Petrology of a new 2 km long drill core into the Mokopane gravity anomaly of the Bushveld Complex, South Africa

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Project Highlights:

- First study of a new 2km drill core into the largest gravity anomaly of the Bushveld Complex
- Potential to study a mineralised feeder zone to the Bushveld Complex
- Opportunity to constrain petrogenesis of 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. In contrast, the magma feeder zones to the intrusion remain unknown. Feeder conduits to mafic intrusions have high mineralisation potential, eg Voisey's Bay/Canada, or Noril'sk/Russia. The present project is in cooperation with Ivanhoe Mines who are engaged in exploring the northern lobe of the Bushveld since 2012. PalRho (an Ivanhoe Subsidiary) is currently drilling a 2km borehole into the centre of the Bushveld's largest gravity anomaly, with the aim to test whether the anomaly reflects a mineralised magma feeder zone. 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 understanding of ore formation, thereby contributing to making exploration and mining of critical minerals (i.e. those that are essential to facilitate the green energy transition) more efficient.

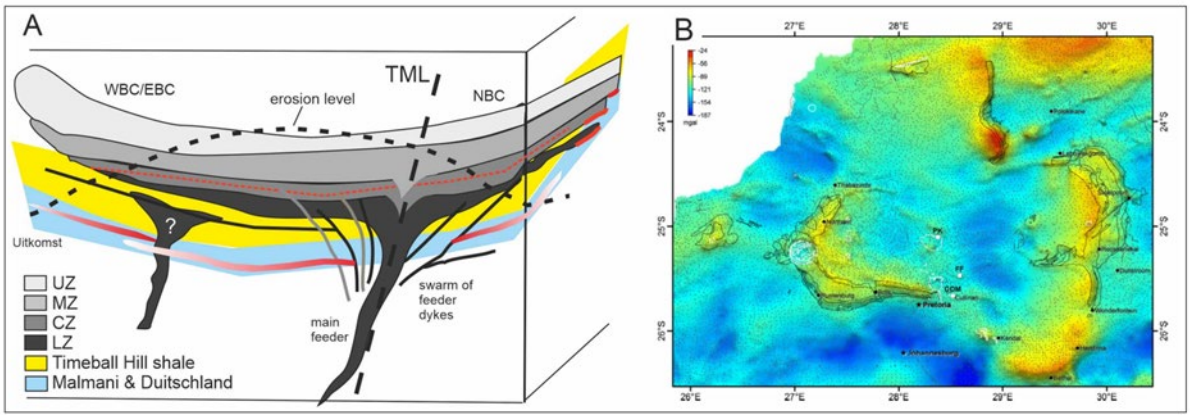

Figure 1: (A) Sketch showing model of potential feeder zone (Maier et al. 2022). (B) Gravity map of Bushveld Complex. Note largest anomaly near Mokopane, at southern tip of the northern lobe (Cole et al. 2014).

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, 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 2026), and 15th International Platinum Symposium in Perth, Australia (September 2026).

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 2027) and MDSG (Jan 2027).

Year 3: Interpretation of data, writing of thesis, writing of manuscripts for publication, presentation of project results at an international conference (mid 2028).

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 international conferences, notably the International Platinum symposium in Perth, Australia, in 2026, SGA in Colorado 2025, and MDSG meetings.

Partners and collaboration (including CASE):

The student will interact with Ivanhoe staff, including Principal Geologist Tim Dunnett, 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 some field mapping.

The student will interact closely with co-supervisor Prof. Jens Andersen 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 WD, Brits A, Grobler D (2022) Mineralised sills in the floor of the northern Bushveld: evidence for trans-crustal sulfide entrainment. SAJG, https://doi.org/10.25131/sajg.125.0019

Further details:

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

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