

Petrology of the first drill core profile intersecting the entire Bushveld Complex, South Africa

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Project Highlights:

- First petrological study of a complete, ~6km drill core profile across the Bushveld Complex
- Potential to constrain nature of a feeder zone to the Bushveld Complex
- Opportunity to study the most mineralised layered intrusion on Earth

Overview:

The Bushveld Complex of South Africa is the most mineralised layered intrusion on the planet. It hosts the Merensky, UG2 and Platreef which are located in the intrusion's Critical Zone and have been the object of numerous detailed studies. However, as yet, there is no complete profile of the complex studied at one locality. The present project is in cooperation with Ivanhoe Mines who are engaged in exploring the northern lobe of the Bushveld Complex since 2012. PalRho (an Ivanhoe Subsidiary) is currently drilling three 2km boreholes near Mokopane to intersect the entire intrusion. The company will make available for study more than 40000m of diamond drill core and associated assay data from adjacent properties and will facilitate a minimum of 3 months of field work and sampling in the intrusion during which they will host the student. The project will provide opportunities to improve our understanding of the stratigraphy and ore formation of the complex, thereby contributing to making exploration and mining of critical minerals (i.e. those that are essential to facilitate the green energy transition) more efficient.



Figure 1: Main magnetite layer in one of the Mokopane drill cores to be studied, using petrographic and geochemical methods.

Methodology:

The project goals will be achieved by logging and sampling drill core, and by analysing the composition of the rocks and their main constituent minerals. The student will use the state-of-the-art laboratories at Cardiff (CELTIC laboratory) and Exeter University. Key techniques include petrographic study of rocks using transmitted and reflected microscopy, mineral compositional analysis using EPMA and QUEMSCAN, chemical maps using FESEM and microXRF, whole rock major and trace element analysis using ICP-MS, in situ isotope analysis of minerals using multicollector-Inductively coupled plasma mass spectrometer (MC-ICP-MS), as well as geochronology by Triple quadrupole ICP-MS and Neoma™ Multicollector ICP-MS. The objective is to establish the petrogenesis of the intrusion and the lithological and chemical stratigraphy of the intersected sequence. We aim to involve the student in the design of the project, including bringing in his/her own ideas on the research direction.

Possible Timeline

Year 1: Literature review, logging and sampling of drill core, microscopic study of samples, 1 month of fieldwork in South Africa, preparation of samples for chemical analysis and beginning of geochemical analytical program. Reporting of initial results at MDSG (Jan 2027).

Year 2: Interpretation of analytical results, 1 month additional field work in South Africa to collect fill-in samples (August), preparation of 2nd batch of samples for analysis, reporting of results at an international conference (mid 2028) and MDSG (Jan 2028).

Year 3: Interpretation of data, writing of thesis, writing of manuscripts for publication, presentation of project results at an international conference (mid 2029).

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

Through interaction with the partner company and the supervisors, the PhD student will be trained in research methodology, mineral exploration techniques, and a variety of petrological, analytical and modelling techniques (petrographic microscope, ICP-MS, FESEM, Laser ICP-MS, microXRF, EPMA, thermodynamic modelling software such as MELTS). He/she will spend 5% of his/her time demonstrating in the School of Earth and Environmental Sciences and thereby gain teaching experience, which is essential when planning an academic career. Further training will be provided through attendance of national and international conferences.

Partners and collaboration (including CASE):

The student will interact with Ivanhoe staff during field work in South Africa. Ivanhoe will provide access to their field areas and >40000m of drill core and matching analytical data and train the student

in drill core logging, sampling, and field mapping. The company will also contribute £1,000 pa to analytical support. The student will interact closely with co-supervisor Dr. Hannah Hughes at Exeter who will provide training in QUEMSCAN and electron microprobe analysis and contribute to supervision in the form of regular in-person and virtual meetings.

Further reading:

Cole, J., Finn, C.A. and Webb, S.J., 2021. Geometry of the Bushveld Complex from 3D potential field modelling. *Precambrian Research*, 359, 106219

Kinnaird, J. A. and McDonald, I., 2018. The northern limb of the Bushveld Complex: a new economic frontier. *Society of Economic Geologists Special Publication*, 21, 157-176.

Maier, W.D., Barnes, S.J., Godel, B.M., Grobler, D. and Smith, W.D., 2023. Petrogenesis of thick, high-grade PGE mineralisation in the Flatreef, northern Bushveld Complex. *Mineralium Deposita*, 58(5), pp.881-902.

Further details:

Please visit <https://target.le.ac.uk/> for additional details on how to apply.

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