University of Western Ontario
Society of Economic Geologists – London Student Chapter

Geology of the Eastern Cordillera of the Andes, Colombia

February 18 – 26, 2018

Objective:

The purpose of this trip is to investigate the complex tectonic systems of the Eastern Cordillera of the Andes, that resulted in the formation of epithermal gold deposits, hydrothermal emerald deposits, extension-associated diapiric activity, and geohazards associated with complex fault systems and volcanic activity. An additional goal of this trip is to collaborate with the members of the newly established SEG Student Chapter of the University of Pamplona (UdP), Colombia.

Trip Participants:

Dr. Bob Linnen – UWO Professor, SEG Faculty Advisor, Trip Leader
Dr. Sheri Molnar – UWO Professor, SEGx Faculty Advisor, EERI-BC Executive Member & Trip Leader
Dr. Neil Banerjee – UWO Professor & Trip Leader
Dr. David Good – UWO Adjunct Professor & UWO W.S. Fyfe Visiting Scientist-in-Residence
Luke Howitt – Graduate Student & Trip Leader
Lindsay Debono – Graduate Student & SEG London Student Chapter President
Povilas Grigutis – Graduate Student & SEG London Student Chapter Secretary
Mailyng Aviles – Graduate Student
Karen Grey – Graduate Student
Dylan Langille – Graduate Student
Kelsey Rozon – Graduate Student
Jay Nigim – Graduate Student
Alyssa Werynski – Graduate Student
Tim Howe – Graduate Student
Cindy Corrales – Undergraduate Student
Patrick Bovingdon – Undergraduate Student
Ryann Keen – Undergraduate Student
Remy Klick – Undergraduate Student
Max Taylor – Undergraduate Student
Jordan Siewnarine – Undergraduate Student
Tyler Travis – Undergraduate Student
Jason Wozniak – Undergraduate Student

Sunday, February 18th
5 AM Departure from UWO to Pearson International Airport. The first flight from Toronto to Mexico City, then to Bogota, Colombia. Overnight at Aloft Hotel in Bogota to prepare for flight to Bucaramanga.

Figure 1. Beautiful sunset just before take-off from Mexico City, on the way to Bogota.

Monday, February 19th
7:30 AM Flight from Bogota to Bucaramanga. Convened with the student group from the University of Pamplona and the Professionals Group in Bucaramanga. Traveled to the California-Vetas gold-mining district to look at high-sulfidation epithermal deposits. Learned about ore minerals commonly found in high-sulfidation environments, different alteration types, structural controls and practiced our knowledge by examining drill core. Drove to Bucaramanga for the night.

Figure 2. The SEG London Student Chapter was warmly welcomed by the University of Pamplona SEG student chapter, and were gifted sombreros upon arrival.

Tuesday, February 20th

Traveled back to the California-Vetas mining district and visited the Minesa mine's "Soto Norte" Project. This is the northernmost representation of Andean high-sulfidation epithermal gold deposits in South America. The participants learned about the local geological setting: NNE trending quartz vein system (~2 km length) hosted within Precambrian Gneiss. Gold grades in the quartz veins are ~6g/tonne, with mineralization aged at 3 Ma. Mineralized areas show heavy argillic, sericitic, propylitic and localized quartz-adularia alteration, as observed in the drill core and outcrop. The tour included visits to the existing exploration tunnel, various outcrops, as well as the examination of cross-sections and scale models of the present and future plans for the mine. Students received lessons on core-logging basics from the Minesa geo-technical staff. Drove back to Bucaramanga for the night.

Figure 3. A) A 3D model of current and future plans for the Minesa mine. B) London and UdP SEG Student Chapters investigating core at the Minesa mine. C) A Minesa mine geologist explains the geology of the gold-bearing Proterozoic gneiss and Mesozoic granitoid rocks. D) View of the Minesa mining camp and previous artisanal mining activity, nestled in the Andes.

Wednesday, February 21st

Traveled to Chicamocha Canyon where students had the privilege to see the Bucaramanga Nest – largest concentration of seismicity in the world! The Colombian Andes are seismically active due to the subduction of the Nazca and Caribbean plates underneath the South American plate. Students discussed the importance of brine mobilization and transport in the Bucaramanga Santa-Marta Fault (BSMF), and the subsequent accumulation of ore-bearing fluids in secondary fault systems. Ore deposits in the region are structurally controlled by secondary/tertiary faults coming off the BSMF. Road-stops looking at various landslide hazards were done along the route, where students discussed the factors affecting slope instability – steepness, seismicity, rain-fall, lack of vegetation, soil composition, etc. Overnight in Chiqinquira.

Figure 4. A) Cindy Corrales and Tyler Travis provide a field presentation of the Bucaramanga Santa-Marta fault system and resulting seismicity in the region; specifically, the Bucaramanga Nest seismic zone seen in the background. B) Jason Wozniak presents on hazards associated with land instability, landslides and mass wasting - common geological processes in Colombia. C) Not an ordinary bump in the road: produced by active, underlying mass wasting. This was the site of a gas station which had to be shut down because it posed an environmental risk caused by land slumping (the underground petrol storage was at-risk of structural damage and leakage). D) A photo showing terracing associated with land slumping activity. The weight of the grazing cows is often the culprit for terracing and resulting slumping of hillsides in Colombia!

Thursday, February 22nd

Traveled to Muzo – the emerald capital of the world! From Muzo, the group traveled in off-road vehicles through the jungle mountains and arrived to the Empavas (Las Pavas) and Vetas Sierra Alta (Vetas Alta) greenfields emerald project. What is unique about Muzo is that emeralds are hosted in sedimentary shales, whereas most of the world's emerald deposits are hosted by igneous/metamorphic lithologies. The group received a tour into a mountainside adit where the underground mineralization was observed. "Cenciro zones" are areas where carbonaceous shales have been leached of all their minerals and have become white. They are thought to have been leached by ascending hydrothermal brines which precipitated the leached minerals in vein networks. Emeralds are locally found formed along these carbonate/quartz veins, but their occurrence is highly variable and currently unpredictable. Along with the mine geologists, the students discussed the formation of the emerald deposits from their underground observations. The end of the tour included snacking on freshly picked guava! Stay overnight in Chiqinquira.

Figure 5. A) Off-roading to the emerald mine was possible by these 4x4 vehicles. B) Geologist at Muzo mine showing off the "gems" of the mine. C) Entrance into the emerald-bearing adit in the mountainside. D) A photo showing the complex geology of the hydrothermally altered Early Cretaceous black shale and evaporitic breccia that hosts the emeralds at the Muzo mine.

Friday, February 23rd

Traveled to the Zipaquirá Salt Dome. Toured La Catedral de Sal (Cathedral of Salt), a 2 km walk into the salt dome and reaching a depth of 180 metres. Salt diapir intrusions are indicative of the local Mesozoic rift regime produced during the Andean Orogeny. The Zipaquirá salt diapir is ~65 Ma in age. Beautiful salt flow features formed during warm, ductile conditions. The salt deposit is currently moving ~3 mm every 6 months, and is currently being mined, producing ~400 tonnes of salt brine daily through H2O dissolution methods. This deposit has produced ~6 million tonnes of salt to date, and was an important resource of salt during the 5th century BCE when the local Indigenous people started mining in the area. Travel to Mariquita for the night.

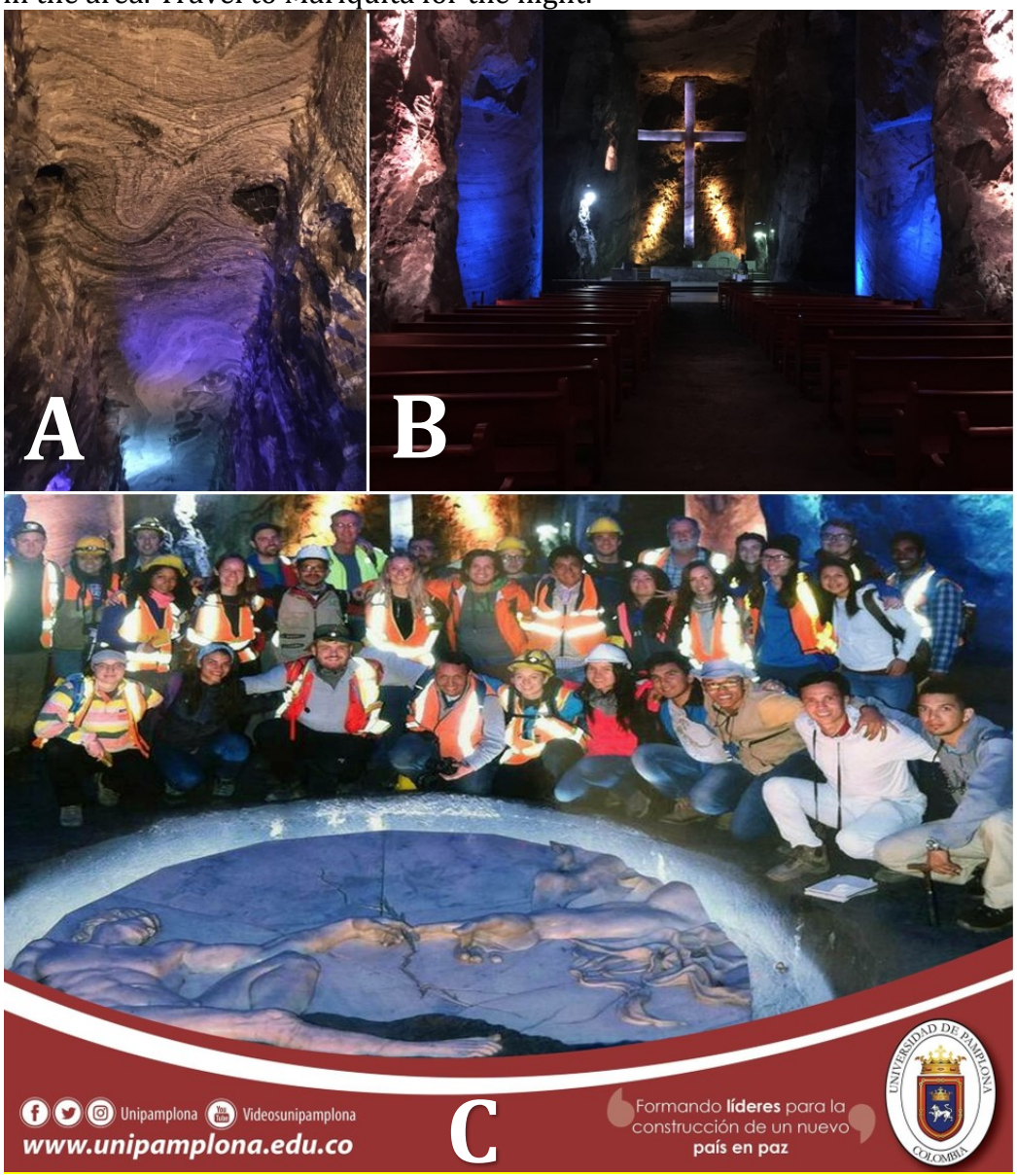

Figure 6. A) The ceiling showing a great example of the ductility of the salt deposit. B) The main attraction at the Catedral de Sal. C) A group photo of the London and UdP SEG Student Chapters, 180 m deep in the Catedral de Sal.

Saturday, February 24th

Traveled to Los Nevados National Park to observe the geology of the Nevado del Ruiz stratovolcano. This is the most active volcano in Colombian Andes with an elevation of 5300 m at its peak. It lies within the volcaniclastics of an upper Pliocene to lower Quaternary pre-Ruiz volcano. It is also at the intersection of the northeast dextral Palestina Fault and several northwest trending normal faults, including the Villamaria-Termales Normal Fault. Deposits exhibit a 1.8 Ma eruptive record. Recent Andesitic flows, tuff and ash deposits, volcanic breccias, and alteration (argillic) associated with ongoing epithermal activity were all observed and discussed. The calc-alkaline Andesites are rich in magnetite due to preferential formation of magnetite rather than olivine. This was observed through magnetic susceptibility readings performed in the field. The students discussed the importance of radio carbon dating the different volcanic paleosol layers, to date eruptive events. The catastrophic Nov 13th, 1985 Ruiz eruption was a testament to the importance of mitigation of volcanic events in the future – measuring seismicity, measuring the pH of water, analyzing gas emission concentrations, isotopes, installing tilt-metres, etc. The students then traveled to Manizales for the night.

Figure 7. A) Nevado del Ruiz stratovolcano, the largest and tallest volcano in the Ruiz-Tolima massif in the Colombian Andes. B) A series of pyroclastic deposits exhibiting the chronologic sequence of past eruptions: paleosols (black), lapilli (yellow), followed by tuff (brown). C) Professors Dr. Sheri Molnar and Dr. Bob Linnen examining a lahar flow deposit. D) Group photo of the London Student Chapter and UdP Student Chapter on the Nevado del Ruiz volcano with rare frailejón trees in the background.

Sunday, February 25th

The last day in Colombia was spent soaking in some Colombian culture in the coffee hills of Pereira, at Tio Conejo. The group was shown the process of how coffee is grown, harvested, prepared, and sold. The coffee was delicious and the hosts were very hospitable, providing a full, delicious Colombian lunch. The last night was spent Pereira.

Figure 8. A) Transportation to the coffee plantation was via military-style Jeeps. B) The view from the Tio Conejo coffee farm, overlooking surrounding farms. C) A "hang out" spot we enjoyed relaxing in. D) Prior to a fantastic meal, we were served fresh Colombian coffee and bananas. E) Coffee beans as they naturally grow. Red ones are ready to be picked. F) Coffee beans after they've been peeled, washed and set out to sun-dry.

Monday, February 26th
Flight from Pereira to Bogota, then to Mexico City. Followed by the final flight from Mexico City to Toronto.

Figure 9. A beautiful photo of the Nevado del Tolima volcano in the Los Nevados National Park in the Colombian Andes, on the flight from Pereira to Bogota. Stunning last views from the plane before we head back home!

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We also thank the SEG Student Chapter at the University of Pamplona, Colombia, for welcoming us to their beautiful country and for showing us the incredible geology of the region.

This report was prepared by:
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