PIMS - Porphyry Indicator Minerals

MDRU
MINERAL DEPOSIT RESEARCH UNIT

PREDICTING MAGMATIC FERTILITY & DETECTING HYDROTHERMAL ALTERATION WITH PORPHYRY INDICATOR MINERALS (PIMS)

A COLLABORATIVE INDUSTRY-MDRU RESEARCH PROJECT

The Opportunity

MDRU's successful porphyry indicator minerals (PIMS) research has established the viability for some resistate minerals to be exploration tools that can contribute to the discovery of porphyry copper systems. These initial findings provide confidence that the specific characteristics of various PIMS can be utilized to contribute to exploration decision-making, particularly for covered deposits, in both hypogene and supergene environments. In much the same way that diamond exploration benefited from knowledge of relative proportions of accessory minerals, and the presence of G10 garnets, we propose that similar indicators of fertility and mineralization can also be established for porphyry deposits.

Primary Objectives

This project will create new tools and screening criteria that will aid in the discovery of new, unexposed porphyry mineralization and will generate new strategies for exploration. To achieve this, we will characterize the occurrence, type, composition, and diagnostic properties of a range of resistate minerals such as apatite, titanite, rutile, zircon and magnetite from various settings within the porphyry environment, for numerous key deposits. There are two key objectives:

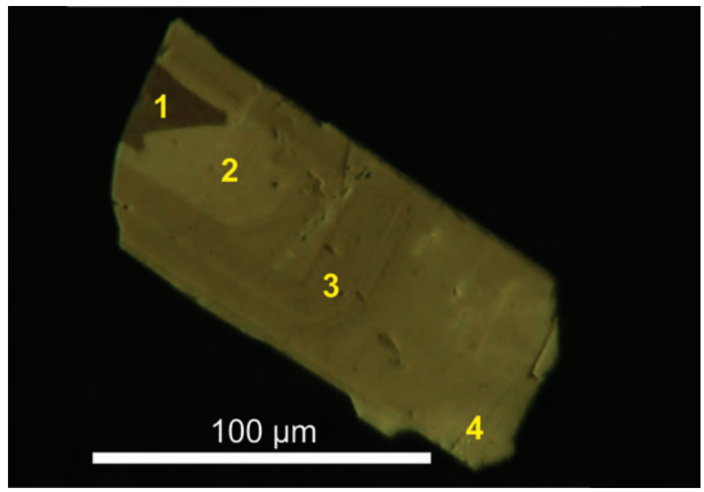
(1) Establish those primary **magmatic fertility indicators** that record formation of porphyry deposits.

(2) Determine those **hydrothermal alteration indicators** that record porphyry related alteration.

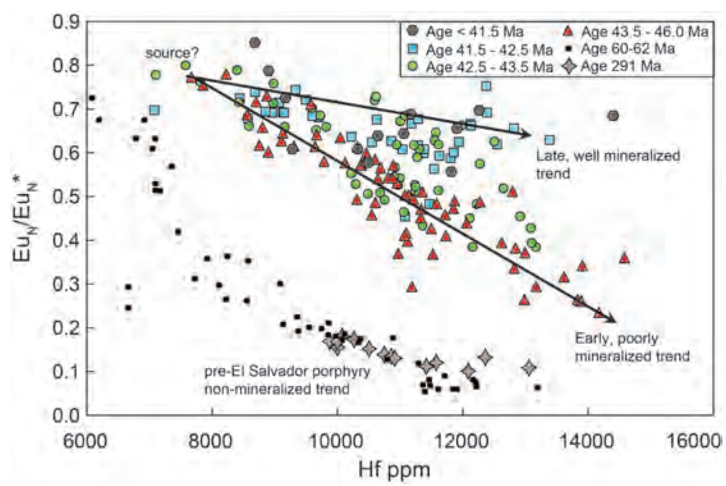
DURATION: 3 years

INITIATION: March 2019

SPONSORS: Sponsorship available now



Subtle changes in apatite zones are revealed by cathodoluminescence (CL). The dark brown core [1] to pale-green rim [4] with intervening alternating green to greenish-brown bands [3] is evidence of magma processes and changing magmatic chemistry. Chlorine and sulphur contents show depletion trends, indicating creation and partitioning of these elements into a hydrothermal fluid capable of producing porphyry copper deposits (Bouzari et al., 2016).



Hf content of zircon can be a proxy for magmatic fractionation and cooling whereas Eu can be a proxy for oxidation state. Combined, they can be a powerful indicator of fertility and mineralizing potential, as shown for the El Salvador district in Chile (from Lee et al., 2017). These textural and chemical changes can be exploited to identify porphyry fertile plutons.

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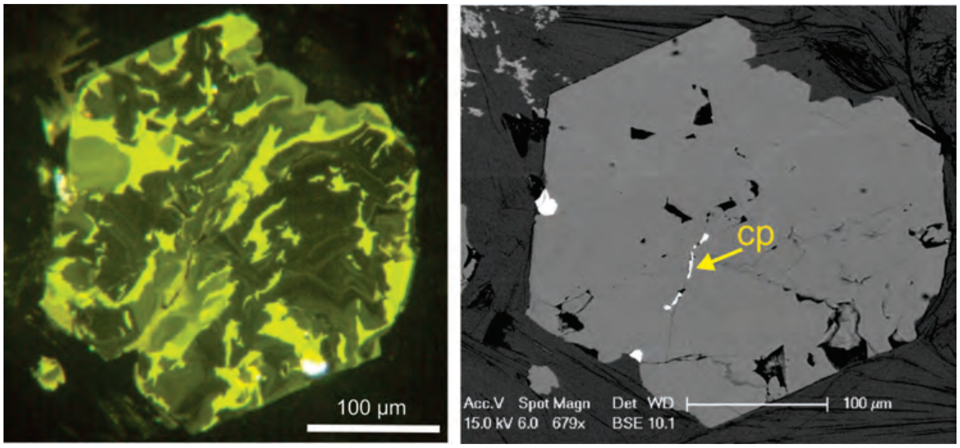
Research Approach

Mineral Texture and Chemistry - Apatite, zircon, titanite, magnetite and rutile are common resistate minerals in porphyry systems occurring across a wide range of host-rocks and alteration assemblages. New findings on the texture and composition of these minerals provide excellent opportunity to develop these features into a robust exploration tool. Cathodoluminescence and SEM imaging provide essential textural clues to the geochemical evolution of the plutons and host rocks. **These features have the potential to identify and perhaps even measure key parameters such as oxidation state, temperature, water, chlorine and sulphur content** that are necessary for the formation of porphyry copper deposits (Ballard et al., 2002; Wainwright et. al., 2011; Shen et al., 2015; Dilles et al., 2015; Bouzari et al., 2016; Lee et al., 2017).

Localities - The project will focus on several sites with well-constrained geology. MDRU has in-house collections from numerous global porphyry deposits, but final site selection will benefit from sponsor input and interest. Porphyry systems from the Andes, southwestern US, BC, Central Asian Orogenic Belt, and Tethyan belts are currently under consideration.



Comparison of CL (left) and SEM image of an apatite grain from a strong phyllic alteration zone of the Highland Valley deposit emphasizes the usefulness of the techniques. CL shows that green luminescent apatite of the K-silicate alteration is overprinted by grey luminescent apatite indicative of the more acidic fluids of phyllic alteration (from Bouzari et al., 2016). The SEM image of the same grain lacks all textural information related to alteration and emphasizes the folly of other studies not utilizing CL.

Project Team

Dr. Farhad Bouzari
Research Associate
MDRU

Dr. Craig Hart
Director
MDRU

Dr. Alan Wainwright
Research Associate
MDRU

Dr. Robert Lee
Research Associate
MDRU

Contact

For more information:

Farhad Bouzari
fbouzari@eoas.ubc.ca

Craig Hart
chart@eoas.ubc.ca

Industry Partnership

This will be a three year project, starting March 2019, with multiple within-project deliverables. Since the project has already been initiated and components are well-developed, several deliverables will be forthcoming in year one. Industry participation in this project is $50k CAD annually, depending on the number of sponsoring companies.