UBC SEG Student Chapter
2019 Field Trip: Summary

BOLIVIA & PERU
7 mines in 3 weeks  
(May 3rd to 19th)

Raul Condestable Mine  
Cerro Lindo Mine  
Cerro Verde Mine  
Cuajane Mine  
Cerro Rico Mine  
San Cristobal Mine  
Uyuni Operations

18 participants  
8 students  
10 industry members
May 3 - Arrived in Lima

Our first day of the trip started in Lima the capital of Peru that has an urban population of almost 9 million. We spent time organizing logistics and taking some medical exams that some mining companies required. We are thankful to the company NEXA Resources, which booked and paid all the expenses for the medical test.

Even though our first day was short in Lima, we had the chance to visit UNESCO world heritage sites (e.g. the Plaza de Armas in the photo). The group gathered in the night and spent some interacting with students from the SEG chapter from the Pontifícia Católica University of Peru.
In the morning, we travelled from Lima to Chincha. The objective was to visit the Raul Condestable Mine. This mine is operated by Campania Minera Condestable, a Peruvian company. The deposit is a Late Jurassic to Early Cretaceous IOCG, which was the old deposit visited in our trip. The deposit is mined underground along some calcareous and permeable volcanoclastic rocks.

The mineralization occurs mostly as mantos replacement and breccias. The deposit exhibits a marked lithological control. The mined minerals comprise chalcopyrite, pyrite, and bornite (photo) with an average grade of 1.9 Eq Cu. Under a flotation process, a final concentrate is close to 11% Eq Cu. In the recovery plant, 50% of the water is recovered after the concentration process. All the recovery process was kindly explained by the mine metallurgist here in the photo.
May 5 - Chincha to Ica

We departed Ica early in the morning to take the arduous, yet beautiful drive into the Andes foothills. Our destination was the Cerro Lindo VMS deposit; owned and operated by Brazilian company, Nexa Resources.

The drive took approximately two and half hours on a single track winding road, which we shared with all other traffic heading to the mine, including ore and explosives trucks! The spectacular views of the desert mountains and valleys, which gradually became greener with shrubbery as we ascended over 2000m to the mine site, helped to ease any driving nerves.
Apart from the various checkpoints and pumping stations along the road, the first sight of the mine was its mill, which perched seemingly precariously and majestically on top of a steep ridge. Below it, the tailings were stacked against the steep valley side, and we posed for a group photograph in front of this view while we waited for our escort. The remainder of the mine had a surprisingly small surface footprint, consisting of a conveyor belt, workers' huts, two five-a-side soccer fields, and the main administrative building. It was incredible to think that these few small buildings in such a scenic location concealed the largest underground mine in Peru and the second largest in the whole of South America.

We stopped by the administrative building for a quick safety introduction and a presentation on the geology of the deposit. We were particularly impressed by the mine’s commitment to recycling water, which otherwise had to be desalinated and pumped from the Pacific Ocean, and its extensive exploration program.
May 5 - Chincha to Ica

We then headed to the core-shack, where we some wonderfully knowledgeable and enthusiastic geologists greeted us. They showed us some drill-core, geological models and surface stratigraphy samples, and had even learned the English mineral names to accommodate us! There are two types of ore assemblages: zinc plus barite, and chalcopyrite with pyrite. Alteration around the deposit includes seritization, chloritization, and silicification. The deposit is thought to have formed as a classic VMS deposit when black smokers on the seabed inducing replacement of the host volcanic rocks. The core shack geologists gifted us each a small core interval of massive pyrite as a souvenir.

After a quick lunch stop in the cafeteria, we were encouraged to leave before an incoming storm hit, which would have made the drive down dangerous. However, we long cleared any bad weather by the time we were back at sea level and were soon on the way to Huachachina, where we would overnight.
May 5 - Nazca

We spent the early morning enjoying our short time in Huacachina. This tourism hot-spot is a desert oasis surrounded by restaurants, bars, and souvenir stores. Some members of the group took a ride on dune buggies over the dunes and went sandboarding, while others enjoyed a short, yet scenic hike to the highest dune before running (or falling) down.

We departed Huacachina mid-morning. Our initial plan for the day was to visit the Marcona IOCG mine. However, a last-minute change of plans at the mine meant that they had to cancel the visit. While this was disappointing, we were told by the apologetic geology team that they too were upset about the cancellation and that it was, unfortunately, beyond their control.
May 6 - Nazca

As an alternative activity, we took a tour of the Nazca Lines. These pre-Inca drawings on the desert floor depict various creatures, patterns, and arrows. They are only visible from above, so we climbed in a small bush plane in groups of four or five, and reveled in the spectacle while trying to ignore the motion sickness. Overall, it was very humbling to see this UNESCO site and to learn a little bit about pre-Inca and Inca culture.

We stopped for a late lunch stop in the centre of Nazca, before heading to our hotel. The rest of the evening was spent relaxing in the hotel pool, while some group members visited the local museum of pre-Inca culture.
May 7 - Museum & Arequipa

One of the long travel days for the group since we have to arrive at the city of Arequipa by May 8th before the scheduled visit to Cerro Verde mine. The drive from Nasca to Arequipa is around 10 hours with some stops for bathroom break and lunch. The group stopped at Chala for a quick lunch but also get a chance to make several touristy fun stops with the recommendation from our tour guide.

Stop 1: historical Inca site that are used for a lot tourists’ visit. We are lucky enough to be there early morning that the attendance for the place did not show up to charge us for the visit. It was a nice hike to the top of the Inca watch tower. The site really well preserved with a lot of the traces of how the Inca people lived. The group took lots of photos and had a good time.

Stop 2: this is followed by a stop to see the geology fault, which extend all the way to Arequipa. The fault is formed around the age of late Cretaous and happens to be the longest and oldest geological fault around the region. The mystery about this fault is actually about the formation which some guessed to be glacier movement and some believed to seismic movement It is a large strike-slip fault and the group took awesome picture there.
May 7

**Stop 3:** The group stop at an olive market and shopped and tasted olive at the market. The local olive farmers are so nice and friendly and invite use to try different olive dish with crackers, cookies, honey and also coco leaf passion fruit tea. It was certainly a very good experiences.

**Stop 4:** the group stop by a small town for lunch and took walk along the beach near the small town Chala. The view is beautiful. The group finally arrived at the city of Arequipa a bit later than expected around 10pm on May 7th, 2019
The visit to Cerro Verde Mine is the second morning early at around 7:00am. The mine visit is very much a surprise. The mine is very well regulated. The international relation director Rosania is a very lovely lady and she is also a wonderful host. Tiffany, the mine photography also recommended a nice restaurant and we also invited Rosania to join us dinner.

The mine visit included: meet up with mine engineer from US, he is also new to the mine and recently started will be here around 3 months. He explained the flow sheet and mine proceeding procedure. This is followed by an introduction presentation about the geology and mineralization of the deposit. Then we had a lunch on the bus before taken to the core shack and then followed by the open-pit mine visit and take group photos.
May 8 – Arequipa & Cerro Verde Mine

Cerro Verde Mine is 30 km southwest of Arequipa. The company is owned by an American company Freeport-McMoRan. It is an open pit mine and has a line life of around 2052. The deposit type is porphyry copper. The mine mostly produces copper and molybdenum. What is worth noting is that the stripping ratio of this mine is very low is 1/1 but since the production is so big that it is able to cover its operating cost. The ore grade is also pretty low around 0.23-0.25 g/ton of copper. The Cerro Verde pit depth around 590m. The Santa Rosa pit is around 360m. There is a future plan to combine the two pits together and form a super pit.

Cerro Verde is a classic porphyry deposit. The deposit contains 3 stage intrusions, alteration stage includes (potassic —> Phyllis —>Argillic) supergene enrichment is located in the Phyllis alteration zone and represent the 2nd mineralization. The mineralization zone include: LC (leach cap), oxides,SS (Secondary Sulphide), TS(Transitional Sulphide) , SP (Primary Sulphide). For a lot of the group members, this is a unique learning experience and learned so much about ore deposit and very impressive.
May 8 – Arequipa to Moquegua

We had a leisurely breakfast in Arequipa and had a few hours to enjoy the city before moving onwards!

Many of us visited the shops and markets to pick up a few last-minute gifts. Arequipa was full of beautiful architecture, quaint cafes and cobblestone streets.

We departed for Moquegua and had a chance to catch some sleep on the bus ride!
May 9 – Arequipa to Moquegua

Arequipa features beautiful architecture set against a stunning backdrop.

Most of the city is constructed of volcanic stone, sourced from surrounding volcanoes.
We had a group dinner once we arrived in Moquegua and checked into the hotel. We also celebrated Dave’s birthday!
May 10 – Moquegua to Puno

We departed Moquegua at 8am and arrived at the Cuajone Mine around 10am. They gave us an amazing presentation on the history of the mine and the character of the ore body. They also let us climb onto some of their huge dump trucks!

We left Cuajone in the mid-afternoon and began our ascent into Puno. There were a few cases of altitude sickness but everyone managed with the help of some coca tea and supplemental oxygen supplied by the hotel.
Cuajone Mine
May 11 – Uros Islands

On our free day in Puno we visited the Uros islands or “the floating islands” on Lake Titicaca. The islands, houses and boats are mostly made out of a type of grass that’s related to papyrus. The locals also eat the grass but to be able to digest it, they also eat the clay that consists of kaolinite, the new ‘super-food’!

The team on one of the grass built boats, nowadays they put empty plastic bottles inside to help the boats float.

The man-built islands usually last around one generation, before building starts again.

Trying on the traditional clothes of the islands.
May 12

Leaving Peru behind we drove over to Bolivia, stopping on the way at the border and by the Tiwanaku archeological site, before reaching La Paz. Straight away at the border there was a different atmosphere than what we had experienced in Peru. We played frisbee with the kids in the neighbourhood and took part in a parade. Tiwanaku, from pre Inca time, is a huge area with amazing sculptures and architecture and we wished we had more time there.

One of many parades of the trip. Best to just dance in the middle of it!

The Gate of the Sun at Tiwanaku archeological site.
Bolivian countryside – a lot of farming, especially quinoa, small villages and llamas.
May 13 - La Paz

In a city surrounded by dynamic terrain and intriguing architecture Valle de la luna (Moon Valley) was our first stop on a guided tour of the city. A 40 minute geomorphological maze formed by erosion of hillside was enjoyed by the group followed by a stop at Killi Killi, an almost 360 view of the city. Snow covered mountains, dense population centers of the city with exquisite hillside architecture and La Paz’s cable car transport system can be viewed from here.

Next on our itinerary was to experience the overhead cable car transport system which allowed us to navigate La Paz as locals would.

The architecture at Plaza Murilo and surrounding government office buildings was enjoyed by the group touring the city.

Members, and our guide, convened for a group dinner to celebrate our first night in Bolivia.
May 14

A 10 hour bus ride from La Paz led us to highest city on our destination, Potosi. Along the way we had the opportunity to enjoy beautiful countryside views of Bolivia along with rural architecture and wildlife.

Late arrival in the evening allowed us to enjoy the tail end of youth cadet parade.

Photo Above: Hillsides and rural architecture.

Photo on Left: Monument to the Virgen del Socavón in distance.
May 15 – Potosi and Cerro Rico

- We visited the historic town of Potosi and the historic Cerro Rico mine that was mined by the Spanish for silver hundreds of years ago. We were fortunate to meet with local Geology professors who gave an in-depth lesson on the geology of Cerro Rico. We also visited the mining museum in Potosi where we saw the machines that were used to fashion silver coins for the Spanish empire. Some of the machines were designed by Leonardo De Vinici. Cerro Rico is still an operating mine today, however it is an artisanal mine and we witnessed the stark contrast in safety precautions between modernized mines and these artisanal mines.
May 16: San Cristobal Mine

San Cristobal is the largest mine in Bolivia. It is a vein-hosted base metals deposit producing Pb, Zn, and Ag, and is the sixth and third largest producer of Zn and Ag respectively in the world. It originated as an artisanal mine during Spanish colonization, and in the 1980’s it became a full scale operation. The mine site geologist were very kind by showing us the drill core and explaining to us how the deposit formed.
May 17 – Uyuni Salt Flats

- In addition to being a natural wonder that attracts thousands of tourists from around the world every year, the Salar de Uyuni is also the world’s largest lithium reserve. The lithium occurs as dissolved lithium chloride in the salty brine that exists below the flat surface salt crust, and is used to create lithium ion batteries, a product growing in demand for use in electric cars. The lithium originated from the dissolution of volcanic rocks in the surrounding area by rain and groundwater, where the dissolved lithium was then carried by streams to the present-day salt flat. The salt flat itself is the result of regional changes in climate, where paleolakes dried up at the end of the last glacial stage. The lithium is recovered by pumping the brine to the surface, where the dissolved lithium chloride can be concentrated by precipitating other dissolved salts such as sodium chloride and calcium chloride through evaporation and chemical precipitation. Once the lithium chloride brine is sufficiently concentrated and purified, the lithium can be recovered by adding sodium carbonate to precipitate the final product, lithium carbonate.

- Our visit to the Salar de Uyuni began with a round of questioning from other tourists who learned that we were a group of geologists. The other tourists described bubbling ponds on the perimeter of the Salar, and were asking us about what was causing the bubbling. We later got to visit these bubbling ponds ourselves, where we became enthralled with trying to explain the phenomenon. One of our industry members went so far as to try to collect a gas sample for later analysis at a lab in Canada. One possible explanation is that the bubbling is caused by CO2 degassing from inflowing stream water as it comes into contact with the salt-rich brine. This is because the streams likely contained dissolved CO2 from exposure to the atmosphere, and the solubility of CO2 in water decreases as salt content increases, and results in degassing.

- After spending time at the ponds, we drove to an island in the middle of the salt flat that was covered with both cacti and the remains of ancient corals that must have lived in the paleolake before it dried up. After touring the island, we enjoyed a very special picnic lunch on the salt flat for the birthday of one of the students. After lunch we had lots of fun playing with taking photos of the mind-bending illusions that tourists love to create on the salt flats.
May 18 – Farewell Dinner

Following our incredible visit to Uyuni, we enjoyed one last dinner together to celebrate the success of the 2019 UBC SEG Field Trip to Peru and Bolivia.
- May 19 -

The end of this amazing adventure!

UBC SEG CHAPTER 2019 FIELD TRIP TEAM