenna

Figure 14: Mastai Ortofrutticoli is built into the space between large boulders

After spending the previous day hiking through a thunderstorm on an ancient Roman Road, we were all looking forward to a restful day in beautiful Chiavenna, Italy. Chiavenna is located at an elevation of 333 meters at the bottom of the Splügen Pass. Chiavenna enjoys a warm and temperate climate; the weather was absolutely beautiful during our time there.

We started our morning with breakfast at the Hotel San Lorenzo. We had the morning to explore Chiavenna and buy groceries for the next few days. After breakfast, many of us followed Reto to a fruit store called "Mastai Ortofrutticoli" (Fig. 14). Reto explained that many of the buildings in this part of town were built between boulders that fell from an adjacent cliff during a rock slide. These buildings are naturally cooled by the airflow between these boulders – we all noted the cool temperatures inside the store.

The store had a huge selection of fresh fruit and vegetables – we all stocked up on the cheap and delicious food to eat on the trail over the next few days. Adjacent to the fruit store was a large open-air market with merchants selling a large variety of clothes, shoes, house goods, and food. After browsing the market for a bit, we split into groups and explored Chiavenna.

A group of us decided to take a walk to a nearby waterfall. After about an hour's walk along the Mera River, we arrived at the beautiful Acquafraggia Waterfalls in the city of Piuro, Valchiavenna. The waterfalls are fed by a lake formed in an ancient glacial cirque to the south of "Pizzo Lago" (Cima da Lägh),. Undeterred by the cold glacial waters, Wally bravely decided to take a swim in the river at the base of the falls (Fig. 15).

Figure 15: Wally swimming at the base of the falls

On the way back from the waterfalls, we took a moment to take a look at the ancient city wall that once surrounded Chiavenna (Fig. 16). Reto later explained that the wall was built in the middle ages and separated the common people who lived outside the city walls from the merchants, artisans, and nobles who lived inside the walls.

Roman Rock Quarry

After the morning exploring Chiavenna, we all met at 1:45 pm to see the ancient Roman soapstone quarry. We learned that the Romans conquered the Valchiavenna area in 15 BCE and started to mine the rock. The Romans started at the top of the mountain and mined all the way to the bottom, leaving a large cut through the rock (Fig. 16).

Figure 16: Remnants of the city wall from the Middle Ages

Figure 17: Roman soapstone quarry

The walls of the quarry had many circular shaped holes. We learned that the Romans extracted circular pieces of rock to manufacture bowls. The soapstone, also known as pot stone, is ideal for cooking as it is fireproof and has a very high heat capacity. This means that once it gets hot, it retains its heat very well. The Romans developed a technique to carve several pots out of one piece of rock, much like Russian nesting dolls. The rock was attached to a wooden shaft and spun by a water wheel driven by the river. Artisans then used tools to carve the pots as the stone spun. We slowly made our way up to the top of the ancient quarry and found a beautiful view of the city below.

San Lorenzo Monastery

Soon after observing the town of Chiavenna from where the royalty used to live, we made our way to the Collegiate Church of San Lorenzo which was built in 1580. We learned that the San Lorenzo courtyard (Fig. 18) was added in the 17th century using a Baroque style and that the columns of the monastery were made from single pieces of quartz-rich gneiss (a metamorphic rock). The beautiful expansive courtyard was designed in such a manner so monks could walk around each morning and pray.

Figure 18: San Lorenzo Monastery Courtyard

Inside the monastery we observed a special piece of soapstone that was carved in 1150 CE and later installed at the monastery. This piece of soapstone depicts the daily activities of the three social classes (Fig. 19): the common people, merchants & artisans, and nobles. It was used by the monastery to baptize the children of Chiavenna. An inner copper part has recently been added to ease the process of baptism, but previous to the insertion of this copper piece the child would be completely immersed into the rather large basin of water.

Figure 19: Baptismal front

Survey of Stone Portal

Figure 20: Stone door portal

After we saw the San Lorenzo Monastery, Reto asked us to walk around the town and collect information about the beau-tiful stone portals located throughout Chiavenna. We split into groups of two and collected information about the stone type, age, and location of the various portals around the city (Fig. 20).

We then compiled all of the data to draw conclusions. We found that the doors inside the city walls were older than those outside the walls. We also see that most of the doors inside the city were made of pot stone, while some of the doors out-side the walls were made of gneiss. The data is summarized in Figures 21 and 22.

Evening in Chiavenna

After an evening of exploring around, the group was treated to a rather fancy dinner at Crot-to Torricelli. Crotto Torricelli is a special location because like the fruit store, Mastai Ortofrutticol, the restaurant was build around the boulder rocks that fell after the landslide. We were surprised by the natural ventilation of the restaurant and were taken aback by the beautiful view of the mountainside. After impeccable service, a full course meal, and some local wine we were happy to call it a day.

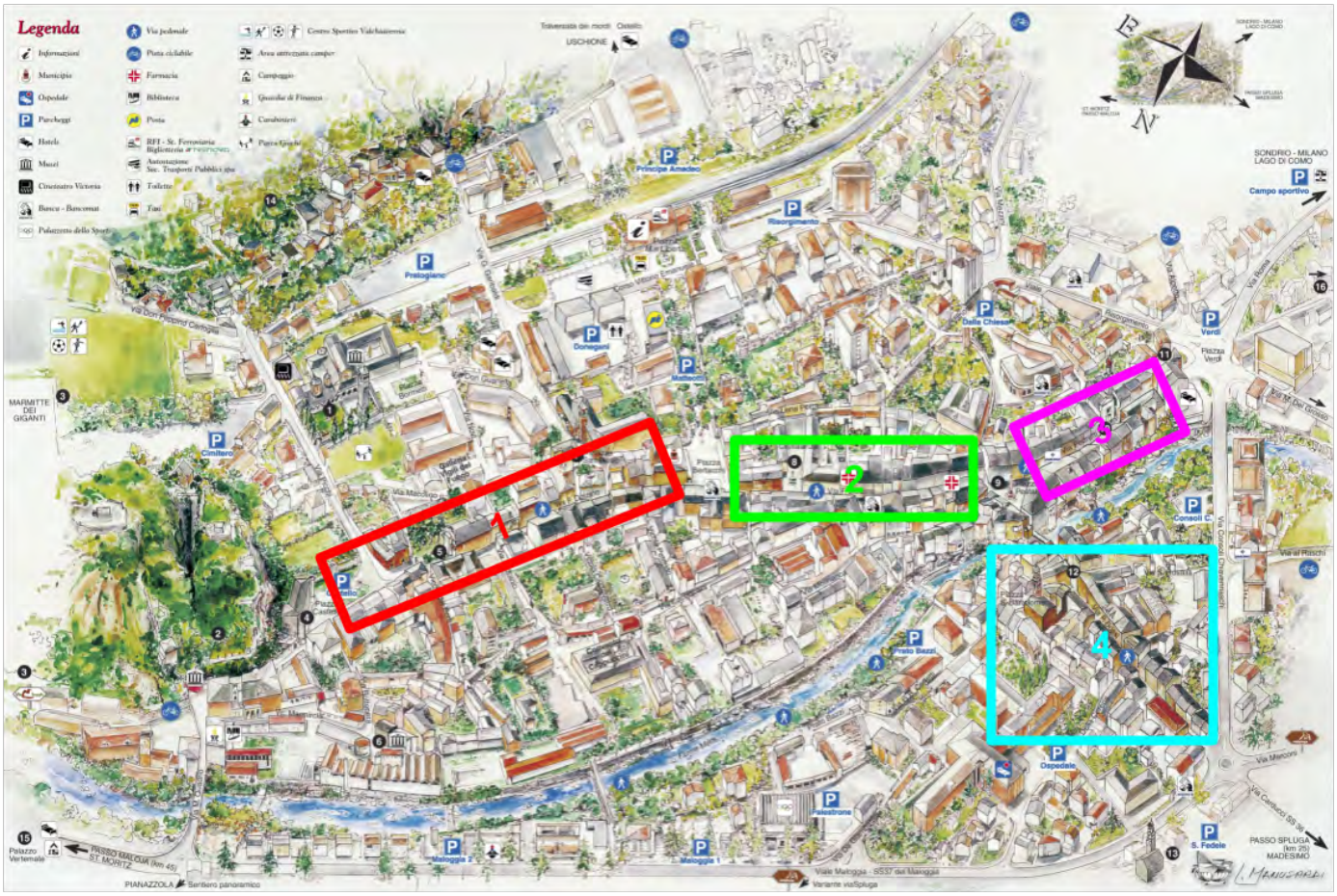

Figure 21: Map of Chiavenna with Areas Depicted

Area	Min / Max Date	Average Date	Stone Types
1	1580 / 1753	1598	Pot Stone, Gneiss
2	1586 / 1617	1600	Pot Stone
3	1546 / 1592	1576	Pot Stone
4	1568 / 1727	1611	Pot Stone

Figure 22: Ages and Stone Types of Portals

Day 5: August 13th

We started our last day in Chiavenna with breakfast at San Lorenzo. After breakfast, we drove to the palace Vertemate, which according to our guide was a mere "rural house" of the family. The Vertemate family consisted of mostly lawyers who sold soapstone as a living. The family name was actually the name of a place. The main palace was located in Piuro, where the majority of the family members resided. It was also where the rest of the village was located. Unfortunately, the main palace and the village were destroyed in a landslide in 1618, along with everyone but 2 members of the family who were away at the time.

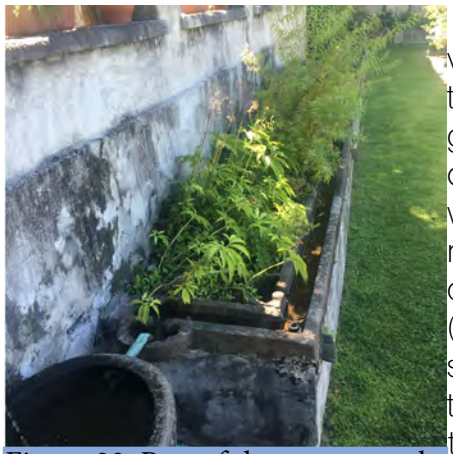

Figure 23: Part of the water canal system

The tour began as we walked past the chapel and entered the vegetable garden located on palace property. Our tour guide told us that the palace was a feudal housing and that nature and vegetable garden were very important to the rural area, even though the garden could be expensive to maintain. She also informed us that the palace was now owned by the town of Chiavenna, who gave the maintenance of the vegetable garden to a company that provided work for disabled people. The vegetable garden had a water canal system (Fig. 23) from the 16th Century. It was of the Renaissance style and it still works today. According to our guide, the canal had multiple holes that one could plug and unplug, and this helped determine where the water would flow. In addition, the vegetable garden had beehives, which supplied the honey production on palace property. There were also many outbuildings around the garden, which served as houses for livestock as well as storage rooms for chestnuts. As we learned throughout the day, chestnuts served as an important food source in the valley around Chiavenna. We then crossed the vegetable garden to see the vineyards growing next to it. These formerly deserted vineyards were now flourishing beautifully, and the grapes helped produce the local wine. According to our guide, grapes were left on the vines to dry out, thus making the flavor of the wine they produced tart, yet sweeter and stronger than normal wine. She said that this type of wine was best served with dessert. Our guide also pointed out to us that the walls around the vineyards were very thick because the town became cold in autumn and that the thick walls were there to help grapes ripen better by retaining more heat.

By now everyone was wondering, how did this landslide happen? Well, in Figure 6 below, we saw this V-shaped mountain. According to our tour guide, the right-hand side of this mountain had no vegetation. It was full of water and clay and there was a running river underneath that clay. This was the cause of the landslide. During the landslide, 1,000 villagers died.

Figure 24: v-shaped mountain (circled in red) responsible for the devastating landslide

We then all walked together to the main building of the palace. This building was of Baroque style, which meant that it had simple decorations and structure on the outside and elaborate paintings and decorations of Classical figures on the inside. It was a Renaissance trend to have Classical figures inside the house, even though the Vertemates were deeply religious. As we entered the main building, we were greeted by four floor-to-ceiling paintings of Hercules, Neptune, Saturn, and Vulcan in the hallway. They each represented one of the four elements: fire, earth, water, and air, and were there to remind people that the palace was a rural structure and that nature was very important. As we walked through the different rooms in the main building, we were told that a couple that sold antiques from Milan restored the palace. Even though some of the furniture might not have been the originals, they were all still from the Renaissance era.

We entered the family meeting room, known as a "stua", shown in Fig. 25. The stua was covered in wood coming from pinewood trees that grow only at elevations above 1500m. These pinewoods are immune against parasites and were easy to carve. Moreover, they helped people feel warmer in the room in the cold winter of the Alps. The stua was also known as the "Juno room" since it featured a large painting of goddess Juno on the ceiling.

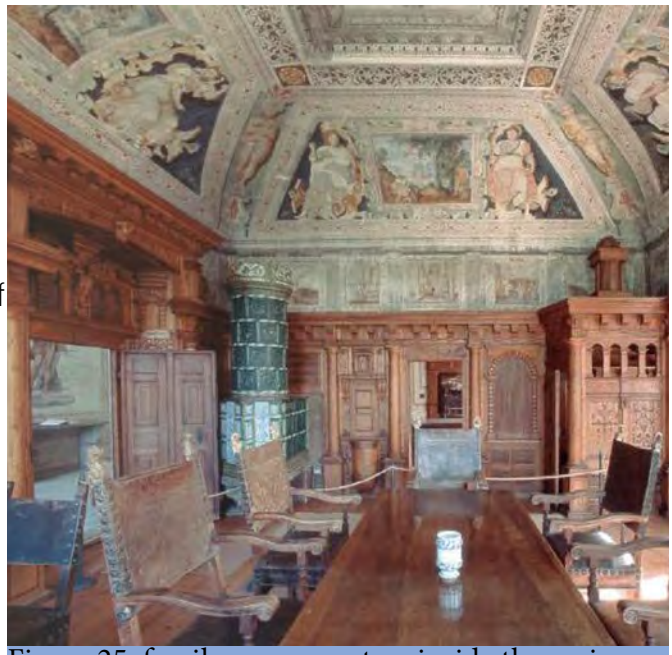

Figure 25: family room, or stua, inside the main palace

We then walked through many other rooms covered in fresco, which just meant the paintings on the wall. One of the rooms we walked through had female figures acting as columns for holding on the weight of the room. I thought the most interesting one was the painting of the female figure sitting down, since she had a door beneath her (shown in Fig. 26). Our professor, Reto, commented that because of the door, she now had to sit there forever. We also walked past the zodiac room, which was covered in fresco paintings detailing the things that needed to be done in each season.

Figure 26: female figure sitting down to hold the weight of the room due to the door beneath her

After we visited the palace, we said goodbye's to Chiavenna and began our drive back to Switzerland. We crossed the border in 20 minutes and stopped for our hike of the day to village Soglio (side story: we narrowly missed a landslide that occurred on August 23rd around this region. In the story published online we could see the bridges that we crossed and the place where we parked our vans). AReto asked us to explore Soglio on our own for an hour or so. As we explored, I noticed that most of the houses in Soglio featured a stoned tiled roof and a wooden beam body. Reto would later explain that these were traditional styled housing and that those with a cement body were either newer houses or older houses repaired with cement. During the exploration hour, some of us decided to play the game sardines (Fig. 26).

Figure 26: Kathryn, Alys, Wally, and Jane playing the game sardines in Soglio

After our exploration, we began our descent and our drive to Pontresina in the Engadine valley. During our drive, we passed by Maloja and lake Sils. Reto explained that Maloja served as a continental divide: every stream south of Majola flowed into the Mediterranean and everything north of Maloja flowed into the Black Sea. We made a rest stop at lake Sils to discuss the geography of the region as well as for Madison's presentation on Romanticism and Alpine literature.

Romanticism was a reactionary movement against the Enlightenment, reason and rationality. It advocated for sight, emotion, and natural instinct and urged people to consider past societies in Ancient Greece, Rome, and Medieval periods. Romanticism also called for natural and cultural preservation, for example Swiss nationalism. We discussed how Jean-Jacques Rousseau's Julie and Lettres Élémentaires sur La Botanique helped starting the Romanticism movement, as well as what the term "sublime" meant. The common themes in Romantic literature involved a mixture of reality and supernatural elements, and frequently featured protagonists who were simultaneously fearful yet drawn to the mountains. Romanticism had a lasting impact on the Alpine regions. It increased tourism as people wanted to see scenes where particular events happened in the books. One such example was Mer de Glace in France. This glacier was a popular tourist destination as it featured scenes from the Frankenstein. Romanticism also helped promote iconic natural features as well as the science fiction genre. It encouraged dystopian fictions in reaction to geological and biological changes in the Alps. As a side story, the central Alps were where Moriarty supposedly fell in the waterfall in the story of Sherlock Holmes.

I really enjoyed the presentation and how people flocked to Switzerland during the Romantic era. Personally, I really enjoyed the art and music from this period and could see the appeal of Switzerland and the Alps to writers, artists, and geologists alike during that time. It was truly a mesmerizing place, being surrounded by green mountains and glistening blue waters. I thought they served as great inspiration for composition of art related to nature. It was no surprise that people came to Switzerland in search of inspiration and "the sublime."

Figure 27: Lake Sils

After the presentation, we drove to the nearby village Sils. As we walked through the village Reto informed us that we were now in the Romansh speaking region in Switzerland. The continental divide we discussed before also separated the Italian and the Romansh cultures. He also told us that because this area was in a very high elevation, the weather tended to get very cold. Thus, people built houses with very thick walls (usually around 1m thick) and very small windows carved into them to keep warmth. Reto then challenged us to think how people were able to design the small windows to receive more sunlight. It turned out, If the windows were cut at 90 degrees, there wouldn't be as much sunlight as if they were cut at a tilted angle.

Figure 28: Typical house with scraffito in Sils

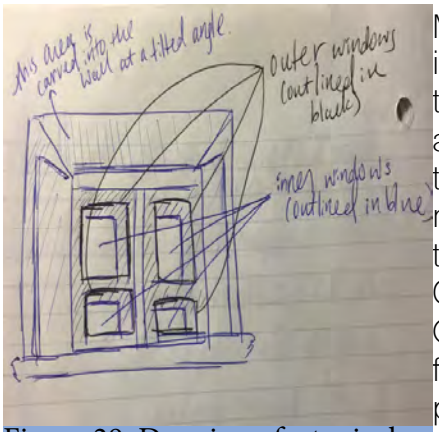

Figure 29: Drawing of a typical window in Sils

Most houses in Sils had drawings known as sgraffito, pictured in Fig. 28, on the corner of the walls. Sgraffito was created by applying a different colored mortar or plaster to the corner of the walls then scratching them off, revealing the contrasting color underneath the mortar. Many sgraffiti consisted of geometric shapes, though sometimes they could be more elaborate.

Our last stop in Sils was the Nietzsche-haus. Friedrich Nietzsche was a German philosopher who stayed at Sils. His old lodging had no sgraffito, but it did contain the traditionally tilted windows. Nowadays when people wanted to build new houses in Sils, they had to follow the design of the traditional houses, with the thick walls and tilted, carved windows.

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Our day ended with our drive to Pontresina and a cog railway up to Muottas Muragl to see the sunset and the starry sky. From the mountains, we could see many villages underneath, including St. Moritz (shown in Fig. 30). We were also incredibly lucky that night since there was the peak of the Perseid meteor shower. Many of us saw the shooting stars, and I was especially excited to see the Big Dipper, since I was never able to see it in the cities.

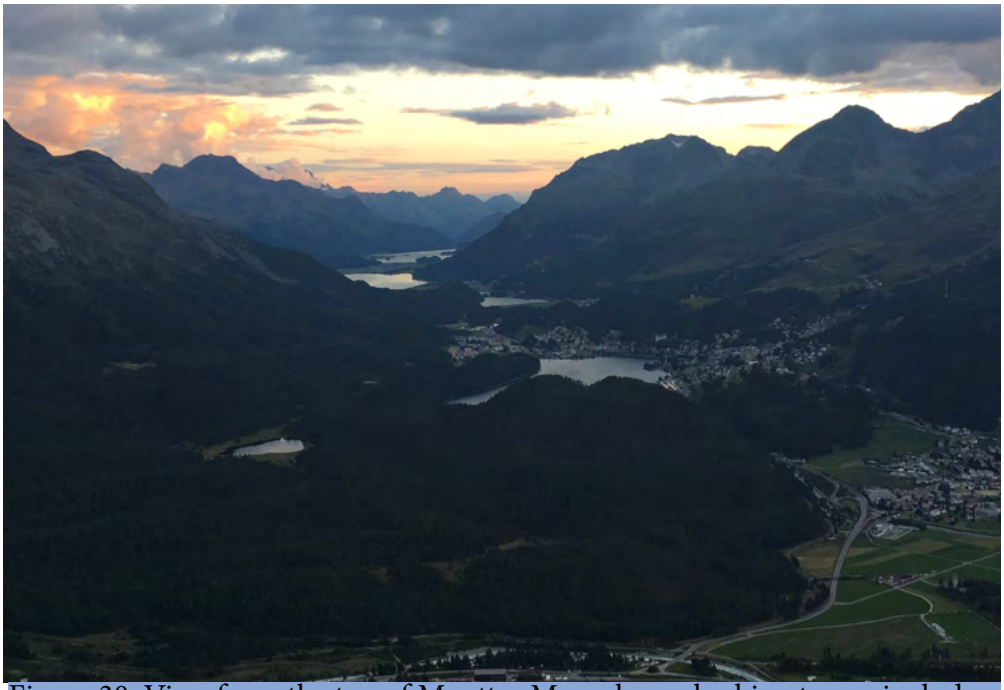

Figure 30: View from the top of Muottas Muragl, overlooking towns including St. Mortz, and a gorgeous sunset view.

Carrie Wang

Day 6: August 14th

Our morning started with a cable car ride to the top of Muottas Muragl, which stands at about 2450 m. Above the tree line, we could easily see the trail in front of us. It shot upwards towards a lake, continued around it, and followed through a cow pasture ending on another higher peak. Viewing the grassy landscape, we asked Professor Gieré why he chose this site. He responded simply, "disappearing permafrost." Looking around the green hills, we looked for what we thought was permafrost. To our surprise, the vegetated area we stood on that continued through the length of the hike was the permafrost. Professor Gieré explained that the active layer of permafrost, only 2–50 cm deep, defrosted during the summer and therefore could sustain life like the short grasses and small flowers we saw on the mountain. Below the active layer, permafrost existed. There is an upper and lower limit to permafrost because heat from the sun defrosts the upper region in the summer and geothermal heat warms the ground through to the lower limit of permafrost. Figure 1 shows a diagram of the active layer, permafrost, and the unfrozen ground beneath.

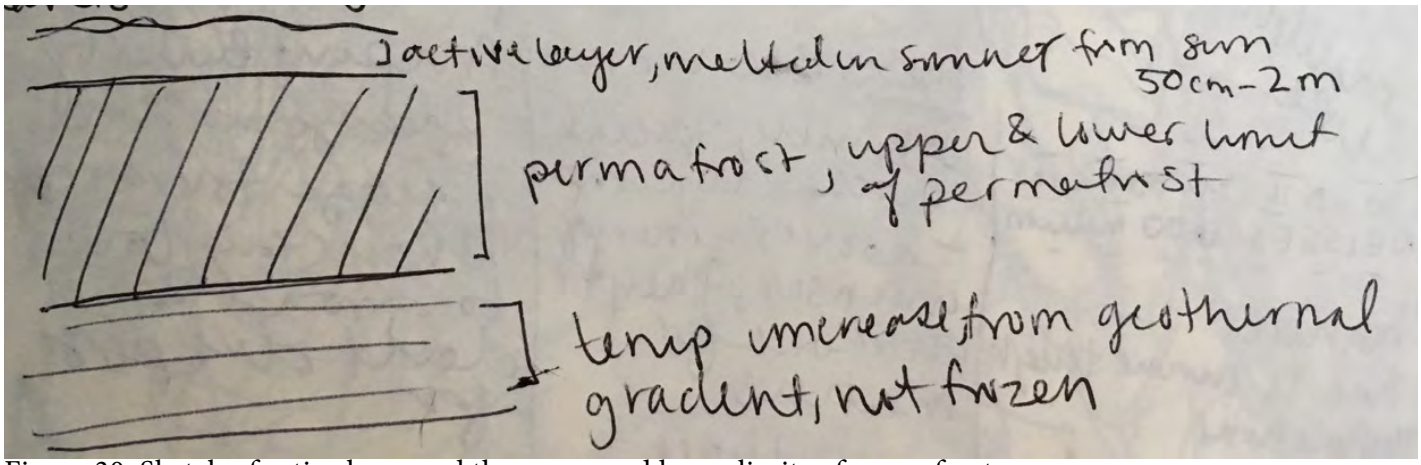

Figure 30: Sketch of active layer and the upper and lower limits of permafrost

Permafrost is of particular importance in the Alps because of the threat it poses if unfrozen. Once defrosted, the once solid soil is now liquid and fluid. Peaks that were once permanently frozen are warming, resulting in devastating mudslides in the Alps. The warming trends in the Alps due to climate change cause these once solid and dependable permafrost regions to melt into huge stretches. Destabilizing permafrost regions in the Alps are of great concern for the villages below warming areas, which can easily be wiped out in the event of a mudslide.

As we continued our hike, Professor Gieré asked us about the tongue like mound of rock formed under the mountain's peaks, appearing to move down the mountain. We could not identify the correct technical term for the structure, but we described it as composed of rock, but appearing to almost be moving and voluminous. Professor Gieré explained that the structure was a talus rock glacier, a mobile mass with a steep face composed of rock bound together by ice. An active talus rock glacier is distinguished from a dead (fossile) talus rock glacier by the presence of a steep slope at the front of the rock glacier's tongue. Talus rock glaciers are indicators of permafrost distribution, both past and present. Today in the Alps, rock glaciers are dying at a quicker than average rate, raising fear in scientists about how and when effects of warming due to climate change will similarly change the local permafrost.

After the debrief on permafrost, we hiked the trail and stopped by the lake (Fig. 31) for Jane's lecture on Alpine fauna. The two main animals discussed were the Ibex (Capra ibex) and the chamois (Rupicapra rupicapra). Both are ungulates found on the rocky ledges of the Alps that have adapted to the extreme conditions of winter in the mountains. The chamois have a dark coat color to absorb the maximum solar radiation for heat. Their feeding patterns differ by season. In the summer they feed twice daily to build up fat reserves for the winter when food is scarcer. The body of the chamois allocated energy from food differently based on season, which allows them to survive the cold and barren winter conditions. At first glance, ibex are distinguishable from the chamois due to the presence of large horns. Ibex are nimble creatures with special hooves that allow them to jump and traverse across the harsh terrain of the Alps. Although not practically useful like their hooves, male ibex grow horns to increase their attractiveness to female mates. They are energy intensive features that have persisted due to their ability to attract mates. They are majestic creatures that have become a symbol of the Alps. Even invertebrates have adapted to the Alps' intense climatic variation. Alpine butterflies vary in freeze tolerance and can tolerate up to almost complete freezing when they stay close to the ground for maximum heat. What all the alpine fauna have in common is the threat they faced posed by humans. Climate change affects all populations, regardless of species. There is no greater peril for these animals and insects than climate change.

Figure 31: Image of the lake on our hike, surrounded by

Figure 32: View of Pontresina from the chair lift

Looking at the trail ahead with fresh eyes and full of knowledge and respect, we continued on the trail to the summit. There, we enjoyed hot cocoas and spectacular views of gliders and paragliders sailing through the whipping winds. Our hike to the bottom proceeded at a quicken pace, with the prospect of taking a chair lift to the bottom instead of walking it. Miraculously, we all made the last chair at 5:30 and shared stunning views of Pontresina from our high perch (Fig. 32).

Abby McGuckin

Day 7: August 15th

7:45 am … We headed out from the Pontresina Youth Hostel where we were staying, Jugendherberge Cuntschett, dewy-eyed but decently well rested after a pretty intense hike up to Chamanna Segantini (2,731 meters) the day before. We were all pretty excited, myself especially so, to get up close to a glacier. I wasn't sure what all the day would have in store, but I was ready. We caught the train around 8:15 am to arrive at the cable car station and I was surprised to see that the "gondola," as the professor had called it, was a large box suspended on a cable (Fig. 33). The view during the ride was spectacular (Fig. 33).

Figure 33: (Left) view from the gondola, (right) view from the ride up to Diavolezza

The ride brought us up to Diavolezza, meaning "she-devil" in Romansh, so-named because of the legend that a beautiful she-devil lived in the mountains, a figure who would enchant hunters to fall in love with her and follow her until they fell to their deaths. When one specific hunter, Aratsch, tumbled to his doom, the she-devil called out "Aratsch is dead" or "Morteratsch," and thus the glacier was named. Once we reached the lookout, I understood why the hunters would be willing to chase her. It was absolutely breath-taking.

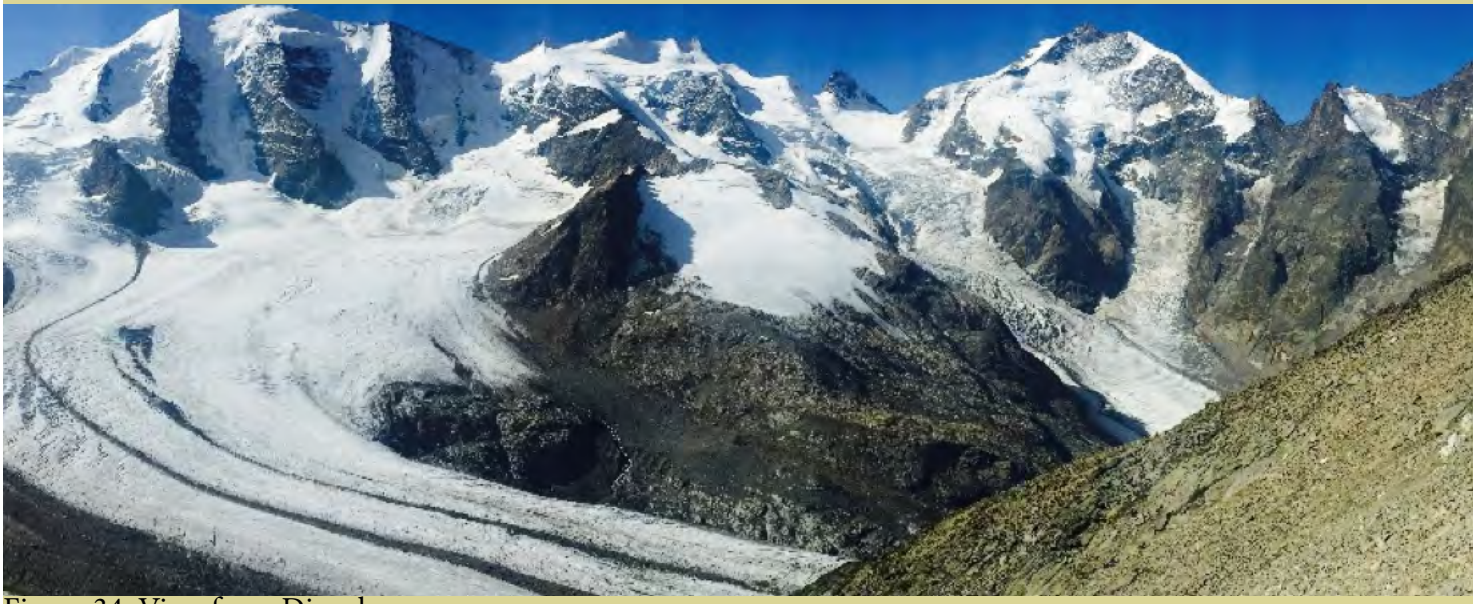

Figure 34: View from Diavolezza

The panoramic view provided a clear lookout point over some of the area's scenic high peaks, including Piz Palü, at 3,901 meters, and Piz Bernina, at 4,049 meters (Fig. 34). Piz Bernina is the highest peak of the Eastern Alps. Reto described to us how hikers daring enough to attempt climbing it usually have to stay overnight somewhere higher up and wake up at 4 am to hike some, stay in another cabin overnight again, and then complete it. The snow covering these mountains can be around 40 meters deep, which creates dangers for ill-prepared hikers. When you step in the snow, you sink up to 5 meters and can potentially fall in crevasses, deep open glacial cracks. For this reason, it is suggested that you do not go with less than three people tied together, so that if one falls in a crevasse, the other two can help retrieve him/her. The mountains also serve as the border between Switzerland and Italy, although hiking up the Italian side of the mountains is a lot steeper and more dangerous. The snow covering the mountains, Reto told us, used to reach much farther – when he was a child he used to ski down! Unfortunately, because of rising temperatures, more and more of the glacier is melting away.

10:30 am … After hearing a little bit about the dangerous glacier hiking, we were eager to begin our own, much less dangerous trek up to Mount Pers, our 3,207 meter destination. We began picking our way carefully over the small, rocky trail (with a steep drop to greet us if we made a wrong step). After about a half hour of hiking, we sat down to hear our first presentation of the day on the weathering of rocks, by Carrie.

The Weathering of Rocks

She told us about the two types of weathering: physical/mechanical and chemical, which involves a change in chemical composition. Both of these work to slowly disintegrate rocks formed deep within Earth's mantle, but which only weather once they are exposed to water and oxygen at the Earth's surface. Mechanical weathering involves the disintegration of rocks into smaller pieces. It can result from frost-wedging, crystal growth, thermal expansion, and human/animal/plant interactions with rock. Frost wedging occurs when a crack fills with water, followed by the freezing of the water; the associated expansion (ice has a volume that is ~ 9x larger than that of water) eventually breaks the rock. When new crystals form in cracks or pores, they may exert a force in the direction of growth called "the force of crystallization," which can eventually break rocks apart. Thermal expansion is the process by which rocks expand when they're heated. On the other hand, when they are cooling, they are contracting when cooled. When the heating and cooling are repeated numerous times, the outer layer of the rock eventually peels off. Because rocks are of mixed composition and different materials expand at different rates, this can have a significant effect on the integrity of the rock.

Chemical weathering is the second major type of rock weathering, and it can be very powerful, due to the abundance of water near the Earth's surface (acidic rainwater makes weathering even more effective). One kind of chemical weathering involves dissolution of minerals, as exemplified by the reaction shown in Fig. 35 for the dissolution of calcite.

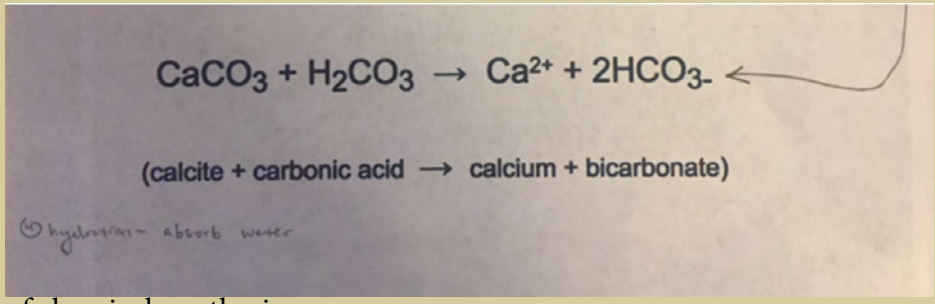

Figure 35: Processes of chemical weathering

Another important reaction is hydrolysis, which occurs when water is chemically broken down after it has been in contact with a mineral, as shown by the example of potassium feldspar breakdown:

$$2KAlSi_3O_8 + 2H^+ + 9H_2O \rightarrow Al_2Si_2O_5(OH)_4 + 4H_4SiO_4 + 2K^+$$

A third form of chemical weathering is oxidation, which occurs, for example, when iron minerals are exposed to the oxygen in the atmosphere. Carrie explained to us that this is a large issue in iron-rich areas.

Weathering is an important process, because though it works slowly, over time its effects can accumulate – one example of this is the Alps themselves, which were once six times their height today!

After listening to Carrie's presentation, we continued hiking until we reached Mount Pers, for an even more spectacular 360° view of the surrounding landscape.

Figure 36: Reto and Justin holding the map

How Glaciers Form (Briefly)

He said that glaciers are active and flow following gravity. Individual crystals morph shapes, enabling the glacier to move, and the brittle texture of ice contributes to crevasses and fractures.

The tops of the fluffy snow-capped mountains are snow; however, underneath is pure ice. The equilibrium line is the line where the amount of ice accumulation is equal to the amount of ice melting. The equilibrium line is not static, it can change. Rocks fall down onto the glacier, which becomes tongue-shaped (Fig. 37) because of the physics of ice flow movement – it has the highest speed at the top and middle of the tongue, and the lowest at the bottom because of friction with the bedrock. The glaciers actually glide because the bottom is sediment-filled water, often with a river flowing out. When glaciers retreat, they leave a lake behind, one of which was Lake Zürich, as we saw on the first day.

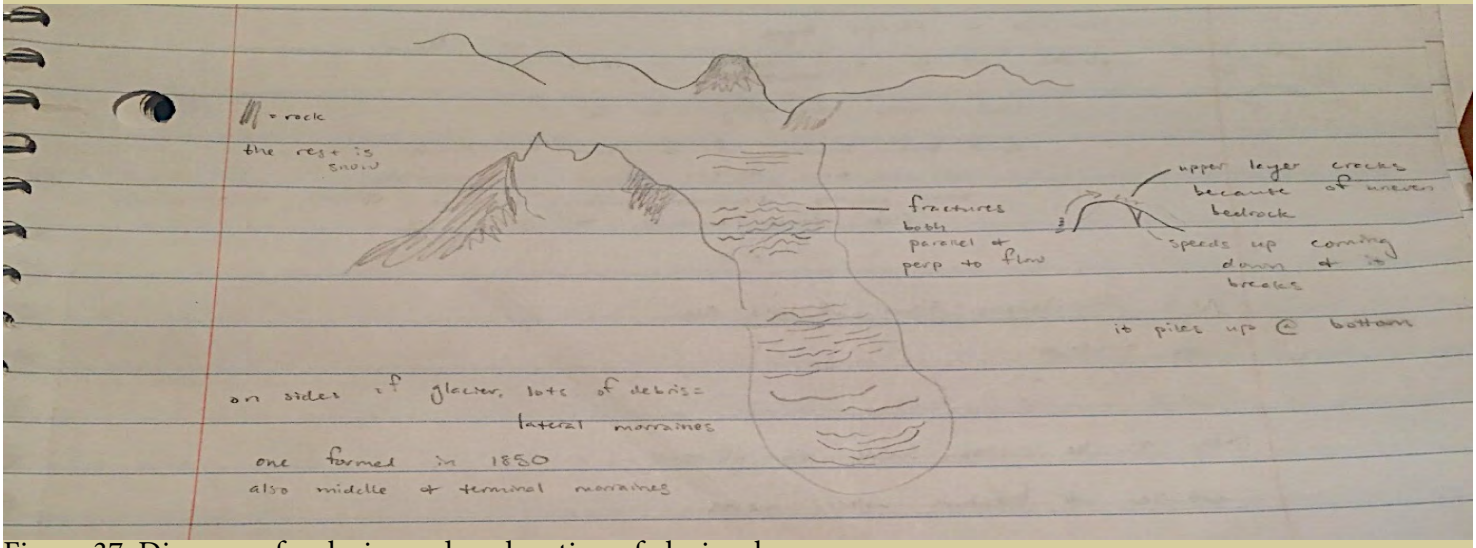

Figure 37: Diagram of a glacier and explanation of glacier shape

After lunch, we headed back to the Diavolezza viewpoint area, each moving at our own pace. I really enjoyed running down some of the downhill stretches, dodging rocks and other hikers as I went. With the view of the glacier on my right and the sunshine above me, it felt amazing to move quickly. When everyone reached the lookout point, we hung out and sunbathed on the rocks until the next gondola came. While we were there we engaged in productive academic discussions, like "what kind of animal would each person be?" (Professor Gieré, you are an ibex). On the gondola ride back, we made two new fluffy friends.

We took the train to the Morteratsch glacier trailhead in the afternoon. Shortly after, we sat down and got to hear two presentations, by Eric and Alys. Eric talked about the ice age and glacier formation, and Alys told us about the Alpine flora and some of their survival mechanisms.

The Ice Age and Glaciers

Eric started by explaining ice ages. He said that during ice ages, we have lower global temperatures (obviously), dropping as low as 12°F. The last Ice Age occurred during the Quaternary Period, which started about two and a half million years ago. The Milankovitch cycles describe the overall effects of changes in the Earth's movements on climate. Three factors are important: eccentricity (deviation from a circular orbit), obliquity (Earth's tilt relative to the axis of Earth's orbit), and precession (rotation of the axis/ the "wobble" on its tilt). The three cycles combined affect the amount of heat that reaches Earth's surface – an important factor when discussing ice ages. When the Earth is in an aphelion position (furthest from the sun) and when it has low obliquity (low exposure to the sun, more ice growth), conditions are ripe for an ice age. In addition to the Milankovitch cycles, there is the Ice-Albedo Feedback Cycle, which describes the positive reinforcement of the reflective power of a surface: when the Earth is snow-covered during an ice age (ice has a high albedo) it reflects more of the incoming light/solar heat than when it has no ice. Reflecting rather than absorbing solar radiation leads to cooling.

After Eric explained how ice ages begin, he transitioned into the presence of glaciers. Alpine glaciers specifically are found in higher mountain valleys, above the snowline. Alpine glaciers often begin in circular-shaped hollows called cirques, flowing out into valleys. They can extract rocks from the valleys, grinding them into U-shapes (we saw one such U-shaped valley on the way coming up from Chiavenna), and sometimes after the glacier retreats it leaves behind hanging valleys along the top ridges of the U-shaped valley. These hanging valleys often result in waterfalls, one of which some of us hiked to near Chiavenna (or unsuccessfully tried to hike to … myself included). When a glacier retreats, it leaves behind moraines, deposits of sediment pushed down. When a glacier advances, on the other hand, it polishes the rocks and often leaves striations on the bedrock. Finally, Eric informed us that because the glaciers on top of the mountains are melting, the mountains become more buoyant, and thus the Alps are actually rising by 1-2 mm per year!

Flora of the Alps

There are three major plant zones in the Alpine biome. The lowest is the montane, where trees (coniferous trees) are still able to grow. Below this zone, in the premontane zone, full agriculture is still conducted. One tree commonly found in this area is the Norway spruce, which Alys told us deposits lots of needles on the soil, acidifying the soil. One study showed that harvesting these trees can have a negative effect on the soil composition, because it leads to nutrient loss. The second major zone is the Alpine zone, which is characterized by large Alpine meadows and lots of plant diversity in flowers and other plants. These plants, Alys told us, have developed various adaptations, including freeze resistance, low statures, and balancing their resources between growth and reproducing, to survive the harsh conditions present at the high Alpine elevations. The highest zone where plants are still surviving is the subnival zone, which contains mostly mosses and lichens.

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In the Alpine zone, common plants include succulents, grasses, lichens, mosses, and flowers. Because of the uneven slope that these plants must grow on, many of them are "clonal," allowing for a more complex and sturdy root system. In addition, some plants have a protective sugar-coating in their structure to prevent rupturing upon freezing; all cell liquid is transferred to extracellular space, coinciding with freezing time. Another important topic that Alys brought up is climate change and its effects on Alpine vegetation. Climate change is having a particularly poignant effect on mountainous regions, three times as fast as on non-mountainous areas. The increasing temperatures are driving the tree line higher and higher, and while plant coverage is increasing (and this is beneficial, generally, in preventing landslides), the growth may not be fast enough to secure the higher land from landslides. This was interesting because in some of the towns, like Pontresina, we were able to see the measures that Alpine cities have had to take to prevent mudslides and landslides. Cities had to put up walls on the sides of mountains to hinder rockfall, and in Pontresina they built a zigzagged channel to prevent mudslides from destroying the whole town center beneath. In this way, we saw the real effects that these non-tree-covered areas have and the dangers they face.

As the glaciers melt, additionally, plants are migrating through the corridors and recolonizing previously frozen land. The higher temperatures, one study showed, are also causing the Cerastium uniflorum, or chickweed, in Austria to disappear. Altogether, the changing climate is having and will continue to have significant effects on the landscape as well as on flora, as time goes on.

4:15 pm … After we heard these talks, we continued our hike to reach the Morteratsch glacier. I think Madison encapsulated this hike quite well with her comment to me, "It's kind of spiritual, walking up to this glacier." It certainly was a sobering experience. Along the way we passed metal markers of how far the glacier had reached in that year (Fig. 38).

Figure 38: (left) Glacier in 1970, (right) Glacier in 2015

When we got up close to the glacier, it was even more impressive (Fig. 38). The glacier had receded quite a bit since 2015, which was hard to believe. Once we reached the ice itself, we saw that there was a heavy river coming from underneath the ice, letting off a steady flow of water.

One thing that I realized, standing there next to the melting glacier, is that it can be really easy to "forget" about climate change in Philadelphia, far away from particularly visible effects of global warming, but being right by this glacier and watching it with my very own eyes, it really drove the message home. The people of the Alps in general face more risks because of climate change, including mudslides and rockfalls. Being more aware of the effects my decisions are having on people living in extreme conditions was certainly a take-home message from the day.

After the hike, we waited around for the train to come and took advantage of this break to order some drinks at the restaurant nearby (Hotel Morteratsch). I tried sips of the different beers and I have to say, the Palü beer was by far my favorite. We were all slap happy and really excited for dinner when the train finally rolled in.

That evening we arrived back at the hostel just in time to scarf down multiple helpings of our dinner, pasta with tomato soup and salad on the side. I made sure to eat every bite on my plate in order to prevent food waste, as our hosts had asked us to do. After dinner, we all had a very low-key night, showering and relaxing in the hostel until we went to bed (pretty early). It had been a tough day and I remember that I fell asleep immediately upon hitting the pillow.

Jane Boszik

Day 8: August 16th

Figure 39: Avalanche, Mudslide and Rock Slide Protection in Pontresina, Switzerland

On our last day in Pontresina, we crossed the local bridge over the Flaz river and walked through town to see a wall built to keep the city of Pontresina protected from landslides, mudslides and avalanches. Since 1882, when British tourists arrived in the area, the mountain town started to construct devices that could protect it from avalanches in winter and mudslides in summer, because the town expanded into areas that lie directly in the path of falling debris. While locals had been living in the area for many years, they chose to live on the outskirts because they knew of the avalanche dangers.

The foreigners' unwillingness to forgo development in such a dangerous area came at a great cost. The town was partially destroyed several times in the past. In 2003, a new dam was built, at a cost of 8 million Swiss francs (Fig. 39). 60 percent of funds came from the governments, 20 percent from the national forestry service and 20 percent came from the village municipality. In the event of an avalanche or landslide, the wall could hold back up to 240,000 cubic meters of snow and up to 100,000 cubic meters of mudslide debris.

The wall was strategically constructed to add stability and insure that regardless of the fall-angle it will be trapped by the wall. Additionally, the wall has a steel gate that would be used for drainage.

As the severity of climate change progresses the city is increasingly more susceptible to destruction. This wall, the different forms of avalanche protection further up in the mountains, and the natural ecosystem services offered by the trees work together to protect the city from danger. Mudslides and avalanches are difficult to predict and geologists currently don't have the tools to make precise predictions.

After our visit, we walked through the town and back to our vans to continue our drive to our final destination Chiareggio. On the way, we stopped at a few major sites.

Figure 40: Dolomite breccia boulder found near Lagalb

Our first stop, was at an ancient rock fall about 20 minutes from Pontresina, near the cable car station of Lagalb. There, we examined the rocks present and had a lesson on their history. The rocks were formed in the Jurassic time period during the Mesozoic era. During that time, about 180 million years ago, the site was a shallow sea in which limestone was deposited. After many years of sed-iment accumulation, a submarine landslide led to the formation of a mixture of rock fragments that originated from different sediment layers. These fragments were cemented into a rock, called breccia, in which the matrix consists of dolomite (another carbonate mineral).

Figure 41: Fossils preserved in a Jurassic dolomite breccia

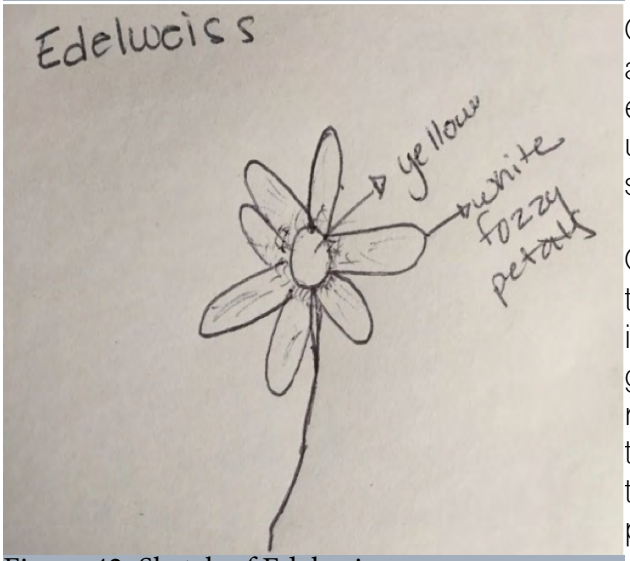

Figure 42: Sketch of Edelweiss

In the breccia, we found belemnite fossils, evidence of early sea life (Fig. 41). Fossils are very common in sedimentary rock, and they provide important information about ancient ecosystems and the age of the host rock.

In addition to fossils, we also found Switzerland's national flower, the Edelweiss, growing on the breccia (Fig. 42). Edelweiss grows specifically on calcium carbonate limestone and prefers rocks at higher altitudes. Because of this, the flower is often regarded as a symbol of the Alps and is protected in many countries, including Switzerland and Italy.

Afterwards, we drove a few miles to the glacial lake, after which the mountain of Lagalb is named. The lake gets its color from the suspended sediments that had been previously held in glacial ice. The sunlight that reflects off the sediment gives the lake its beautiful turquoise tint (Fig. 43).

Our next stop was the Cavagalia Glacier Garden in Cavagalia, Switzerland. Here, we had lunch and Joe gave a presentation on the Structure of the Earth and how earth's crust is formed. His presentation helped us further understand the origin of the rocks and the faults we had seen previously.

Afterwards, we hiked for a short while to the Glacier Garden, where we saw giant pots that were shaped by the melt water of the ancient Palü glacier during the last ice age. Over time, high-pressure glacial water, till and gravel worked the solid rock to mill large holes into the rock. The formation of similar potholes can be observed today in the adjacent river. This river also originates in the Palü glacier, which today is a dwarf compared to its predecessor.

Figure 43: Glacial lake in Lagalb, Switzerland

After our stop in Cavagalia, we visited the town of Poschiavo at the bottom of the valley, where we admired its beautiful buildings, its cathedral from the 16th century as well as an ossarium. Finally, we crossed the border back into Italy and drove to our home for the next 3 nights, Chiareggio.

Gabrielle Davis

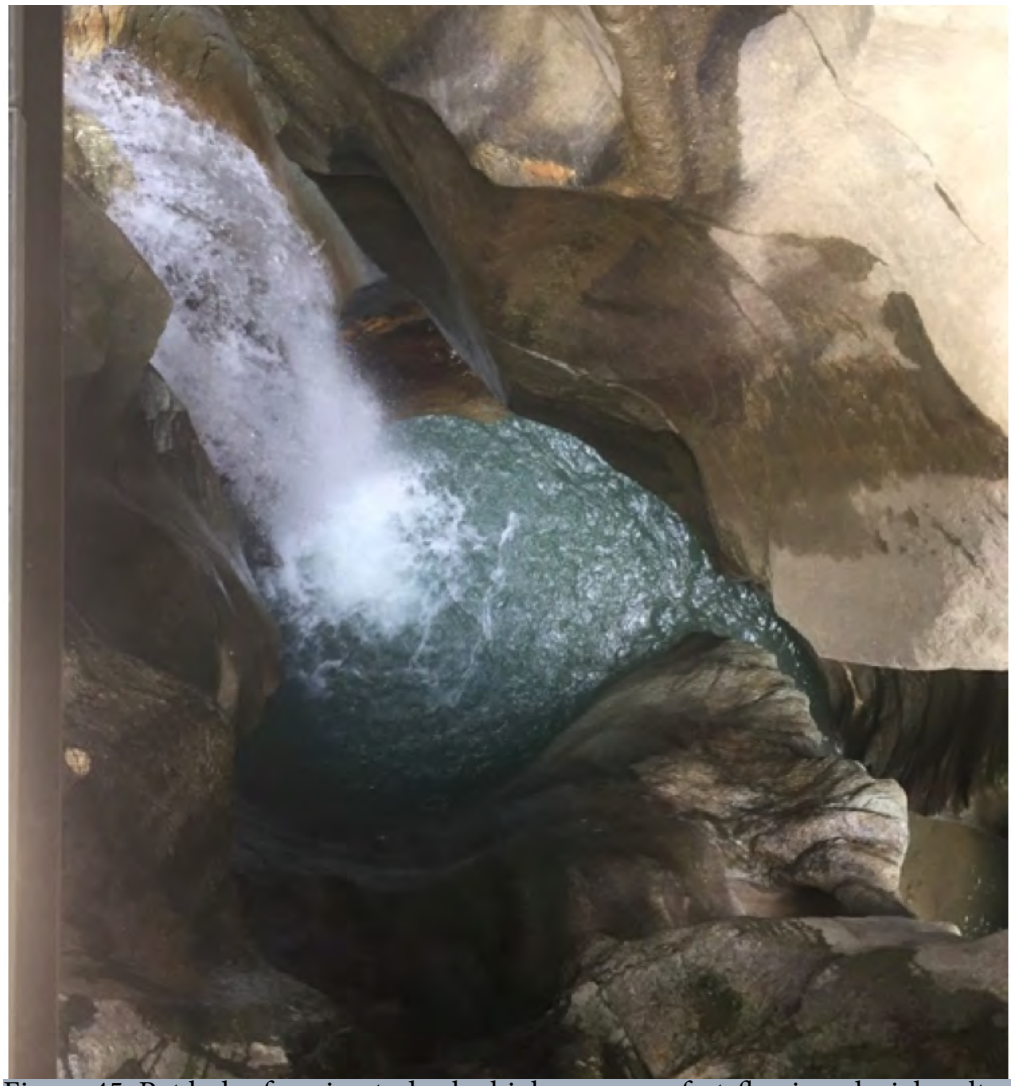

Figure 45: Pot holes forming today by high-pressure, fast-flowing glacial melt water

Day 9: August 17th

Woke up by my 6:10 am alarm in an attempt to catch the 6:22 am Chiareggio sunrise, I was disappointed that the mountains obstructed the view preventing me from seeing the sun (Fig. 1). However, being able to see the mountain afar with no signs of clouds, indicates the perfect day for an adventure: one that will challenge our practices from the previous hikes.

Reto warned us that today will be the most demanding hike in this trip. All of us made sure we ingest as much food in the morning and brought up a good lunch to consume at the destination. After all, it is the thought of the delicious Italian dinner that will drive us up to the mountain peak. Today's hike will bring us from Chiareggio at 1600 meters in elevation to Rifugio del Grande Camerini at 2550 meters, it has an elevation gain of almost 1 kilometer, that is little more than 200 floors if one were to climb it in a building.

Figure 46: Map of the area with trail highlighted in orange

The trail started out below the tree line, so we walked through a region full of flora. I noticed there were a section where the trees were bent and most of them were leafless, as if some lumberjack left them there after cutting them down. Reto explained that this is due to an avalanche crashing toward the bottom of the valley a few years ago. The roots and the trunks of the trees were not strong enough to stop the avalanche, resulting in this disheartening scene (Fig. 47).


Figure 47: Tree fall as the result of an avalanche

Along the trail, we found bushes of blueberries. Reto pointed out that the trail was bordered by blueberry and juniper bushes as well as by other bushes bearing similar blue berries, which however cannot be eaten. Whenever we encounter a bush with blue-purple roundish fruit, Reto will identify for us if it is safe to consume. I did not learn to identify them, as I gobbled up as many blueberries as I could find, realizing that I may not have had enough breakfast prior the hike.

We soon arrived at the midpoint of the ascent for a short break and prepared for our next presentation. One thing that caught our attention was the donkey not far from us. Walter and Jane immediately ran to it for a closer look at the adorable creature. Recalling the Romanesque painting in Church of St. Martin, one tile depicted Jesus entering Jerusalem riding a donkey instead of a commonly used horse. Wanting to closely investigate this holy mammal, I followed right after Walter and Jane. The donkey had flies resting all over her face; carefully, we wiped off the bugs and fed her with some grass. A few of her companions joined, where we fed them as well (Fig. 48). Right when we were enjoying each other's company, Reto called us back for the presentation.

Figure 48: Walter and Jane approaching a donkey

The topic of the day was about rocks. By identifying rocks of a region we can interpret their origin. Katherine familiarized us about how rocks are formed and how they cycle from magma to different types of rocks. The 3 main types of rocks: igneous rocks, sedimentary rocks, and metamorphic rocks are the result of different phases in the rock cycle and we were able to observe them during this hike.

As seen from the trail map (Fig. 46), we would be crossing a few rivers on the way to Rifugio del Grande Camerini. The running water caused the rocks to be very slippery, many of us slipped even crossing with caution. Nonetheless, it was a great place to ease off to wash our fruits and examine some of the exposed rocks, making drawings in our notebook.

Figure 49: Granite with white rectangular shaped feldspar crystal

The region we were standing on was at the edge of a magma chamber 30 million years ago. Since the ancient magma was trapped inside Earth's crust as it cooled, we called these rocks intrusive igneous rocks. The granite we found all over (Fig. 49) is a common example. Unlike extrusive igneous rocks, produced through volcanic eruptions, the magma cooled very slowly, in this case, it took about 8 million years. Because the process of cooling was so slow, large feldspar crystals were able to develop. They can be recognized on the basis of their white color and rectangular in shape. In the same granite, we also observed other minerals, such as dark micas and quartz. In one area, we studied a mixture of many different rock types, which were embedded in a matrix of granite. This mixture is called an intrusive breccia and was formed at the edge of the magma chamber when the melt incorporated fragments of the surrounding rocks.

By noon, everyone made it to the peak. Like the other cabins we have seen previously, the building at the peak also gets its supplies from the helicopter. The majority of the energy is from the

solar panel, but we also saw a wind generator (Fig. 6) assisting energy production. Immediately after lunch, we placed ourselves comfortably on the rocks and we laid on the ground enjoying the beautiful sunlight and the tranquility on the top of the Alps.

Another very common rock surrounding us was a metamorphic rock, which originally was a submarine basalt. Unlike the granite, this rock is more brittle and has clear lines alternating between black and white. The pressure increase during the metamorphic process caused the rock to be deformed, resulting in a schistosity. While not shown in the figure, some rocks display distinct folds. The folding was caused by a second deformation that affected the rock during the formation of the Alps. Looking up close, one would see tiny feldspar crystals, but different from the one we saw earlier. The red surface of the rock shown in Fig. 50 is a sign of chemical weathering, indicating the presence of ferric iron. After all these observations, I became fascinated with rocks. The 1 km elevation gain has worn me out, but disregarding the fact that I should be removing some weight off my backpack, I selected some of the prettiest ones as souvenirs to carry down to the valley.

Figure 50: Metamorphic rock made from basalt

The most important lesson of the trip today was learning to make observations, and Reto challenged us with a simple question, "what do you see?" This time we were asked to observe macroscopically (Referring to the landscape in Fig. 51). Recalling from previous studies people called out: "talus!", "cirque!", "tree line!", "moraines!", etc, while they are correct, none of the answers were what Reto had in mind. But it was right in front of our eyes: the line where the soil color changes from red to gray (seen from left to right on Fig. 8) and the same line where vegetation changes from plenty to none. The line is where the mantle (right) merges with Earth's crust (left), a vivid line was rare to find on this planet.

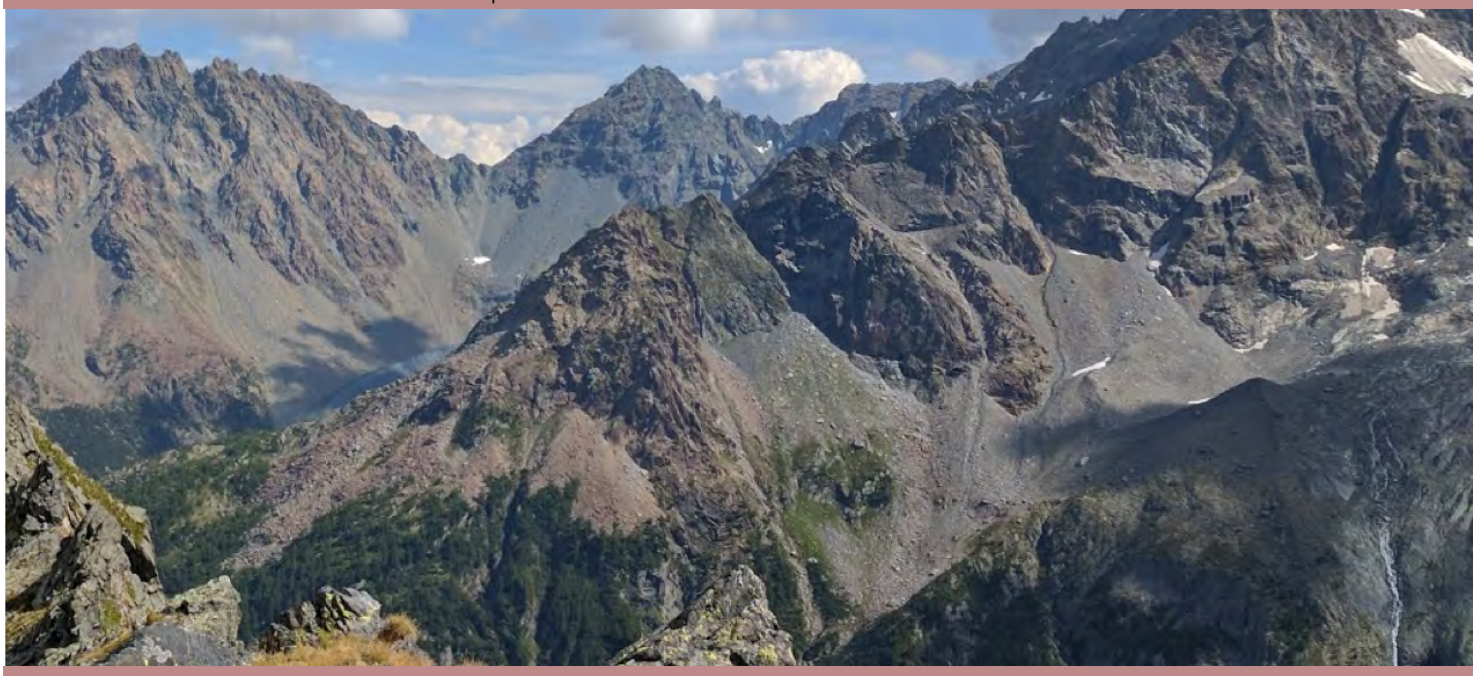

Figure 51: Scene near the top with a distinct geological feature

To many people, perhaps the most exciting part of the day was when we hiked with our four limbs. On the way down, we encountered an almost vertical cliff that would be too dangerous to go down without the chain for the support (Fig. 52). For each step, we grabbed onto the chain as tightly as possible, carefully inspected the rock below us to find one that is suitable to place our feet. By relying on our shoes, the chains, and Reto's instructions, all of us made it down without much difficulty.

Figure 52: Anurag climbing down from a nearly vertical cliff

The last part of the descent was very scenic. We walked down a narrow valley full of plants, various flowers blooming while many had already turned into fruits. Right next to us is a very steep cliff, where the plants grabbed onto the soil as tightly as possible, and we, the bipedal humans, had to be careful on every step we took. We warn each other if we found an unstable or a slippery rock as a caution for people behind. Out of the blue, a scream of terror stopped us all. We were nervous: "What happened?", "Did someone fall?" Anurag relieved us promptly, "Don't worry! It's okay!" Carrie's ear was stung by a bee. We pulled out a pair of tweezers and Anurag removed the sting from Carrie's ear. Carrie was nervous that she might be allergic to the sting, but everything was fine with some pain reliever. We continued our journey towards Chiareggio where a surprise awaited our return.

After a few days with Professor Reto, we found our adventures full of surprises. Being able to identify geological features and knowing how they come to be enlivened our curiosity to discover more wonders of this world. I could not ask for more. But shortly after we tidied up ourselves after the hike, we were guided to Hotel Chiareggio's wine cellar in the basement where we were presented with a table full of wine and cheese (Fig. 53)! All the fatigue from the hike was suppressed by the joyful moment. The hotel owner's daughter was there with us, where we learned about her study at the university in Milan and how she helped her father to run the hotel business. The chilly stone room was immediately filled with noises and laughter thanks to the hospitality of the hotel's owner.

Figure 53: Wine cellar for preserving food and wine at Hotel Chiareggio

Eric Yeh

Day 10: August 18th

We began the day at the Albergo Chiareggio, where we were treated to another delicious Italian breakfast. Then we set off through the town of Chiareggio to reach the starting point of our next hike in the Valmalenco Valley. This hike followed part of the trail for the Valmalenco Ultra Trail race that will stretch 86 kilometers over three days in late August. This year is the first time the race will be held, and it will be an extremely demanding, but beautiful, trail for the athletes. The portion of the race's trail that we hiked had many interesting features along the way. We stopped to observe some granite, and learned that the granite on this trail was 2 million years older than granite we had seen the day before. Another interesting feature we noticed was that many trees had curved trunks. The soil along the mountains is in constant motion due to the melting permafrost. As the soil slowly slides down the mountain, the trees move along with it. This process produces trees with incredibly curved trunks (see Fig. 54). These trunks can be turned into instruments known as the Alp Horn, which were previously used by herders to signal across mountains. The horn has no keys and different lip movements produce the tones, so this instrument takes significant skill to play (see Fig. 55). There are few musicians that still know how to play the Alp Horn, but it remains an icon of the Alps.

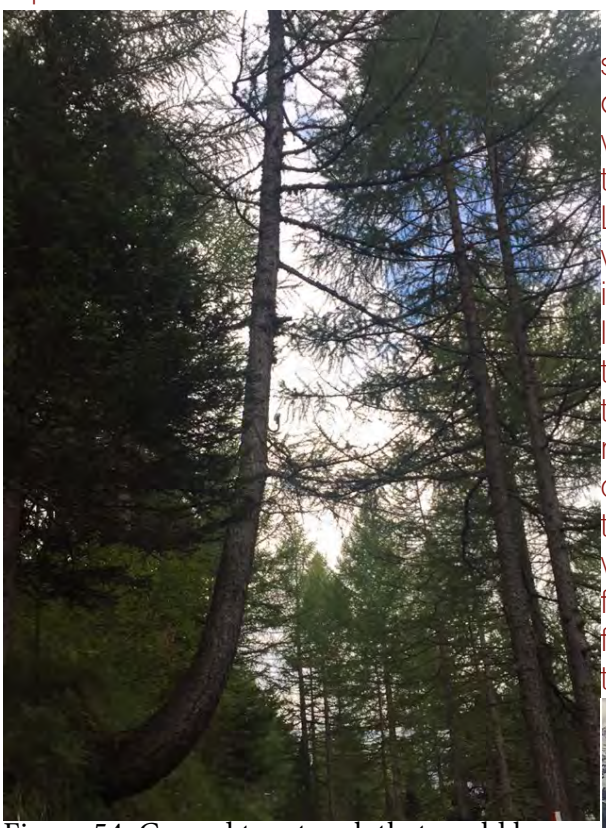

Figure 54: Curved tree trunk that could be used to create an Alp Horn.

We continued to make our way up to a cabin that sold ice cream and other snacks, which many of us purchased despite the early hour. Outside this cabin there was an educational sign about how trees are studied in the Alps. The two most important trees in the Alps are the Larch, which is unique because it loses its needles each winter, and the Stone Pine. The trees of the Alps are studied to learn more about the vegetation, climate and pollution of the area. In the Valmalenco Valley there are trees that are over 1,000 years old. Examination of the rings in the trunks of the old trees can provide scientists with information about the climate over many centuries. This can be done by taking a cross section of a dead tree trunk or by taking a narrow core out of a living tree trunk. If the climate was favorable for the trees in a specific year, the ring is fairly wide compared to years when the climate was less favorable. Therefore, scientists can see exactly which years the climate was impacted by volcanic eruptions or other major events, because trees would not have grown as much during these periods. Scientists can also observe when parasites overtook the trees by looking at the width of the tree rings, a method called dendrochronology. The bark of trees can also be examined to provide useful information on air pollution.

Figure 55: Alp Horns being played in Switzerland. These instruments are rarely played today, but remain an icon of the Alps. Source: https://en.wikipedia.org/wiki/Alphorn

We continued to make our way up to a cabin that sold ice cream and other snacks, which many of us purchased despite the early hour. Outside this cabin there was an educational sign about how trees are studied in the Alps. The two most important trees in the Alps are the Larch, which is unique because it loses its needles each winter, and the Stone Pine. The trees of the Alps are studied to learn more about the vegetation, climate and pollution of the area. In the Valmalenco Valley there are trees that are over 1,000 years old. Examination of the rings in the trunks of the old trees can provide scientists with information about the climate over many centuries. This can be done by taking a cross section of a dead tree trunk or by taking a narrow core out of a living tree trunk. If the climate was favorable for the trees in a specific year, the ring is fairly wide compared to years when the climate was less favorable. Therefore, scientists can see exactly which years the climate was impacted by volcanic eruptions or other major events, because trees would not have grown as much during these periods. Scientists can also observe when parasites overtook the trees by looking at the width of the tree rings. The bark of trees can also be examined to provide useful information on air pollution. The method of dendrochronology, including the study of tree bark to measure air quality and pollution, is frequently applied to scientific investigations in the Alps.
After learning about the trees, we continued up the trail to a small mountain church. This church was used to honor those who died from landslides or other disasters on these mountains. The families displayed pictures or personal belongings of the deceased. This solemn moment reminded us of the destructive power of landslides in the Alps. Several times during the trip we learned how landslides are increasing in frequency due to the decrease in permafrost from climate change.

Outside this church, Josh Lauder gave his presentation titled "Plate Tectonics and the Formation of the Alps". He described the seven main tectonic plates and the secondary plates that form the lithosphere. The crust formed by these plates is only one percent of the entire Earth's volume, and the rest is the mantle and the core. We learned that flow causes the tectonic plates to move very slowly, thus the plates interact with each other. When this happens plates can collide and squeeze together, causing one plate to subduct and one plate to move upwards. The density of the plates determines the subduction plate and the upward moving plate: the more dense plate is subducted, and the less dense plate moves on top of the subduction plate. Plates can also diverge, or move apart, from each other and this process creates large rifts, which are located mostly in the ocean. Finally, the plates can slide past each other along faults known as transform faults, which can cause earthquakes. Josh emphasized that due to all of these processes the Earth is a dynamic planet that is continuously shifting. Earlier in Earth's history there was one single landmass, known as Pangea, and one large ocean. Alfred Wegener, who noticed that all the continents appeared to fit together like puzzle pieces, proposed this theory but it took many years to be accepted by the scientific community. New land features, such as mountains, can be formed when the plates shift. The Alps were formed when the Eurasian plate and the African plate collided, and the African plate was pushed up to form the mountains. The process of building mountains is known as orogeny. The orogeny of the Alps was a relatively recent event and the mountain range has a predictable future. The Alps will be weathered, which will form shorter, less jagged mountains, similar to the Appalachians.

After Josh's presentation we talked about how the Valmalenco Valley has large amounts of serpentinite rock. This is a metamorphic rock that is used frequently for construction, because it is very dense and can have beautiful folds. Therefore, areas of the valley are known for having serpentinite quarries.

Then we continued up the trail and came across a bog (see Fig. 56). This site was originally a lake that was taken over by vegetation. This vegetation died and accumulated over time. Then the pressure from all of the dead vegetation formed peat. This substance is similar to coal in that it is a fossil fuel that can be burned for energy. However, just like coal, it is a dirty energy source that creates great amounts of air pollution. Therefore, peat is a controversial energy source, but remains in use in many areas of the world today. While we sat near the bog, Gabby Davis gave her present-

ation titled "Cultural Development Within the Natural Constraints of Alpine Topography". She began with a brief overview of the history of different populations that have lived in Switzerland. The first tribes to settle the area were Celtic and arrived in 500 BCE. Over the next several hundreds years, other tribes arrived in Switzerland including the Burgundians and the Lombardians. These tribes were highly influenced by the Romans and adopted many aspects of Roman culture. Over time the topography of the Alps helped contribute to the development of unique languages. In 1848, Switzerland became a nation and there are now 4 official languages: German, Italian, French and Romansh. Some cantons in Switzerland speak multiple languages, which can cause great controversy. In 2013, there was a referendum in part of the canton of Bern (German speaking) to decide if the French-speaking part of the canton should become part of the French-speaking canton Jura. However, 72% of the population voted not to switch, which showed the people's allegiance to the culture of their canton. Switzerland is clearly a diverse place with several cultures that contribute to the overarching Swiss culture. The culture of Switzerland values food such as chocolate and cheese. Additionally, the traditional music of Switzerland was heavily influenced by the Alps. In order for better communication, herders would use the Alp Horn or yodel across mountains. Overall, we learned that culture is hard to define and that Switzerland has a complex, but exciting, culture.

Figure 56: The peat bog seen along the trail. A glacial moraine is also visible behind the trees.

After Gabby's presentation, we continued up the trail to our lunch spot. We ate just uphill from a stone house that is used by herders in the valley. After our daily picnic and nap, we examined a geological map of the Valmalenco Valley. We would see this important map many more times during our stay in this area. The map began as a simple topographical map of the area. Over several years, Master's students would walk through the entire area, making observations about the types of rocks they found. Then this data was aggregated to form a geological map that shows exactly what types of rocks can be found in the valley. The rock types were differentiated by color, and there were several symbols on the map that showed unusual types of rocks. The map displayed that a significant amount of the Valmalenco Valley is mantle rock, which we were able to observe many times on the hike.

After this lecture, we began our final descent of the trip, and hiked back down to the town of Chiareggio. After a short break back at the hotel, we attended a geology lecture given by Dr. Gieré's former professor, Dr. Montrasio. He explained that the Valmalenco Valley is a great place to study geology because every major geological process can be seen there. He then informed us that there are 3,000 – 4,000 different types of minerals but only 1% of those minerals have the property of fluorescence. This property is a special case of luminescence, in which the mineral itself gives off light. There are several types of luminescence, which can be caused by heat, light or mechanical processes, such as squeezing or shocking a rock. These other types of luminescence are much more common, but fluorescence is rare.

Dr. Montrasio typically leads night tours along the riverbed to show tourists the fluorescent rocks but we were lucky to receive a demonstration just for our group at the hotel. Dr. Montrasio showed us rocks from his personal collection, all of which were collected from the riverbed in the Valmalenco Valley. The UV lamp that he used was a relatively simple device that could emit visible light and two different wavelengths of UV light. Dr. Montrasio described how the power source for the device had evolved from a large, heavy machine he would have carried in a backpack to the modern lamp he can simply carry in his hand and pocket. When he held the UV light over the rocks certain crystals would show their fluorescent properties very vividly. Rocks that appeared gray under visible light became bright green, yellow and purple under the UV (see Figs. 57 and 58). This is because the chemical properties of the fluorescent minerals are different than non-fluorescent minerals. The fluorescent minerals contain specific elements, such as uranium, calcium or tungsten. The analysis of these minerals is very complex and expensive, so not all of the fluorescent minerals are currently understood. Some minerals appear in certain UV wavelengths but not others, so Dr. Montrasio demonstrated both wavelengths of UV light on the rocks. The lecture was truly a unique and fascinating experience.

After the lecture, we enjoyed another fabulous dinner. This was our last night in Italy, and we were all thrilled to spend it at the wonderful Albergo Chiareggio!

Alys Farregamo

Figure 57: Fluorescent crystals due to uranium.

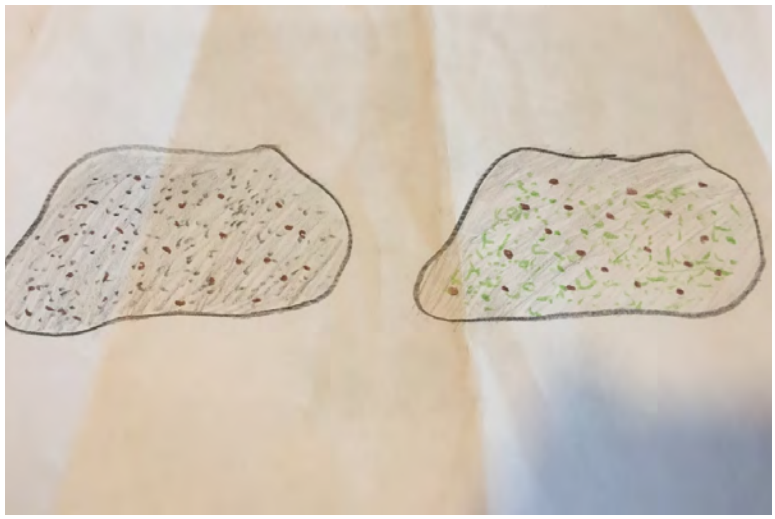

Figure 58: This drawing shows the same rock as Figure 57. The left is the rock under normal light with brown and black crystals. The drawing on the right shows the same rock under the UV light; many additional crystals are now visible as green fluorescent crystals.

Day 11: August 19th

We began our day with our final breakfast at the lodge in Chiareggio in Italy. After breakfast, we each bought lunch from a local store across the road that seemed to sell every product imaginable despite its rather small size. From hair products to countless bottles of local wine to foreign snacks, it seemed as if there was nothing this store did not offer. Finally, thirty minutes and two trucks full of suitcases later, we boarded the vans and commenced our drive to Bellinzona, Switzerland.

Our first stop along the way was the Bagnada Mine, which is located a short drive away from the lodge in Chiareggio. Once we arrived, our guides Diego and Carmen greeted us and we began a 20-minute uphill walk to the entrance of the mine. Although this was the shortest "hike" we did throughout the trip, many of us still found ourselves wary from the steep trek. We later learnt that the miners hiked on even steeper routes over much longer distances to reach the mine, all while carrying their various mining tools (Fig. 59). Experiencing this taste of the miners' lives allowed us to gain perspective into how arduous their lives truly were. Many miners lived in neighboring towns and had to wake up at dawn every day to begin work – this helped us deeply appreciate the fact that Reto had generously given us an 8:30am leaving time for this particular morning.

At the entrance, we armed ourselves with hairnets, helmets, and warm clothing and began walking into the mine. As soon as we stepped in, we quickly noted the stark drop in temperature. At a cool 7º Celsius, the mine was much chillier than we had anticipated. Carmen noted that the mine remains at 7º Celsius all year round, which we all found interesting given the drastic changes in the weather outside.

Upon entry, we were given a brief history of the mine (Figs. 58). The Val Malenco mine was discovered in the 1920s by an engineering company from Milan and it underwent intensive mining all the way until the mid 1980s. The two natural resources that were sought after were asbestos and talc – asbestos was used to fire proof objects and talc was used in cosmetics. Unfortunately, it was later discovered that asbestos was carcinogenic, but talc mining still remains a crucial pillar of the valley's economy. Nevertheless, during the years when the asbestos trade was still popular, miners sacrificed a great deal in order to obtain more of it. Carmen noted that the excavation of the mine was rather rudimentary and based solely on manual labor with no machinery. She told us that miners would often send young children, aged ten to thirteen, deep into the mines to check whether dynamite had exploded properly or not. We were all saddened to hear that this practice caused the deaths of countless children.

Figure 58: The interior of the Val Malenco mine

Figure 59: Tools the miners used to prepare for blasting within the mine

Figure 60: Quartz and garnet display in the Mineral Museum in Lanzada

Figure 61: Reto saying goodbye to Diego and Carmen

Our tour inside the mine lasted around 45 minutes and we explored 4 of the 9 floors of the mine. It was extremely interesting to travel inside the mountain and walk in the same tunnels used by the miners. We were given the opportunity to watch two videos about the lives of the miners and it was interesting to learn that virtually everyone in the community – men, women, children, and even the elderly – participated in manual labor needed to foster the mining industry. Typically, men aged 20 to 60 would work inside the mines themselves and women would sort out the asbestos and the talc outside and carry them back to the villages in baskets. At the end of the tour, our guides turned off the lights and we had to find our way out using a small lamp, just as the miners had done before. After visiting the mine, we toured the mining museum where we learnt even more about the perils the miners faced. We observed tools the miners used and saw vivid photos of their harsh working conditions.

We then drove to the town of Lanzada where we had a serene picnic style lunch at a park. Some members of the group played on the flying fox, swings, and slides with the local children after lunch.

Shortly after that, we crossed the street and visited the mineral museum. Since Val Malenco is one of the most mineral rich areas among the Alpine valleys, there was a plethora of mineral species on display. Over 260 minerals were showcased, such as beryl, talc, rhodonite, pyrite, garnet (demantoid), and magnetite. Figure 5 shows a section of the quartz and garnet display in the museum.

After exploring the museum, we had gelato with Diego and Carmen at a bar nearby. They are old friends of Reto's, so they all had a good time catching up with each other (Fig. 61). We got a chance to speak to them as well and Carmen laughed at how all of us had opted for chocolate or vanilla flavored gelato instead of the local specialties. After chatting with them, we walked back down to the vans where Reto bid his friends farewell and we began our drive to Lake Como.

Around one and a half hours into the drive, we reached Lake Como where we got out of the cars to take a short break. Lake Como is the third largest lake in Italy and is world-renowned for it's beauty. Unfortunately, as soon as we arrived it began to rain (Fig. 62). Nevertheless, the members of our group were undeterred and we all exited the vans to walk along the path by the lake. A few students even changed into swimsuits and swam in the lake for 15 minutes, which they all found extremely thrilling. Unfortunately, the weather took a turn for the worse and lightning began to strike in the surrounding areas. After changing clothes and freshening up with another gelato (local flavors this time), we got back into the vans and headed to our final destination – Bellinzona.

Figure 62: The storm looming over Lake Como

After another two-hour drive, we arrived at the lovely town of Bellinzona. All of us were immediately taken aback by how beautiful the city was – the stone cobbled streets, the neatly lined pastel houses, and the castles encircling the main square all made the town one of a kind. We checked into the hotel and were given an hour of free time before dinner and a few of us took this opportunity to walk up to the Montebello Castle, which is located near the hotel. The timing turned out to be perfect because we reached the top of the castle just as the sun began to set. The view from the top of the castle walls was spectacular – the glistening sun cut through the mountains and shined golden light against the town, as shown in Eric's photo in Figure 63.

Figure 63: Sunset from Montebello castle in Bellinzona

After watching the sunset, we walked back down to the hotel Albergo Croce Federale where we had dinner at the hotel's restaurant. Reto had told us how amazing the food (particularly the pizza) was at this particular restaurant so we were all extremely excited to try it. While I opted for a Tagliatelle Bolognese, all the people around me ordered pizzas. I tried bites from each person and – as Reto said – the pizza was very, very good indeed.

After dinner, we walked to the foot of another castle in Bellinzona called Castelgrande and then took a lift up to the top. Castelgrande is a UNESCO World Heritage Site and the oldest of the three castles in Bellinzona. It was finished in the 15th century, and it's purpose was to fortify against the Italians. Castelgrande is located directly opposite the Montebello Castle, so it was nice to see the town from all angles. The view from the castle at night was breathtaking – the flickering town lights, the illuminated castles, and the stars enveloping the city easily made it one of the most spectacular views from the trip. Unfortunately, the darkness also made the beautiful scene hard to capture on camera, but we all undoubtedly have vivid memories of the scenery that night (Fig. 64).

It was quite windy on top of the castle and we soon found ourselves running around the grass and singing to keep warm. After frolicking in the large space for around an hour, we walked back down to the hotel. By the time we got back it was already 11:30pm and we were all rather tired from the events of the day. Overall, this day was filled with history, culture, geology, and fantastic food and we were all upset that the trip was coming to an end.

Katherine Chan

Figure 64: Night views from Castelgrande

Day 12: August 20th

On the last full day of our Penn in the Alps trip, August 20th, 2017, our group began the day with a nice breakfast at our hotel, Croce Federale (located on Viale Stazione 12A in Bellinzona, Switzerland), followed by a stroll through the quiet town of Bellinzona up through a long, winding uphill path to one of the most spectacular vantage points in the city, the Montebello Castle. After taking a few pictures of the stunning view, we sat on the grass and Reto described the history of Bellinzona. The entire town is a UNESCO world heritage site! The town changed hands quite a few times in the past. For example, it was previously owned by Milan, and Italian is still the predominant language of the area. Switzerland gained control of the town around 1500 but the Italian language remained. Reto then described the three main castles in Bellinzona: Montebello Castle, where we sat, which was built in the late 13th/early 14th century. Castelgrande (Fig. 65) is the castle in the center of town which was partially built in the 13th century and completed in the 15th century. It was a very strong fortress for the city that we visited the night before. Figure 4 shows the relative positions of these two large central castles in Bellinzona. The third castle, Sasso Corbaro, is the smallest castle and it was built around the turn of the 16th century, a few hundred meters higher up on the hill.

Bellinzona enjoyed a highly strategic position because when the Gotthard pass opened in the 13th century, a constant flow of traffic poured through the valley for trade and transport. There used to be a wall connecting the castles, which allowed the city to tax anyone and anything that passed through their gates.

Cloud Formation

Ironically, there was not a single cloud in the sky for Nayadis Couce's presentation (as shown in all included photos with the sky in frame) so the concepts she presented would have been hard to visualize without the pictures and diagrams she provided in her handout. She discussed the intricacies and difficulties of weather forecasting with advective & convective weather situations. She described four types of advective weather situations. 'North Foehn' is where cool humid air hits the Alps and forms thicker clouds that will likely become a thunderstorm on the north mountainside. Once airflow travels down the other side of the mountains, it warms up and dissipates. The second is 'Bise,' where in the case of the Alpine weather systems, a high-pressure system near England will hit a low-pressure system near the Mediterranean.

Figure 65: Aerial photo of Castlegrande in Bellinzona

This creates low fog on the mountains and wind currents throwing around clouds. Usually this will result in a light mist, drizzle or even snowflakes. The third is South Foehn, which is similar to North Foehn but instead there is a low-pressure system on the northwest side of the Alps by the English Channel and high pressure over the Balkans and Northern Italy. The fourth type of advective weather situation is West Winds, which is the most common weather in the Alps, around 220 of the 365 days of the year. Humid air flows from over the Atlantic Ocean to Europe almost every day forming pressure cells and bringing along polar front waves that cross the Alps. Thunderstorms can form very quickly and unpredictably when a cold front comes into a warm area as the pressure and temperature levels vary so drastically. Convective weather situations, by contrast, are defined by relatively small pressure differentials between adjacent atmospheric areas. Two types of convective weather situations are Anticyclones and Flat pressure distribution systems. I found it particularly interesting when Nayadis and Reto both explained how pressure thresholds create elevation boundaries where cloud formation stops, thus giving clear height boundaries on which clouds often sit.


Figure 66: Anurag presenting on soil formation and erosion at Montebello

Similarly fascinating was our discussion about how dust or pollution in an area around dew point can create clouds, so some cities such as Dubai will intentionally create clouds to cool down the city when it gets unbearably hot. Also, pollution create clouds which have a higher albedo (reflects more light/heat) so it can actually cause drought. An interesting note was that temperature inversion creates foggy valleys which are essentially a lake of cold air where the air is coldest on the bottom of the valley and warmest above, this can create beautiful landscapes where mountains stick up above the fog. Some more relevant points from the presentation were that some of the most consequential turbulence in airplanes happens when we hit cumulonimbus clouds and the updrafts around mountain valleys are great for gliders, like we saw a few days ago on our hike. Mountains complicate weather systems dramatically, thus are consistently interesting to study!

Soil Erosion

The next and final presentation was from Anurag Makineni (Fig. 66), who presented on soil formation and erosion. He began with the most basic and important principle: soil is formed by rocks and biomass breaking down. Glaciers & rivers break up rocks to form particulate matter that then gets carried away by wind or water! Rain water flows to rivers and carries out sediment and deposits it by the river. Rivers break up rocks and sediment all day everyday, and the speed of water as well as the distance of transport change the size of the particles produced. For example, silt and clay are produced from slow rivers and gravel results from faster rivers. In fluid driven erosion, the sheer stress is proportional to the velocity and viscosity of fluid or air eroding it: the higher viscosity, the higher intensity and similarly, the higher velocity, the higher erosion intensity. Landslides have two major causes, the first is gravity driven erosion, where more friction is needed to hold a steeper angle of slope and if that friction threshold is undercut, a chain reaction of sliding and falling rocks will come crashing down. The coefficient of friction determines how well rocks, soil and sediment are held in place. Friction combined with tree and plant root systems hold soil together well, but permafrost is more effective at holding the soil together. However, when it melts, it becomes much easier

to erode and slide. Flash floods in the desert just run over the sand and soil and don't soak much into the ground, which is similar to mudslides on the sides of mountains in the Alps. A Swiss village called Gondo had a landslide resulting in millions of Euros worth of damage and 13 tragic deaths. Europeans have learned from these unfortunate tales and have developed landslide mitigation strategies such as big retaining walls over villages and roads. Ground cover vegetation works well, but recently textiles have been frequently used to hold soil in place. They also put up nets to protect highways from falling rocks, and they never cut down mountain forests above villages because this is notorious for causing easy landslides. Many nearby areas to Bellinzona are soil negative, meaning they are losing soil faster than they make it. We closed the discussion with some horror stories about billions of dollars worth of damage dealt by a massive soil eroding event near Los Angeles that closed a highway that Anurag was going to use to drive south in California. These types of landslides and rock falls close highways very frequently in the Alps.

After finishing the presentations, we were free to roam around the Montebello Castle and the town to eat lunch. The Museum in the castle had interesting artifacts but the labels were only in Italian, so we mainly used the time to climb up to the top and enjoy the view. We went for lunch at a restaurant in the main square near our hotel and then packed up the vans to drive all the way back to Zürich! We stopped on the way for a snack and a break and then contin-ued back to our beloved Hotel California, right near the river. I took a walk by the swans and almost got my fingers bitten off by some hungry swans. (Fig. 68). We met Justin (Fig. 67) and Reto's love-ly wives and cute baby and had a great final dinner before we headed back to the hotel to depart back to the US in the morning.

Josh Lauder

Figure 67: Justin with his wife and daughter

Figure 68: Swans on Lake Zürich