Projects with Prevec 2020

Bushveld Complex mineralization

I am interested in petrogenetic processes in layered intrusions, particularly those relating to the origins of oxide and sulphide mineralization. These studies normally involve microscope petrography, and geochemistry (major and trace elements, sometimes PGE data, and occasionally radiogenic isotope data). Connections with Glencore (Cr, Pt and V in western and eastern lobes) and with Ivanhoe (Flatreef deposit, northern lobe) allow for a variety of possible projects involving the sampling and study of drill core from active mining areas. Core is available in the department representing sections of the Upper Critical Zone from the eastern and western Bushveld Complex, and additional samples can be acquired. Possible or ongoing projects include:

- The transition from Upper Critical Zone into Lower Main Zone, particularly across the Bastard cyclic unit and overlying mottled anorthosites, to examine the relationship between PGE and chrome enrichment and petrology.
- The relationship between oxide reefs and their leucocratic (‘anorthositic’, s.l.) footwalls
- Detailed studies of the Critical, Main and Upper Zones of the Bushveld involving collaborations with Dr Roger Scoon (consultant) and various industry partners.
- A collaborative project with Dr Nic Tonnelier (NMMU) is focusing on the relationship between carbonate contamination and oxide (chromite and/or magnetite) and sulphide (Cu-Ni-PGE) mineralization.

Past or ongoing student projects have included:

1. Siyasanga Dyan (2018-present) MSc student, Rhodes University, “Carbonate contamination and its implications for oxidation and ore formation in the Upper Critical Zone of the Northern Lobe, Bushveld Complex, South Africa”. Supported by CIMERA and Ivanhoe Minerals (Pty) Ltd.
3. Yogendran Arunachellan (2014-present) MSc student, Rhodes University, “Petrogenesis of MG chromitite reefs of the Critical Zone, western Bushveld Complex, South Africa”, supported by Glencore-Xstrata and funded by NRF grant to SP. (part-time; submission in early 2020 planned).
4. Darryn van Hyssteen (2017) MSc Rhodes University, “Petrology and geochemistry of magnetite V ores from the Upper Zone of the Bushveld Complex, Western Lobe”, sponsored by Glencore (NRF-funded).

Karoo magmatism: crystal suspensions and emplacement mechanisms

Changes in our perceptions of how mafic intrusion emplacement and crystallization processes occur have been developing over the past two decades, based on seminal studies of lava lakes, sills, impact melts, and layered intrusions. End-Karoo magmatism has been extensively studied in the extrusive phases (e.g., work by J.S. Marsh on Drakensburg & Etendeka basalts), but relatively little geochemical work has been done on the unmineralised intrusive rocks (i.e., everything other than the Mt Ayliff Complex; see above), apart from recent work on the Golden Sill by French and South African-based researchers. Recent work building on their database suggests that early crystallization, crystal compaction, and trapped liquid remobilization can be identified near the margins of Beaufort Group sills, which are distinctive inasmuch as they form so-called saucer-shaped sill complexes with steeply-inclined sections which offer unique exposures of gravity-controlled lateral processes in the
southwestern Karoo. A database is being established based on petrography, mineral chemistry, and geochemistry in order to constrain this relatively novel story.

Past student projects have included:

1. Dylan Molyneux (2018-2020) MSc student, Rhodes University, “Petrogenesis and multiphase emplacement of late-Gondwanan Jurassic sills, Karoo Supergroup, South Africa”.

Non-Bushveld magmatic ores: Cu-Ni-PGE sulphide and oxide ore mineral petrogenesis

Other studies of magmatic ores in which I have been involved have included research on the Bushveld-aged Uitkomst Complex (Mpumalanga), which hosts chromite and massive sulphide ores, the Mesoproterozoic Koperberg suite (Northern Cape), which hosts Cu ores, and the Jurassic Mount Ayliff Complex (Eastern Cape), which hosts Cu-Ni-PGE sulphides. I have suites of rock powders and thin sections for Koperberg pyroxenitic rocks which remain to be studied, thin sections from Mt Ayliff’s lobes which can be further studied, and all of these have the potential to be revisited and locally remapped. There is a strong possibility of collaboration on Mt Ayliff with Dr N. Tonnelier of NMMU, probably with emphasis on mineral studies relating to mantle sources. Other studies on these rocks could include mapping, petrology and modelling of contact metamorphism and magma emplacement models.

2. Bantubonke Ntsaluba MSc candidate, Rhodes University, “Petrogenesis of the Mount Ayliff Intrusion, Eastern Cape, South Africa”, sponsored by Vale Inc. (c/o Ian Fieldhouse).


4. Geoffrey Howarth (2013) Ph.D. student, Rhodes University, “A petrologic, geochemical and isotopic investigation into the origins of magnetite horizons in the Panzhihua Intrusion, Sichuan Province, China” (with Prof. Mei-Fu Zhou, Hong Kong University).

5. Yogendran Arunachellan (2013) Honours student, Rhodes University, “Geochemistry and mineral composition of massive magnetite ore vs. gabbroic host rocks from the Baima and Taihe layered intrusions, SW China”.


7. Sean Linkermann (2011) M.Sc. project; “Origins, evolution and metallogenesis of the Palaeoproterozoic Kemi Intrusion, Finland”, with Prof. Tuomo Alapieti (University of Oulu), supported by a grant from the Finnish Academy.


Other recent/ongoing projects with no current loose ends

**SCLM and/or depleted mantle in the Palaeoproterozoic: isotopic and geochemical evidence**

Palaeoproterozoic mafic magmatism is represented as dyke swarms, belts of fault-bounded sills, and variably-preserved flood basalts, with minor associated felsic magmatism (granitoids and rhyolites) across central Ontario (Canada), northern Finland, and the Kola Peninsula (Russia). In general, these are characterized by enriched radiogenic isotopic signatures, consistent with either modest crustal contamination by Neoarchaeon crust, or an enriched mantle source, possibly remelted subcontinental lithospheric mantle (SCLM). These intrusions are also typically leucogabbro-noritic, with poorly developed ultramafic components, and lack massive magmatic sulphides, although significant exceptions exist from the Russian and Finnish examples. Recent work on the Kemi and River Valley
intrusions suggests that depleted mantle was involved, possibly of boninitic origin, with crustal contamination deriving from relatively ancient crust implicated.

Above, sulphide-mineralised basal breccia zone, Dana Lake South showing, River Valley Complex, Canada. At right, fat, grey, old balding man saws up outcrop.

3. Sean Linkermann (2011) M.Sc. project; “Origins, evolution and metallogenesis of the Palaeoproterozoic Kemi Intrusion, Finland”, with Prof. Tuomo Alapieti (University of Oulu), supported by a grant from the Finnish Academy.

**Pseudotachylites, mylonites, impacts and ages**

Zircon ages are seen as incorruptible and unquestionable recorders of magmatic ages. However, evidence from rocks rendered geological complex by large bolide impacts and related shock metamorphism and crater evolutionary processes, combined with pre- and post-impact orogenic activities, demonstrate that misleading age-data can be produced, resulting in significantly erroneous geological interpretations of the geological history. Studies of regionally metamorphosed sills in volcanosedimentary rocks associated with impact heating and localised shearing are attempting to resolve these events and identify cryptic melting which has produced post-emplacement magmatic zircons and complex deformation textures.
Pseudotachylitic and/or mylonitic breccia in Drury Twp metaleucogabbro.

Veinlet of partial melt cross-cutting deformational fabric, Drury Twp metaleucogabbro.

1. John de Bruyn (2016-2020) MSc. student, Rhodes University, “Constraints on deformation and melting of the Palaeoproterozoic Drury Township leucogabbro, Southern Province, Canada”. With in-kind support from Laurentian University (Canada) and Wallbridge Mining (Canada).


Other projects

There are and have been various other student projects which don’t fall into any of my themes, such as those involving hydrothermal Cu-Pb-Zn sulphide ores, and several involving soil & groundwater contamination by Pb & Zn adjacent to mines and smelters; all of these were in Namibia.

In addition, one of my major themes hasn’t had an Honours project because of the nature of the sampling, but there are possibilities here too:

Evolution of impact melt sheets and their target rocks

These studies also fundamentally based on petrography, petrology and geochemistry, with a large component of thermal modelling of impact melt sheets. Most of this work is based on the Sudbury Igneous/Impact Complex in Canada, but there are some analogous features from the Vredefort impact which can be examined in a similar way. I have a sample suite of the “impact melt” rocks from Vredefort (rocks & thin sections), and additional sampling can be undertaken.

Prevec, Büttner, other coworkers