The dynamics of country rock assimilation and PGE mineralisation in layered mafic intrusions

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Closing Date

Midnight, 9 January 2022

Funding Status

Fully funded project

Eligibility

EU, EEA, Swiss and UK students only

About the project

Country rock assimilation exerts a primary control on the compositional and rheological evolution of crustal magma bodies; depending on the assimilant, it can trigger deviations in the liquid line of descent, add volatile elements (H2O, CO2, S) and/or alter oxygen fugacity (fO2). In volcanic settings, assimilation can impact the timing and style of eruptions, and in intrusive systems, it can play a critical role in the formation of intrusion-type ore deposits by inducing the saturation of sulphide minerals. This intrusion-type mineralisation is particularly important for Platinum Group Elements (PGEs), where it forms the largest deposit on Earth (the Bushveld Complex, South Africa).

Despite its first-order importance, the physical and chemical dynamics of country rock assimilation in magmatic systems remain poorly understood. Studying this process is inhibited by difficulty in detecting assimilation signatures using conventional petrological techniques and a paucity of study sites where samples can be spatially related to their assimilant source (e.g. determining their proximity to intrusion margins). This knowledge gap has major implications for our fundamental understanding of crustal magma evolution and inhibits exploration for intrusion-type mineral deposits.

This project will use the Carlingford Complex in the north of Ireland as a natural laboratory to study the physicochemical dynamics of magma assimilation. The complex includes a Palaeogene layered gabbro suite which has been eroded to produce excellent exposure of the magmatic stratigraphy. It is surrounded by a variety of country rocks and previous studies have identified well-preserved petrological evidence of contamination extending from the intrusion margins into its interior. The Irish Palaeogene intrusions represent one of the most prospective sites for PGE mineralisation in Europe and preliminary exploration has identified elevated PGE concentrations associated with the Carlingford gabbros. Specifically, the project will:

- Establish whether assimilants move from magma chamber margins into their interiors by passive diffusion or reactive porous flow through geological/geochemical mapping and petrographic analysis of Carlingford country rock contacts.
- Quantify spatial variations in the amount of assimilation through the Carlingford Complex, determining whether country rock contaminants are localised at intrusion margins or well-mixed throughout the magma body using bulk-rock and in situ trace element and isotopic analyses.

- Develop a new petrological tool to identify sulphide-saturated crystallisation from trace element analyses of silicate minerals.
- Correlate sulphide saturation with the concentration/type of country rock contamination to determine how assimilation impacts intrusion-type PGE mineralisation.

By spatially tracing country rock contamination and sulphide saturation throughout a well-exposed layered mafic intrusion, the project will improve our fundamental understanding of magmatic processes and place new constraints on the genesis of intrusion-type PGE deposits, informing future minerals exploration.

The student will undertake several field seasons in the north of Ireland (Co. Louth) to geologically/geochemically map the Carlingford Complex and collect samples. Full training will be provided in all necessary analytical and modelling techniques at Trinity College Dublin and the University College Dublin, including SEM, LA-ICP-MS, TIMS and XRF. This PhD forms part of the SFI Critical-Ireland project. The student will work closely with other members of the Critical-Ireland team to integrate their results and achieve the projects broad objective of understanding the fundamental magmatic processes which generate PGE mineralisation. Results will be communicated to industry through the iCRAG consortium.

We seek an enthusiastic and motivated individual to undertake this project within the active Geochemistry research group at Trinity College Dublin. The applicant should have a strong background in Earth or physical sciences, including a BSc, MSc or MSci in a relevant subject. No specific laboratory or modelling experience is required but the applicant should have some prior knowledge of igneous petrology. Experience in fieldwork, geochemical analysis and/or data manipulation is desirable.

For all enquiries, please contact Dr Michael Stock, Michael.Stock@tcd.ie.

Application procedure

To apply, the following documents should be submitted to Michael.Stock@tcd.ie in advance of the closing date:

- A personal statement, demonstrating the applicants experience and motivation for undertaking this project (max. 2 A4 pages).
- The applicants CV.
- Two academic references (these can either be submitted by the applicant or confidentially by the referees).

Shortlisted applicants will be invited to interview in February 2022 and will be informed of the outcome within one week. On receiving an offer, the successful applicant will be required to submit supporting documentation (e.g. degree transcripts) to the TCD Academic Registry.

Funding notes

This studentship is fully funded for 4 years by a Frontiers for the Future Project grant, supported by Science Foundation Ireland and Geological Survey Ireland. It is open to EU, EEA, Swiss and UK applicants only.

The project start date is September 2022 (or earlier by negotiation).

References

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