Petrogenesis of gold in shear zones, a case study of hydrothermally altered rocks in the Southeastern Desert, Egypt

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Key Words
- Geology, geophysics, mineralization, Egypt, economic geology

Overview

The exposed Egyptian Pan-African basement complex occupies an area of about 100,000 km² and occurs mainly in the Eastern Desert, Egypt, forming a rugged belt extending the full length of the Red Sea coast. The Eastern Desert of Egypt has been mined for gold since ancient times and nearly 95 historical mines have been identified in the region (e.g. El-Ramly et al., 1970; Hagag and Abdelnasser, 2021; Hume, 1907; Marten, 1986; Sabet et al., 1976). In particular, the Daghbag and Bakriya districts, situated in the central block of the Egyptian Eastern Desert, are mainly composed of Precambrian ophiolite mélange (serpentinites, metagabbro, mafic metavolcanics, and metasediments) and island-arc metavolcanics that have been intruded by syn-tectonic (quartz-diorites and granodiorites) and post-tectonic granitoids (monzogranites and syenogranites). These units have subsequently been cut by dykes and quartz veins, which form in alteration zones (Fig. 1).

Understanding the petrogenetic processes that lead to gold formation in this region is critical for improving exploration techniques and extraction efficiency. Remote sensing is key technique that can be used to identify lithological units, geological structures, and different hydrothermal alteration zones associated with various mineralization types. Geophysical data play a great role in mineral exploration through the detection of alteration zones associated with mineralization.

This project aims to (1) decipher the petrogenesis of gold mineralization and physico-chemical conditions of gold precipitation based on geochemistry, petrology, and fluid inclusion analysis and (2) perform geophysical work to delineate the surface and subsurface structures, and locate shear zones that control gold mineralization in the region. This work will focus on designing best practices for integrating geological and geophysical data in a region with abundant and easily accessible gold-bearing, shallow-level shear zones, which occur in many Proterozoic and Archean terranes worldwide.

Methodology

A student working on this project will gain experience in the following tools and techniques:
- Field work, structural mapping and identification of mineral assemblages and deformation fabrics in the field
- Optical microscopy
- X-ray fluorescence (XRF) analysis
- Scanning-electron microscopy (SEM)
- Electron probe micro-analysis (EPMA)
- Fluid inclusion analysis using a freezing-heating stage
• Geophysical methods (e.g. element boundary mapping and depth estimates from seismic data, CET grid analysis for mineral exploration and structural interpretation across area using RTP grid, and modeling of the depth and geometry of magnetized ore bodies).
• Analyzing remote sensing data (e.g ASTER data) to map lithological units and hydrothermal zones.

Timeline

Year 1: Doctoral training courses, literature review, fieldwork planning, fieldwork and sample collection, sample characterisation, and laboratory training.

Years 2 and 3: Follow-up fieldwork. Microanalytical work (XRF, SEM, EPMA), isotope geochronology (LA-ICP-MS), and petrological modelling. Data compilation and interpretation. Presentation of results at domestic and international conferences.

Year 4: Data integration, thesis completion, write papers for submission and publication in scientific journals.

Training & Skills

The successful student will join the Hard Rock research group at the University of Oxford, UK, which has a long-standing history of research excellence in metamorphism, magmatism, and metallogeny. They will also have the opportunity to integrate with faculty at external institutions and industry partners at annual career fairs.

The student will be trained how to conduct a field campaign, how to prepare and characterise geological thin sections, and perform advanced petrological and geochemical analyses of igneous and metamorphic rocks. This will include hands-on work with SEM, EPMA, and LA-ICP-MS equipment in both Oxford and with partners at the British Geological Survey. Training will also be provided on how to conduct geochemical and petrological modelling of metamorphism, anatexis, and melt crystallization.

The student will also be mentored on how to prepare scientific results for presentation at international conferences and how to write papers for publication in high-profile, international journals.

References & Further Reading


Further Information

Applicants may contact any member of the supervisory team for further information:

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