EARTH SCIENCES

ADVANCED GEOLOGICAL FIELD METHODS
TRIP REPORT
SOUTHERN IBERIA
FEBRUARY 16TH-24TH 2018

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Molino Rio Alájar

Field Trip Summary

Twelve senior Earth Science students from St. Francis Xavier University (StFX) participated in an eight-day advanced geological field methods course held in Southern Iberia from Feb 16th to 24th. Southern Iberia offers unique and varied geology, including excellent exposure of an ancient continental collision zone that formed during the collision of Gondwana and Laurussia, during the amalgamation of Pangea. This ancient suture zone stitched ancestral North America to Europe approximately 300 million years ago, and provides a rare exposure of this important geological relationship. The region also hosts the world famous Iberian Pyrite Belt, a geological terrane that is rich in volcanogenic massive sulfide deposits that are actively mined today. The trip focussed on educating students on geological mapping and tectonic interpretation, economic geology, as well as surface and underground mining and exploration operations in Spain and Portugal.

The Department of Earth Sciences professor Dr. James Braid, with the help of Dr. Donnelly Archibald, organised and led the trip. During eight intensive days in the field, students practised observation, mapping, interpretation, and presentation skills in a location with a unique geological history. The area afforded a rare opportunity for students to witness examples of many important geologic processes that they had only learned about in theory in the classroom. The first 4-days were guided field activities, followed by a three-day independent mapping project that allowed students to expand and apply their skills. Each of the first 4-days had a different geological theme, and ended with evening projects and group discussions. The final deliverable of the 3-day independent mapping project was to create a detailed report and a digital map.

The international field school was made possible through generous funding from Dr. David Palmer (Probe Metals), Lundin Mining, the Prospectors and Development Association of Canada (PDAC), Kinross Gold, the StFX Dean of Science, the StFX Research VP, and the StFX Department of Earth Sciences.

Program of the Field School:

Feb 17th - Practical field methods review: Geological mapping of Rio Alájar and Gil Marquez led by Dr. James Braid

Feb 18th - Ore deposits in the heart of Pangea: Mapping of the Iberian Pyrite Belt field led by StFX MSc student, Lori Paslawski

Feb 19th - Underground mine and processing plant tour of Neves Corvo VMS Mine in Portugal

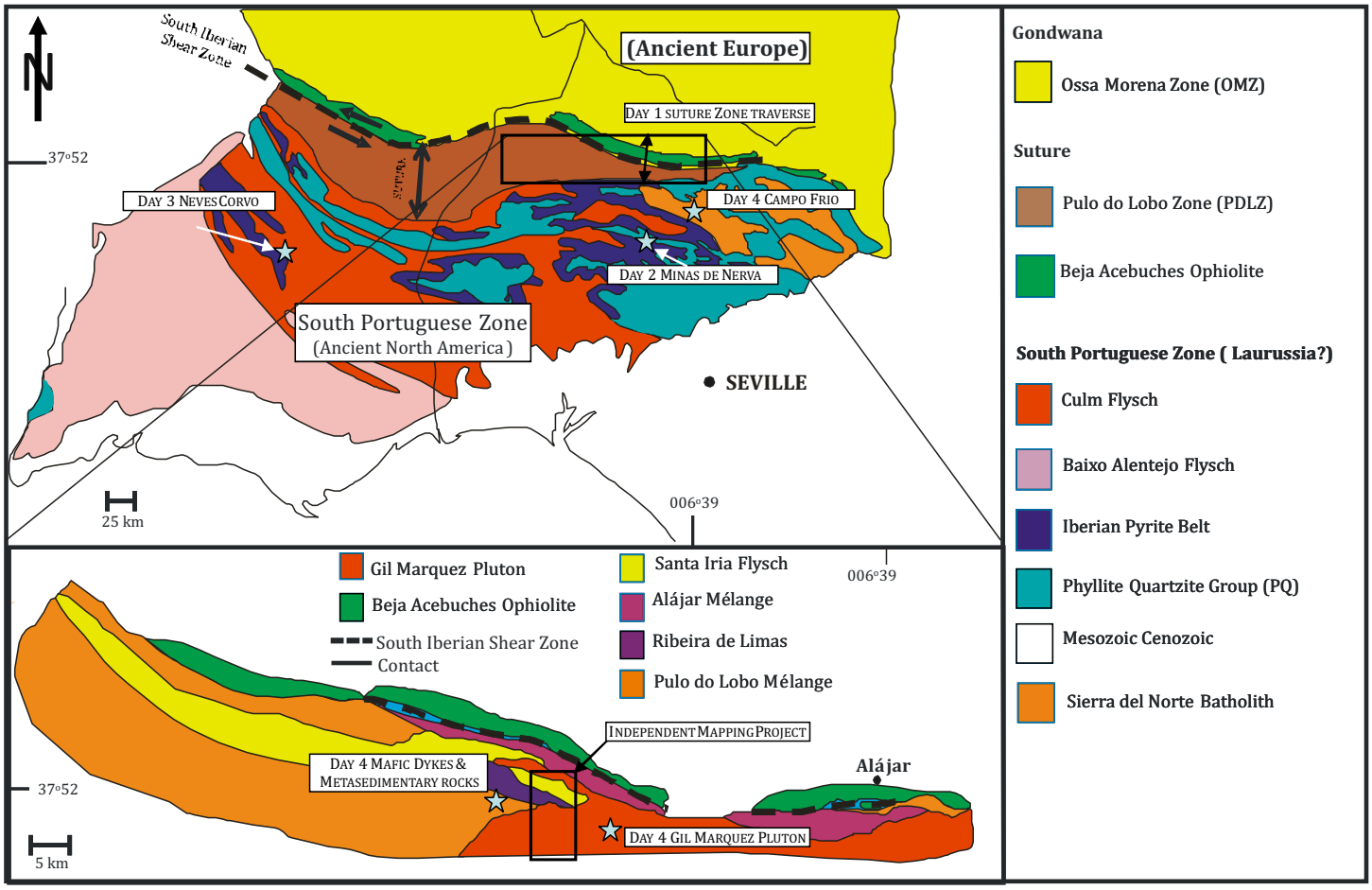
Feb 20th - Magmatism and deformation in an evolving orogeny: Igneous textures and magmatic systems evolution led by Dr. Donnelly Archibald

Feb 21st-24th - Independent Mapping project

StFX Earth Sciences students examining an outcrop along the Rio Alájar transect

Saturday February 17th, Day 1:

After a long travel day from Antigonish via Halifax, Toronto and Madrid, students arrived in Seville, Spain, and travelled by car to the field camp located near the town of Alájar, Spain. The first day focussed on observation skills, proper field note taking, basic geological field skills, and an introduction to some of the significant geological features of the region. The morning began with a short drive to the Pena Alájar (715 m elevation), that overlooks most of the significant geologic features of the area. Students then hiked the Alájar River for the remainder of the day.



Maps showing the regional geology of Southern Spain and Portugal, and the locations visited by the StFX Earth Sciences students

James Braid describing geological relationships to StFX Earth Sciences students

In pairs, students navigated a beautiful trail along the river to eleven stations with the overall goal of interpreting the geological story recorded in the rocks in the area. Students collected field data to create a map and geological cross-section of the area. The hike traversed the suture zone between ancestral North America and Europe in the heart of the ancient supercontinent Pangea over 300 million years ago.

StFX Earth Sciences students Sean Freeborne (left) and Colin Ross pause to take photos along the Rio Alájar transect

Sunday February 18th, Day 2:

On the second day, students were introduced to the geology of the Iberian Pyrite Belt near a copper mine in Rio Tinto, Spain. The field site, Minas de Nerva, is located in an area that has been mined since Roman times. The mine is located on the eastern side of the Iberian Pyrite Belt (IPB) of the South Portuguese Zone – the lower continental block that accreted to the Gondwanan (ancient European) margin during the formation of Pangea. The IPB hosts massive sulfides deposits with some of the highest concentrations of Cu and Zn in the world. These mines have produced gold, silver, copper, lead, tin, and iron.

The ore deposits are Volcanogenic Massive Sulfide (VMS) deposits; however, there are uncertainties as to the exact processes associated with the formation of the ore bodies and the host rocks that form an important part of the story of the ancient collision between North America and Europe. Students spent the day exploring the geology of the Minas de Nerva section, and mapping along a 2-km transect of the Rio Tinto river.

Students created a geological map detailing the geological history recorded in the exposed rocks. In the evening, students presented and defended their map and geological history. The Nerva section is an excellent example of the typical IPB stratigraphy, and contains a variety of rock types with interesting features (e.g. pillow basalts; bimodal volcanism) and well-preserved contacts that provided important clues about the tectonic evolution of the area.

StFX Earth Sciences MSc student Lori Paslawski introducing the geology of Nerva

View of the ancient mine workings at Nerva

Monday February 19th, Day 3:

On day three, students travelled to the Neves-Corvo mine in Portugal. Half of the students went underground to learn about the underground mining processes with Neves Corvo chief geologist Nelson Pacheco, and the other half of the students toured the processing plant at the surface. The mine extends to ~1000m below the surface and there are >200km of roads underground!

A Canadian Company (Lundin Mining) owns the Neves-Corvo mine and the local Portuguese company Somincor operates it in the western part of the IPB. The morning began with a safety briefing and an introduction to the geology of the area. Students learned that the Neves-Corvo VMS deposits occur within the volcanic-sedimentary complex that consists of felsic volcanic rocks separated by shale, and a discontinuous black shale horizon that is located immediately below the sulfide (ore) lenses. Thrust-faults duplicate the stratigraphy of volcano-sedimentary and younger sedimentary units that complicates mining and exploration in the area. The whole assemblage was folded into a gentle anticline oriented NW-SE that plunges to the southeast, resulting in ore bodies distributed on both limbs of the fold. At Neves-Corvo, they are actively mining in four of the six ore bodies that they have discovered.

The students who visited the underground mining operations travelled to a depth of 600 m to look at actively mined faces of the massive-sulfide lenses, and to witness the underground rock-crushing station in action!

StFX staff and students at the Neves Corvo Mine, Portugal. Dr. Donnelly Archibald (back left), Dr. James Braid, Pat Hamilton, Caleb Grant, Andrew Flower, Sean Freeborne, Lauren Walker, Colin Ross, and Garrett Merz. Shelby Park (front left), Bailey Malay, Talia Bobenic, Olivia Pushie, Mary Besaw, and MSc student Lori Paslawski.

The other students experienced a tour of the on-site ore processing plant that mills and separates the ore into concentrates that the mine exports to smelters in China and elsewhere in Europe. Both the underground and surface tours were an amazing opportunity for students to get a taste of an active mine environment. The geologists and metallurgists who guided the students were exceptional and answered any questions asked by the students. They also allowed the students to collect rock samples in the mine to take as souvenirs of their experience.

In the afternoon, students attended a presentation about the exploration, mining, and ore processing that currently takes place at Neves-Corvo. Although this is currently one of the largest Cu-Zn mines in the world, the exploration team is actively searching for new deposits in the region.

StFX Earth Sciences students ~600m underground at the Neves Corvo Mine, Portugal

StFX Earth Sciences student Caleb Grant and Dr. Donnelly Archibald examine core at the Neves Corvo exploration facility

This unique opportunity offered insight into the operations of a large mine. The presentation was followed by an equally unique visit to their core library led by Neves-Corvo's head exploration geologists. Student examined over 1 km of core over the course of the afternoon. Interestingly, the core was stratigraphically equivalent to the rocks that the students mapped at Nerva during the previous day.

Tuesday, February 20th, Day 4:

On the fourth day, the students visited three outcrops that recorded magmatism associated with the formation of Pangea. The first stop, the Campo Frio pluton, displays textbook examples of magma mixing and mingling textures. Students were tasked with applying the concepts learned in their igneous petrology classes to unravel the sequence of intrusive events. These textures are interpreted to represent the injection of one magma into another. Some geologists posit that these processes occurring at depth are triggers for volcanic eruptions or ore deposit formation.

At the second stop, the Gil Marquez pluton, the students described a granite pluton emplaced concurrently with the collision between Laurussia and Gondwana. The textures preserved in the plutonic rock indicate shallow emplacement and deformation before the magma was crystalline. The final stop was a stream outcrop of gabbro dykes near Gil Marquez. Students examined the field relationships to determine that the dykes represent the last gasps of magmatic activity in the area.

Magma mingling textures at Campo Frio

StFX Earth Sciences students examining the Gil Marquez pluton

February 21st-24th, Days 5-8:

The final three days of the advanced geological field methods course involved students working independently on a geological map of the Alájar region. Students worked in pairs to collect field observations, rock descriptions, and structural measurements while traversing the Rivera de los Baños.

The region consists of similar rock types to those observed on the guided field days, as well as many new and interesting geological relationships that provide tangible examples of the processes and relationship the students have learned about in their undergraduate courses. The students were tasked with creating a geological map of the area and to write a report discussing the rock types, rock relationships, structural geology, geological processes, and overall tectonic history of the area. Upon returning to StFX, the students defended their maps and reports in an oral exam administered by the course instructors.

StFX Earth Sciences students Andrew Flower (left), Pat Hamilton, Garrett Merz and Caleb Grant examine an outcrop in the independent mapping area

StFX Earth Sciences students enjoying an early morning coffee in Castro Verde, Portugal near the Neves Corvo Mine. From left to right, Colin Ross, Caleb Grant, Patrick Hamilton, Andrew Flower, Garrett Merz, Sean Freeborne, Lauren Walker, Olivia Pushie, Talia Bobenic, Bailey Malay, Mary Besaw and Shelby Park

Thank you again to our major donors: Dr. David Palmer (Probe Metals), Lundin Mining, PDAC, Kinross Gold, the StFX Dean of Science and StFX VP Research and the StFX Department of Earth Sciences.