Fully funded PhD studentship

Developing a new model for the emplacement of magmatic sulphide megabreccias in the Zambezi Supracrustal Sequence

Host institution: University of Leicester

Key words: Mineralisation, sulfides, magmas, conduits, Ni-Cu-PGE

Supervisory team: Dr Dave Holwell (University of Leicester dah29@le.ac.uk), Dr Tiffany Barry (University of Leicester), Prof Adrian Boyce (SUERC) and Mr Simon Purkiss (Consolidated Nickel Mines)

Project Highlights:

- Working at the interface of research and industry to test new models for how Ni-Cu-PGE sulfide breccias are formed
- Fieldwork in Zambia, including experience of exploration and mining techniques with industrial training
- Join an active research group with world-class research into mineral deposits with links to industry

Overview:

Magmatic sulfide deposits (MSD) are the world's primary source of Ni and PGE, and major producers of Cu. One of the most prospective geological locations for magmatic Ni-Cu-PGE sulfide deposits are conduit systems above and below magma chambers. Most traditional models involve sulfide formation at depth, with them being swept *up* into their current position. However, new models for sulfide breccia formation in conduits involve *downward* movement of sulfide liquids [1], which require a major shift in approach towards ore genesis and exploration models.

The Munali Ni deposit, Zambia, is a conduit-hosted ultramafic megabreccia with massive sulfide matrix [2]. It is located close to a craton margin; a setting recently identified as highly prospective for the development of MSDs [3], within the Zambezi Supracrustal Sequence (ZSS). Traditional models have advocated upward movement of magmas and sulfides, but recent reassessment of this may reclassify the model for formation. This project will redefine the model for ore genesis and represent the first systematic study ever to be undertaken on the Munali deposit, with major implications for the interpretation of similar deposits worldwide.

The aims are to:

(1) Develop a robust model for magmatic emplacement and ore genesis that can help define further resources in the ZSS.
(2) Determine the role of crustal contamination in ore genesis and characteristics,
(3) Investigate the distribution of ore metals along strike and down dip to identify feeder zones and magma pathways.
(4) Define implications for exploration for other magmatic intrusions in the region using a range of geochemical proxies for sulfide mineralisation
(5) Provide new constraints on emplacement dynamics for this type of deposit.

This project is a superb opportunity for a student to apply a wide range of techniques in economic geology research to industrially-relevant problems. It will provide the student with excellent employability skills applied to a career in either research or the minerals industry.

Fieldwork around the Munali mine in southern Zambia, just a few hours' drive from Victoria Falls.

Methodology:

This project will use integrated field work, mineralogy, geochemistry, and S isotope analysis.

Fieldwork. Field relationships will be mapped underground and logged from extensive drill core. Sampling will take place during two field seasons in Zambia, supported by the on site mining team.

Labwork at Leicester. The project will employ a multi-technique approach, undertaking aplied mineralogy and geochemistry.

Labwork at SUERC. The student will spend time at SUERC under the supervison of Prof Boyce, undertaking S isotope training and analysis to directly address aim 1.

Training and skills:

Students will be offered 45 days training throughout their PhD including a 10 day placement. In the first year, students will receive training as a single cohort on environmental science, research methods and core skills. Throughout the PhD, training will progress from core skills sets to master classes specific to the student's projects and themes.

Additional training in the core technical methods for the project will be available from the supervisory team and colleagues at Leicester (LA-ICP-MS, microprobe, SEM); and at SUERC (stable isotopes).

International conferences and workshops will provide opportunity for further project-specific and wider scope training.

Key skills that will be developed include industry- and research-appropriate: fieldwork; sampling; geochemical analysis; mineralogical analysis; petrography; and data management.

The student will receive specific industry training whilst in the field with Consolidated Nickel Mines; including full safety training. Technical skills will include core logging, underground mapping, field mapping, soil sampling for geochemical analysis, and training in the use of GIS software packages.

Partners and collaboration:

Consolidated Nickel Mines are a UK-based company that own the Munali Nickel Mine in Zambia. They will provide financial and logistical support, and embed on-site industrial training in Zambia, and office-based training in the financial and business side of the mining industry in their London office.

Simon Purkiss is a metallurgist involved in the development of new metallurgical process to treat difficult or challenging metallurgical problems.

Dave Holwell is an expert in the application of applied mineralogy and geochemistry to the study of magmatic sulfide deposits, with a particular focus on southern Africa.

Adrian Boyce is Professor of Applied Geology at SUERC, where he has run the NERC Isotope Community Support Facility since 1992. He has been a leader in mineral deposit and applied stable isotope research in the UK and beyond for over 20 years.

Possible timeline:

Year 1: Literature review of Ni sulfide deposits and regional geology. Field season in Zambia for sample collection, mapping and field training with Consolidated Nickel Mines.

Year 2: Analysis of Munali deposit samples and development of geochemical and mineralogical characteristics. Isotope analysis at SUERC. Second field season to follow up initial results and sample regional exploration targets.

Year 3: Development of models for emplacement, the origin of magmas and the prospectivity of the regional targets. Placement in the London office of Consolidated Nickel Mines.

The student will present their work at international and UK conferences.

Further reading:

[1] Barnes SJ, Cruden AR, Arndt N, Saumur BM (2015) The mineral system approach applied to magmatic Ni-Cu-PGE sulphide deposits. Ore Geology Reviews.
[2] Begg GC, Hronsky JAM, Arndt NT, Griffin WL, O'Reilly SY, Hayward N (2010) Lithospheric, Cratonic, and Geodynamic Setting of Ni-Cu-PGE Sulfide Deposits. Economic Geology, 105, 1057–1070.
[3] Evans, DM. 2002. Geodynamic setting of Neoproterozoic nickel sulphide deposits in eastern Africa. Applied Earth Science, 120, 175-186

Further details:

At Leicester you will interact with one of the most prominent economic geology research groups in the country, with links to industry and other research groups worldwide. Leicester are the lead organisation in the NERC-funded, multi million pound TeaSe project, which the student will become part of.

Applicants should have some experience of economic geology, field work, geochemical or mineralogical research, preferably in magmatic deposits. Some industry experience is desirable, but not essential.

For more details on this project, or copies of the references, please contact Dave Holwell (dah29@le.ac.uk) or 0116 252 3804.