Tectonic and climatic controls on porphyry copper enrichment in the Central Andes

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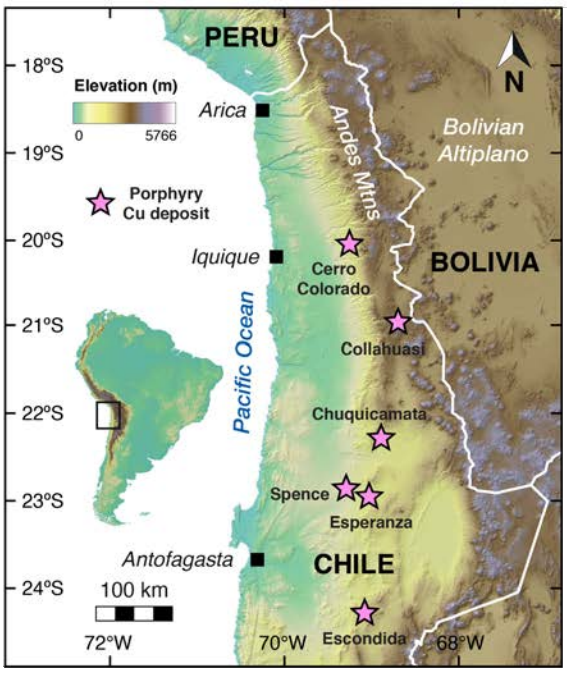
Background

Porphyry copper deposits (PCDs) are the world's principal commercial source of copper. Formed from metal-bearing hydrothermal fluids associated with granitic batholiths, they are typically found in convergent plate margin settings, such as northern Chile in the Central Andes. Although these systems begin their life a few kilometres deep in the crust, erosion and tectonic activity exhume them to the surface, where they interact with oxygenated groundwater. Chemical reactions between sulphide minerals and this oxygenated water create acid that leaches the copper and reprecipitates it in an enriched "supergene blanket" of ore. This process can more than double the copper content of a deposit, making supergene zones a primary target for mineral exploration.

Northern Chile hosts some of the largest and richest supergene blankets in the world (notably the huge Chuquicamata and Escondida deposits) and yet the area lies in the Atacama Desert, one of the driest places on Earth. The onset of this dry climate is thought to relate to uplift of the Andes mountains, which created a rain shadow on their western side. This raises fundamental questions about how and when supergene enrichment occurred, when and why it stopped, and how regional changes in tectonics, climate, sedimentation, and hydrology might have affected mineralisation.



Left: *Major porphyry copper deposits in northern Chile on the western margin of the Andes mountain range.*

Above: *Bristol PCD Group PhD students Ed Bunker and Simon Dahlström collect samples in the Atacama Desert.*

Project goals and methods

This PhD project will investigate the roles of tectonic uplift, exhumation, and climate on supergene enrichment along the western Andean margin in northern Chile. In this area, extensive deposition of fluvial gravels proximal to major sites of mineralisation offers an opportunity to place spatial and temporal constraints on patterns of exhumation, transportation, and deposition of igneous material related to PCDs.

Project goals include:
(1) Conduct a detrital provenance study of gravels using U-Pb geochronology and (U-Th)/He thermochronometry.
(2) Use numerical modelling to constrain the exhumation history of igneous clasts in the gravels, from emplacement at depth to exhumation and fluvial transportation on the surface.
(3) Relate patterns of exhumation and deposition to regional tectonic and climatic constraints.
(4) Determine how these patterns may affect the formation and preservation of enriched PCDs.

CASE award

This is a CASE project with the global mining company BHP Billiton. Over the course of the project, the student will work in Chile working on mine properties owned by the company and visit the Copper exploration group in Santiago.

The Bristol PCD Group

BHP Billiton has a close relationship with the University of Bristol through its sponsorship of the Bristol PCD Group (bristolpcd.org). The group is focused on investigating the links between volcanism, petrology, tectonics, geomorphology, and mineralisation. It currently comprises 4 academic staff members, 2 dedicated post-doctoral researchers and 5 PhD students, as well as many national and international collaborators. The student will join the Bristol PCD Group, and have the opportunity to attend regular "This Week In Copper" discussion meetings.

Necessary skills and interests

The project will provide research training in field skills, analytical techniques, and numerical analysis. Applicants should be prepared to work at high elevation in remote and rugged terrain, have a strong interest in large-scale continental tectonic systems, and a willingness to master a number of quantitative techniques.