Tracing the effects of the Neoproterozoic oxygenation event on the redox state of the Mozambique ocean and associated sub-arc mantle

Overview

The Neoproterozoic is a critical era in Earth history, during which there were many dramatic climatic, tectonic, and biological shifts. In particular, the breakup of Rodinia and subsequent formation of Gondwana represent significant chapters within the supercontinent cycle. Further, the Neoproterozoic Oxidation Event (NOE: 800–540 Ma), which led to oxygenation of the deep ocean (Fig. 1), paved the way for the evolution of Eukaryotes and the appearance of animals. Further, the pervasive dispersal of oxygen accompanied by deep-ocean oxia is thought to have changed the redox state of the sub-arc mantle at convergent plate margins, which are the most geologically active sites on Earth today (Kelley and Cottrell, 2009).

Alongside BIFs, Alaskan-type complexes are remnants of the roots of island arcs and form at the crust–mantle boundary through partial melting of underlying mantle rocks (Jagoutz and Schmidt, 2013). Their mineralogy can therefore be used to assess the redox state of the sub-arc mantle wedge. The Eastern Desert exposes three main Alaskan-type complexes (Genina Gharbia, Akarem, and Dahnib) that host Cu-Ni-PGE bearing sulfides. Generally, the complexes demonstrate concentric zonation patterns, with ultramafic cores of peridotite and outer rims of gabbroic rocks. They are of Neoproterozoic age and display varied temporal positioning relative to the NOE. In this work, BIFs and ultramafic units of Alaskan-type complexes in Egypt will be studied to provide high-resolution constraints on the timing and extent of the NOE and its record within the ANS.

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)
- Laser ablation multi-collector inductively coupled mass spectrometry (LA MC-ICP-MS)
X-ray Absorption Near Edge Structure (XANES)

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, ICP-MS, XANES spectroscopy) for Fe^{3+}/ΣFe, measuring Cr isotopes, and acquiring Re-Os isotope signature of the ultramafic rocks.

Year 4: Data integration, thesis completion, papers for international journals/conference presentation.

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 rocks. This will include hands-on work with SEM and EPMA equipment in Oxford and with LA-ICP-MS and synchrotron techniques in nearby facilities. 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


Khedr et al. (2020) Formation of banded chromitites and associated sulphides in the Neoproterozoic sub-arc deep-crustal magma inferred from the Alaskan-type complex, Egypt. Ore Geology Reviews, 120, 103410.

Further Information

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