



University
of Regina



ESC 497 – International Field Trip to Colombia

February 9th-23rd, 2026



Image 1: Students and Instructors standing in front of volcaniclastic flow deposits of Volcano Nevado del Ruiz at 4150m above sea level.

Introduction

The International Field School in Colombia was designed to expand students' geological knowledge through direct exposure to diverse aspects of Andean geology, including volcanology, tectonics, sedimentology, petrography, structural geology, and geomorphology. A secondary objective was to immerse students in Colombia's cultural landscape, contributing to the University of Regina's internationalization initiatives.

The field course took place from February 9 to 23 and was divided into two main components: (1) volcanism (Image 1), risk mitigation, structural geology, and geomorphology of the Central Cordillera, and (2) sedimentology, stratigraphy, paleontology, geomorphology, and basin analysis in the Eastern Cordillera. Throughout the trip (Image 2), students observed fluvial and mass-wasting processes, as well as tropical weathering and erosion, all within the context of distinctive Andean geomorphology.

The program was delivered in partnership with local institutions—Universidad de Caldas, Universidad EAFIT, and Universidad de Los Andes—where faculty, along with undergraduate and graduate students, provided field guidance and expertise. In addition to its scientific focus, the course offered a valuable opportunity for students to engage with and better understand the cultural context of the region.

Part 1 – Volcanology, Structural Geology, and Geomorphology of the Central Cordillera

The Central Cordillera of Colombia is one of the country's three principal Andean ranges, extending in a north-to-south orientation between the Cauca and Magdalena River valleys. The three cordilleras have developed as a result of the ongoing subduction of the Nazca and

Caribbean plates underneath the South American Plate.

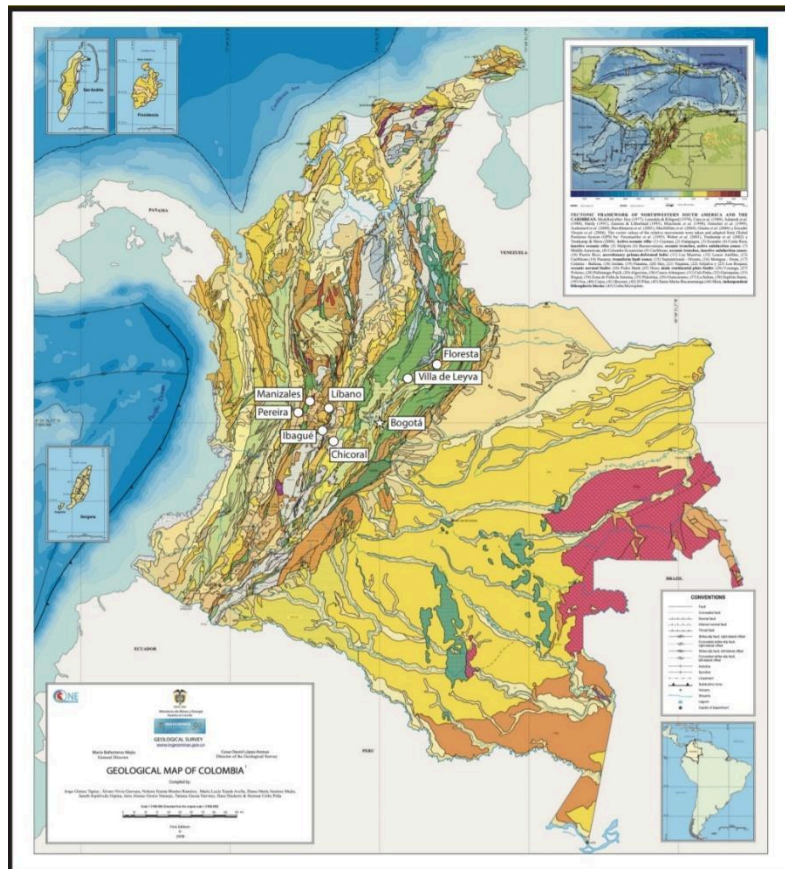


Image 2: Geological Map of Colombia showing the locations of the field trip.

Geologically, the central range is characterized by a complex assemblage that includes metamorphic basement rocks of the Cajamarca Complex, Paleozoic to Mesozoic sedimentary sequences, and extensive Mesozoic to Cenozoic magmatic arcs. These units record multiple tectonic events, including subduction-related magmatism, crustal shortening, and terrane accretion. The Central Cordillera also hosts numerous intrusive bodies and volcanic complexes, reflecting its long-lived magmatic activity and its key role in the geological evolution of Colombia.

Activities:

February 11th: Introduction to Local Geomorphology and Volcano Risk Management in Manizales

The first day of the trip, the students explored the geomorphological expressions of the tectonic activity that influence the area, and noticed aspects of slope stability (Image 3). The study tour started at a location close to the Chipre Tower, where it was easy to see the control of the north-south fault system on the volcanism distribution in the region. The north-south fault system is parallel to the Pacific subduction zone. Moreover, the instability of the area points to the fact that the Central Cordillera is part of the active subduction zone. Personnel from the Colombian Geological Survey (SGC for its initials in Spanish: *Servicio Geológico Colombiano*) imparted a class on volcanic activity (Image 4), risk management, and monitoring methods of 23 volcanoes. Out of these 23 volcanoes, 11 are polygenetic, such as Cerro Machín and Nevado del Ruiz.



Image 3: Geomorphology, creep and mass wasting processes close to La Francia neighborhood, in Manizales.

The day continued with a tour of the Universidad de Caldas, which included the museum, library, educational facilities, and the Earth Sciences department, providing a broad evaluation of the academic work and resources.



Image 4: Students taking notes from the Volcanic Risk Management presentation, presented by Manuela Castaño at the Servicio Geológico Colombiano (SGC).

February 12th to 13th: Villamaría-Termals Monogenetic Volcanoes, Glacial Valleys, Volcaniclastic and the 1985 lahar deposits of Nevado del Ruiz

The Grupo de Investigación en Estratigrafía y Vulcanología (GIEV) CUMANDAY joined the field trip as instructors and guides. Their teachings helped the students understand the geological history of the region by identifying lithologies, geometries, and structures of volcanic products of the Colombian cordillera. During these days, the students were able to analyze Villamaría-Termals monogenetic volcanoes, and understand the differences between monogenetic and polygenetic volcanoes. The students also had the chance to observe the chemical composition of rock units, identify the most predominant lithologies - from the metamorphic rocks of the Jurassic period to the plutonic rocks of the Eocene period, and finally, notice the geomorphology dominated by steep slopes and carved by the glacial valleys (Image 5), which, in turn, are influenced by animal activity.

Image 5: Glacial valley close to the road.



The highlight of the day was observing the volcanoclastic deposits of the Nevado Del Ruiz volcano, where the students learned about Plinian eruptions and associated deposits (Image 6). They were able to identify pyroclastic flows and surge deposits and learn to distinguish between them using size, and mineralogy (Image 1). One special stop was Armero. The 1985 eruption of Nevado del Ruiz generated violent lahars that buried the town of Armero and claimed the lives of the 25 000 inhabitants. The scenario depicted in the textbooks came to life while walking amongst the ruins of the town.

As the group approached the Armero ruins, the students learned about the impact of geology on society and the mitigation measures needed to prepare the population for possible volcanic hazards. The other stops included observing different types of monogenetic volcanoes in the Pijaos region, the three scoria cones in the Gualanday complex, and the geomorphology of El Tabor maar.



Image 6: Group observing the 1985 lahar deposits on Lagunilla river valley.

February 14th-15th: Lahar Deposits of Cerro Machín Volcano, Cajamarca Complex and Pyroclastic flow deposits of Nevado del Tolima Volcano

On February 14th, the students worked in groups to create stratigraphic columns of the young lahar deposits along the Coello River (Image 7) and Gualanday (Image 8). They used mineralogy, fragment size, cohesion, colour, and fragment shape as criteria for describing each unit and understanding secondary deposit variations from high-sediment to high-water ratio. The deposits ranged in size from ash to block dimensions, with blocks that were dacitic in composition and that travelled kilometres from different volcanoes and domes; it also included metamorphic rocks of the Cajamarca Complex. The deposits illustrated the Plinian eruption of the Cerro Machín volcano that melted the mountain's glaciers, sending lahars into the surrounding valleys.

The following day, the students observed the metamorphic rocks of the Cajamarca Complex (Image 9), which was formed in a tectonic setting dominated by volcanic arc magmatism, Permian subduction, and basin development of Colombia. The complex is

dominated by greenschists and graphite schists. The site visited was located about 11km from the Nevado del Tolima Volcano.



Images 7: Lahar deposits near the town of Coello.



Image 8: Gualanday deposits.



Image 9: Cajamarca Complex close to the Combeima River.

The outcrop was affected by rock falls over time. The fractures in the rock, influenced by tectonic events in the Jurassic, contained good examples of cataclasites, breccias, and mylonites related to structural features.

A short walk away, the outcrop was a block-ash pyroclastic flow deposit from Nevado del Tolima Volcano. The sub-angular to angular blocks, andesitic in composition, set in an ash matrix, indicate a primary deposit (sediments to gas), that once ran rapidly downhill and spread around the region. The outcrop demonstrated the collapse and fragmentation of the intracrater dome.

February 16-17th: Cerro Machín Volcano formation, Crater & Dome, Geyserites and Cocora Valley

Early in the morning, the students embarked on a trip to see the Cerro Machín volcano up close (Image 10), located on the eastern flank of the Central Cordillera. Cerro Machín is known as the most active and explosive volcano in Colombia, having erupted at least six times over the past 5000 years, in two Volcanic and four Plinian style eruptions. The formation of this polygenetic volcano is related to the subduction of the Nazca Plate beneath the South American Plate, and it is built above schists and biotitic quartzite of the metamorphic Cajamarca Complex. The crater is 2.5 km wide; a 900-year-old intracrater dome that towers 400 m above the crater floor dominates its center. The students were able to hike inside the crater for about 2 hours (Image 11), where they observed the dacitic composition and the area's Andean forest and gained insight into its formation and current state.

After observing the volcano, the next stop was at the geyserites (Image 12) near Cerro Machín. Hydrothermal springs were approximately 80°C in temperature and neutral in pH, with no sulphur present in their composition.



Image 10: Panoramic view of Cerro Machín Volcano. On the steep slopes, closer to the road, there is a beans plantation.



Image 11: Students crossing a soccer field inside the crater. The dome is visible on the right side of the image. The edge of the crater can be seen on the left side of the image.

The reason the water is not acidic relates to the water cycle, and to the fact that the rainwater doesn't come in direct contact with the magma before streaming out on the slopes.

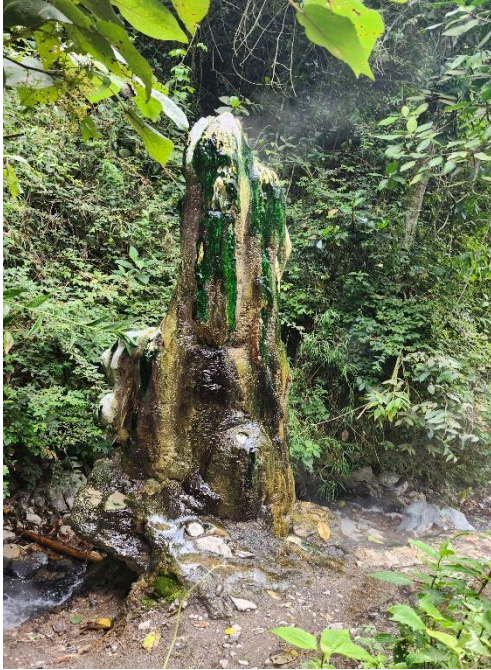


Image 12: Geyserite from the Cerro Machín Volcano



Image 13: Cocora Valley in Salento

The Cocora Valley (Image 13) in Salento was a magnificent stop for both geological and biological aspects.

PART 2: Stratigraphy and Structural Geology of the Eastern Cordillera

Regional Geological Setting

The Eastern Cordillera of Colombia of the northern Andes represents a classic fold-and-thrust belt developed under compressional tectonic conditions. This deformation results from the complex Andean orogeny, driven by the convergence of the Nazca, Caribbean, and South

American plates in multiple stages over the past 90 million years. The Eastern region exposes a diverse stratigraphic record, with notably exquisite archives from Paleozoic to Cretaceous units that have been variably deformed by thrust faulting, folding, and localized salt tectonics. These processes have created complex structural features while preserving extensive sedimentary successions that record shifts in depositional environments through time.

Field Observations

February 19-20th: Santa Rosa de Viterbo and Floresta

The first two days of fieldwork in the Eastern Cordillera were conducted in the towns of Santa Rosa de Viterbo and Floresta. The focus was on geomorphology and structural expression of thrust faulting, as well as on incredible fossils at the UNESCO World Heritage site of Floresta (Image 14). Well-exposed thrust systems provided insight into the compressional deformation that characterizes the Eastern Cordillera. In particular, the presence of tectonic windows exposed older stratigraphic units beneath overlying thrust sheets, illustrating the stacked nature of the orogenic wedge. A key highlight of this portion of the trip was examining the Devonian fossil assemblage in the Floresta Formation, guided by local guide and expert Don Luis Becerra



(Image 15, 16). The fossils (Image 14) found included trilobites, brachiopods, bivalves, bryozoans, corals, and crinoids. This assemblage indicated a shallow marine environment where marine invertebrates thrived.

Image 14: Bryozoan fossils ranging from 2 to 10 cm, from the Devonian Floresta Formation.



Image 15: Students watching presentation presented by Don Luis Becerra, Museo de La Vida in Floresta.



Image 16: Students and instructors taking one last picture with Don Luís Becerra.

The students spend a good part of the day constructing a stratigraphic column spanning from the Devonian Floresta Formation to the Cretaceous Tibasosa Formation, capturing a significant

portion of the regional geological history and highlighting major transitions in depositional environments and sedimentation patterns over hundreds of millions of years. These observations provided important context for understanding the basin's early geological history prior to the Andean orogeny, during which these rock units were deformed.



Image 17: Student in front of Devonian Floresta Formation for the stratigraphic column exercise.

February 21st-22nd: Villa de Leyva and Sáchica

Fieldwork during the second part shifted focus to the Villa de Leyva and Sáchica region, where a more in-depth Cretaceous stratigraphic succession was examined. The observed sequence extended from the Jurassic Arcabuco Formation to the Cretaceous Churuvita Formation, representing a range of marine depositional environments within an extensional backarc basin. These marine sequences were rich with Cretaceous marine vertebrates, including ichthyosaurs, plesiosaurs, pliosaurs, and early turtles, which we observed in great detail at the Museo Paleontológico de Villa de Leyva. Observing these units provided an opportunity to study lithological and depositional changes, which reflected fluctuations in sea level, sediment supply, and the biosphere during the Cretaceous.

One of the most eye-opening structural features observed was the change in fold vergence from west to east, reflecting the progressive evolution of the fold-and-thrust belt and deformation history of the region. Additional insights into the tectonic framework were provided by our guide, Dr. Jose Duque from EAFIT University in Medellin, who described the region's structural evolution in the context of Andean orogenesis. Of particular interest was the role of salt tectonics, especially in the vicinity of Zipaquirá. The presence of evaporite layers acted as weak zones that facilitated deformation, resulting in unusual structural geometries.



Image 18: UofR students with Dr. Jose Duque and his students from EAFIT U in front of large tectonic folds near Sáchica.

Image 19: Overturned folds logged in the Cretaceous section near Sáchica.





Image 20: Viewpoint over the Sáchica valley. The large green patches are onion plantations. The region produce about 70% of onions sold in Colombia.



Image 21: Students observing ancient wetland deposited during uplift. Colombian version of our badlands, but at 2500m above the sea level.

Cultural Aspects of Colombia from the students' perspective

Colombia has a rich culture, delicious food, welcoming people and amazing art. From the moment they landed in the country, the students were fascinated by the colourful environment, sticky humidity, and meandering roads. The food was very different from the typical Canadian menu, full of tropical fruits, beans, rice and potatoes, soups and corn arepas.

From the calm rural areas to crowded cities, the students were able to meet wonderful locals, visit impressive museums, ask questions, and learn some Spanish words, integrating themselves into the Colombian daily life. This field trip helped the students learn from each other, showing them a different perspective on life and highlighting the importance of traveling. Soon after returning to Canada, the students were already missing the warmth, the nature and the people of Colombia. They will never forget their first impressions of this bright country.

Conclusion

This field excursion provided a comprehensive view of the geological complexity of the Central and Eastern Cordillera of the Colombian Andes, bringing volcanology and geomorphology together to understand the tectonic activity and illustrating the close relationship between stratigraphic development and tectonic deformation. Through studying volcanoes, and lahar deposits, the students were able to identify the properties of units and geological time related to the magmatic arc and its activities. Through the study of thrust faults, tectonic windows, fold vergence, and salt-controlled structures, it became evident that the present-day architecture of the region results from prolonged and dynamic geological processes. The integration of field observations across multiple scales, from fossil assemblages to regional structural patterns, reinforced the importance of combining stratigraphic and structural approaches in geological interpretation. Overall, the trip provided a valuable opportunity to apply classroom concepts in a real-world setting and deepen understanding of the processes that shape fold-and-thrust belts.

ACKNOWLEDGMENTS

We would like to express our special thanks to our sponsors and academic support for assisting us on this wonderful field trip. This opportunity will always be remembered and will guide us in our future careers as geologists and geoscientists: **UR International, CanAlaska Uranium Ltd., DKM Engineering Ltd., Over the Hill Orchards & Winery, Prospectors & Developers Association of Canada (PDAC), Universidad de Caldas, Servicio Geológico Colombiano, Observatorio vulcanológico de Manizales, Universidad de Los Andes, Universidad EAFIT and Asociación Museo de la Vida.**