

Department of Earth Science and Engineering, Imperial College London and Department of Earth Sciences, Natural History Museum

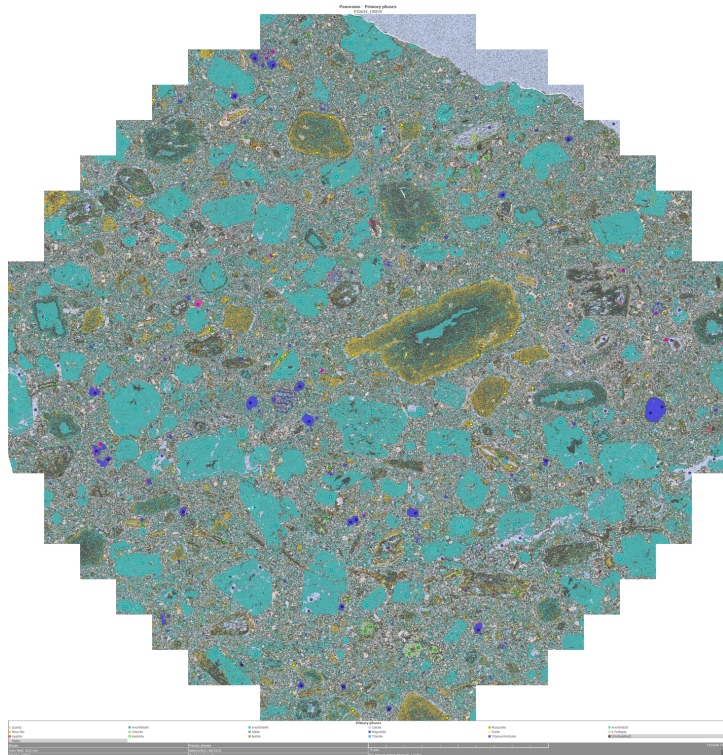
PhD Project 2024

Developing a chemical audit approach for characterisation of mine site material: implications for magmatic and hydrothermal transport, critical element recovery, environmental impacts and waste repurposing

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AIM The aim of the project is to develop and test an analytical workflow that will enable integration of bulk and grain-scale analytical techniques to deliver a self-consistent chemical and mineralogical characterisation of mine site materials. This workflow aims to mineralogically and chemically characterise mine sample materials as completely as possible, particularly in terms of: (1) geochemical tracers of igneous and hydrothermal processes; (2) potential by-product elements and minerals that could be targets for recovery; (3) hazardous and deleterious

elements/materials that could induce negative environmental and community impacts; and (4) contaminant elements that may impact economic viability of the repurposing of waste materials.



TESCAN TIMA automated SEM mineral map of a porphyry sample from the Dizon Cu-Au porphyry system, Philippines. Points selected for major, minor and trace element analysis are shown by coloured dots. Resin mount is 25 mm diameter.

BACKGROUND Governments, including in the UK, now recognise that society must respond urgently to the increasing pressures on natural resources - in particular because of the dependence of low carbon energy production on a diverse array of metals. To meet this challenge, society must discover and develop mineral resources in a sustainable way and our proposal aims to make a contribution to these important objectives. We will use cutting-edge technology in a multidisciplinary study to help develop a better understanding of Earth processes and their importance to mineral discovery, mineral processing, critical metal residence and disposal/use of waste. The project will help to maintain and enhance the London Centre for Ore Deposits and Exploration (LODE), the leading academic research unit in the UK tackling mineral resource geoscience and. The project

addresses the following UKRI skills gaps: modelling, multi-disciplinarity, data management, numeracy, translating research into practice and fieldwork.

OBJECTIVES AND METHODS

The proposed study will develop what we call a *chemical audit* in which we aim to quantify, as far as possible, the mineralogy of the sample and the mineralogical residence of each element and its relative abundance in each mineral as a proportion of its total abundance in the complete sample. The resulting audit should be self-consistent in terms of bulk geochemistry, bulk mineralogy and mineral crystal-chemistry. This study will initially be applied to porphyry copper mineral systems but can ultimately be extended to any other kind of ore deposit type. A proof of concept study as part of a NERC-DoST (Philippines) PPD grant successfully demonstrated the principles of the approach which combines: (1) conventional 'complete characterisation' bulk rock sample analysis of ~60 major, minor and trace elements; (2) X-ray diffraction (XRD) and thermogravimetric analysis for bulk mineralogy; (3) mapping and quantification of grain-scale mineralogy using digital petrographic imaging and automated SEM mineral mapping (TESCAN TIMA); and (4) microanalysis of mineral compositions using scanning electron microscopy energy dispersive spectroscopy, electron probe microanalysis and laser ablation ICP-MS. Mineral zonation in terms of trace elements will be investigated using LA-ICP-MS mapping. Ultimately, bulk sample properties estimated from grain-scale analysis will be reconciled with the bulk, meso-scale analyses. The implications of the results for understanding igneous petrogenesis and hydrothermal transport, discrimination of fertile mineral systems, and the residence of critical and hazardous metals in rocks will be explored.

STUDENT PROFILE We are looking for a well-qualified and highly motivated Earth Sciences/Geology graduate who wishes to carry out a cutting edge PhD in economic geology/mineralogy/geochemistry and gain experience in a range of mineralogical and geochemical analytical methods. Excellence in geochemistry and mineralogy are essential; experience of microanalytical techniques and statistical data evaluation, including data analytics are desirable. A desire for involvement with the Imperial Student Chapter of the Society of Economic Geologists and outreach activities will be beneficial.

TRAINING The successful student will join the London Centre for Ore Deposits and Exploration (LODE) research group in the attractive environment of South Kensington, London, that includes researchers from University College London, Imperial College London and the Natural History Museum. The student will have the opportunity to work in the state-of-the-art analytical suite at the NHM. The student will receive training in field mapping, core logging and sampling, laboratory best practice, SEM techniques, laser ablation ICP-MS instrumentation and analysis, data reduction and statistical analysis. Attendance and presentation of results at major UK and international conferences will be supported in the research programme. All postgraduates have access to transferable skills workshops at Imperial College and additional professional development and public engagement opportunities at NHM. Attendance at regular seminars on ore geology, geochemistry and the wider Earth Sciences is required.

FUNDING Funding for the project scholarship will be via a successful application by the student to the NERC SSCP DTP, TARGET Mineral Resources CDT or other scholarships programme at Imperial College London. Additional research funding will be provided by the project partner. Applications for further support for conference and workshop attendance will be made to the Society of Economic Geologists student grant program.

FURTHER INFORMATION If you are interested in the project and would like to have further details please contact Jamie Wilkinson at j.wilkinson@nhm.ac.uk

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