Summary of SEG Field Course: Ore Deposits of Northern Chile

The latest international field course organized by the New Mexico Institute of Mining and Technology SEG Student Chapter took place during January 8th through 13th of 2017. Students from New Mexico Tech and Stanford University were joined by faculty from NMT as well as exploration geologists from Rio Tinto and First Quantum Minerals for visits to epithermal and porphyry ore deposits of northern Chile. The NMT SEG Student Chapter would like to thank the Stewart R. Wallace Fund award committee for their support and Dr. William X. Chávez, Jr. for leading an exceptional and informative trip.

Our course began with a visit to the artisanal Comahue copper mine, where students and professionals observed the characteristics of andesite-hosted copper oxide ores and were led in geochemical discussions by Dr. Chávez. Comahue is a structurally-controlled deposit with very erratically distributed chrysocolla-atarcamite-specularite mineralization making the mineral distribution in this type of mineralization difficult to model. Dr. Chávez also discussed the origin of this mineralization and the economics of such an operation.

Following Comahue, the course visited the historic mine Cerro Alcaparosa. This area still contains significant and extremely rare coquimbite and copiapite, mined for its use as a leachate for copper. This location brought into discussion favorable environments for specific mineral groups based upon their solubility and stability in arid environments.

![Outcrop of purple coquimbite hydrating to yellow copiapite.](image)

The newer Gabriela Mistral deposit provided an excellent opportunity to observe how technology is playing an ever-growing role in mine safety and economics. Gabriela began operations in 2014, allowing for the mine to use automated haul trucks, substantially improving the safety conditions of operations. Dynamic leach pads are also utilized at Gabriela, increasing the recovery of copper in their SX/EW facilities. A geologic overview, provided by chief geologist Claudio Nicolas and geologist Jacob Espinas, provided an excellent glimpse into the unique geology of the Gabriela deposit. The porphyry system is hosted by several episodes of intrusions, surrounded by Precambrian metavolcanics, and situated in an alluvial plain with minimal outcrop.
What makes this deposit uncommon in northern Chile is the poorly developed supergene enrichment. After a geologic and safety review, the group viewed portions of the operations, including the automated haul trucks, dynamic leach pads, and core review.

Lauren Megaw of Stanford University diligently making her way through the core review at Gabriela Mistral.

Elizabeth Deboné provided our group with an exceptional explanation of the geology at the Chuquicamata deposit on January 10th. This site is a world class deposit, and host to one of the largest open pits in the world. Chuquicamata’s elongated oval shaped pit is due to the Domeyko fault system the porphyry used as a conduit. The hypogene grades here are spectacularly high due to the multiple fluid enrichment events. Chuqui’s mill and smelter are fed by surrounding mines, allowing them to convert to underground operations without shutting down production. Following the mine visit, we were provided a tour of the old town of Chuquicamata. We were given an exquisite telling of the town history, including the fact 40% of the town is now covered in waste piles from the mine.

A park in the old town of Chuquicamata is still maintained for tours. Waste pile from the mine are viewed in the background.
The Rodomiro Tomic mine provided an excellent core review and discussion of indicators for exploration of Cu mineralization. Examination of the supergene profile through core review led to discussions about Fe-oxides from chalcocite and adsorption of Cu onto Mn-oxides. The mineralized porphyry at Rodomiro Tomic is hosted by a Permo-Triassic granodiorite that has been weakly metamorphosed.

The Sierra Gorda mine is another recently explored and developed operation. Due to its high Mo content, the mine made no plans to recover supergene Cu, and instead built a mill to recover hypogene Cu and Mo. Andrés Molina, chief geologist, provided a very detailed explanation of the Sierra Gorda geology, including mineralization and alteration. A variety of felsic intrusions hosts the mineralization at Sierra Gorda, surrounded by an andesitic country rock. The discussion of mineralization was tied to alteration at Sierra Gorda, which possesses a variety of alteration beginning with propylitic zones in the country rock extending to and argillic cap within the porphyries. While there is variety in alteration, it grades downward rapidly to very minimal alteration.

The course ended with a visit to the Nahuallon project, a Cu porphyry deposit with significant supergene Cu-oxide mineralization of chrysocolla-brochantite and rare dioptase. The deeper supergene profile consists of chalcocite-covellite assemblages. The hypogene is hosted in monzonite to diorite intrusive porphyries, and surrounded by lower Jurassic-age andesites. The course was provided an extensive tour of the property, ending with a core review of the supergene Cu-oxides.

Core review of the significant Cu-oxides present at Nahuallon.

All of the student members of the NMT SEG Student Chapter would like to thank Dr. Chávez, the professionals in attendance, and especially the Stewart R. Wallace Travel Fund committee for their support in providing such a productive and memorable field course.
Professional Participants

Dr. William X. Chàvez, Jr.-NMT, course leader
Dr. Navid Mojtabai-NMT
George Steele-Rio Tinto
Santiago Arnillas-First Quantum Minerals
Saul Brena-First Quantum Minerals
Sergey Kuzin

Student Participants

Samantha Caldwell* NMT
Francizska Stopa * NMT
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Lauren Megaw-Stanford University