

Projects with Prevec

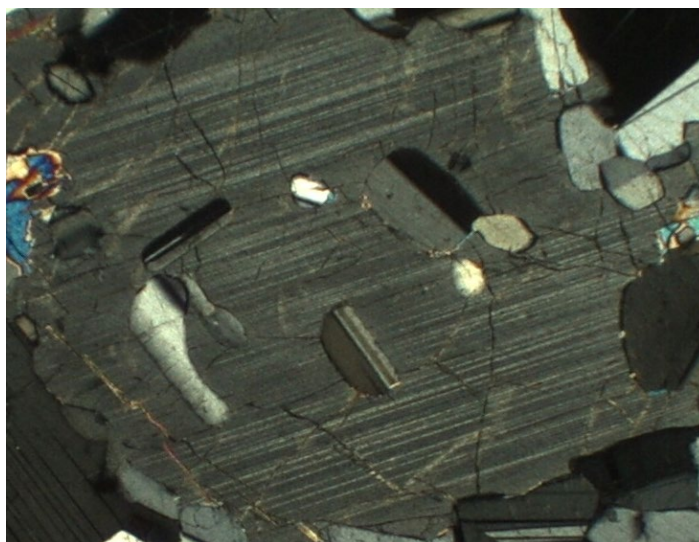
Bushveld Complex mineralization

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.



Irregular and delaminated chromitite with anorthositic footwall in core, MG-group, Eland Mine, W. Bushveld.



Resorbed plagioclase in orthopyroxene; evidence of disequilibrium in Merensky Reef footwall, Winnaarshoek, Eastern Lobe, Bushveld Complex.

Past or ongoing student projects have included (listed with year of completion/graduation):

1. Siyasanga Dyan (2020) 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.
2. Lasni Botha (MSc candidate) Rhodes University, "*Effects of the Steelpoort Pericline on the eastern margin of the Rustenburg Layered Suite in the Spitskop area*", supported/sponsored by BCR Minerals (Pty) Ltd.

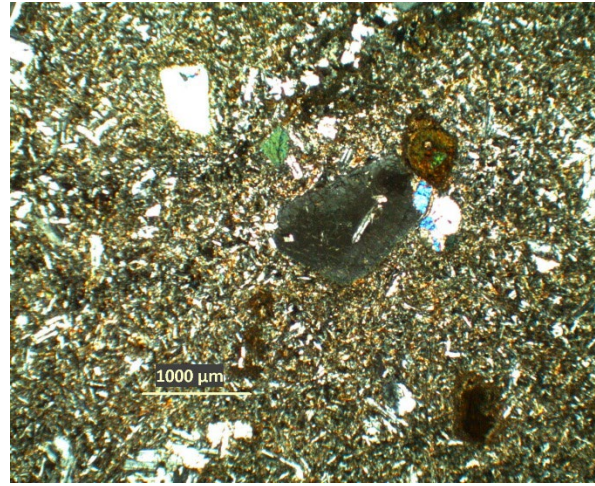
3. Yogendran Arunachellan (2020) MSc student, Rhodes University, "*Petrogenesis of MG chromitite reefs of the Critical Zone, western Bushveld Complex, South Africa*", supported by Glencore-Xstrata and funded by NRF grant to SP. (part-time; submission in early 2020 planned).
4. Darryn van Hyssteen (2016) 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).
5. Adina Iorga-Pavel (2016) MSc Rhodes University, "*Constraints on magnetite ore genesis, Bushveld Complex Upper Zone, Northern Lobe*", sponsored by Bushveld Minerals (Morris Viljoen).
6. Savvas Largatzis (2016) MSc Rhodes University, "*Constraints on the emplacement of PGE-chromitite reefs in the Upper Critical Zone, Bushveld Complex, South Africa*", sponsored by Glencore (NRF-funded).
7. Mark Raines (2015) MSc Rhodes University, "*Evolution of the Merensky Reef, Bushveld Complex, South Africa: isotopic and petrological constraints*".
8. Darryn van Hyssteen (2014) Honours Rhodes University, "*Petrology and geochemistry of magnetite ores from the Upper Zone of the Bushveld Complex, Northern Lobe*", sponsored by Bushveld Minerals (Morris Viljoen).
9. Savvas Largatzis (2015) Honours Rhodes University, "*Constraints on the emplacement of PGE-chromitite reefs in the Upper Critical Zone, Bushveld Complex, South Africa*", sponsored by Glencore (NRF-funded).
10. Devin Kaminer (2014) Honours student, Rhodes University, "*Petrogenesis of the Displat facies of the Platreef, Bushveld Complex, South Africa*", sponsored by Anglo Platinum (James Winch).
11. Simon Everitt (2013) Economic Geology MSc student, Rhodes University, "*Evolution of the UG2 unit, Bushveld Complex, South Africa: mineral composition and petrological evidence*".
12. James Cumming (2008) Honours student, Rhodes University, "*Influence of potholes and IRUPs on mineralised horizons, Kroondal Mine, western Bushveld Complex*", sponsored by Xstrata Mining (Mr Jan-Pieter Gräbe).

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.



North-dipping inclined Karoo sill in Beaufort Gp clastic sediments, Middelburg area.



Phenocrysts in chilled lower marginal rocks to dolerite sill, Colesburg area.

Past student projects have included:

1. Mr Ronald Samakomva (2024) Honours student, Rhodes University. "The quantification of igneous fabrics in Karoo sills and their implications for emplacement and crystallization mechanics: a case study from the Colesburg Sill, Eastern Cape".
2. Dylan Molyneux (2020) MSc student, Rhodes University, "*Petrogenesis and multiphase emplacement of late-Gondwanan Jurassic sills, Karoo Supergroup, South Africa*".
3. Dylan Molyneux (2017) Honours student, Rhodes University, "*Petrogenesis of a Jurassic Middelburg-area dolerite sill, Eastern Cape Province, South Africa*".
4. Mr Mawande Ntantiso (2016) Honours student, Rhodes University, "*A geological investigation into the paragenesis of the Jurassic-aged Colesburg Sill, Free State, South Africa*".
5. Kanyisa Sicwebu (2014) Honours student, Rhodes University, "*Petrogenesis of the Taylor's Koppe Dyke contact with Karoo sediments, Eastern Cape, South Africa*". Cosupervised with Dr P. Horváth.
6. Bantubonke Ntsaluba (MSc candidate), Rhodes University, "*Petrogenesis of the Mount Ayliff Intrusion, Eastern Cape, South Africa*", sponsored by Vale Inc. (Ian Fieldhouse).

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.



Cu-bearing breccia, Koperberg intrusions, Carolusberg mine, N. Cape Province.



Chromitite seam with pegmatoid in pyroxenite, Uitkomst Complex, Mpumalanga.

1. Edmore Marima (2022) MSc student Rhodes University, "*Cu sulphide ore petrogenesis and constraints on the role of sediment assimilation: Koperberg Suite, Northern Cape, South Africa*", cosupervised with Prof. S. Büttner, supported by O'okiep Minerals.
2. Kyle Smetherham (2016) Honours Rhodes University, "*Dyke interaction with pyroxenitic lower zone rocks, Uitkomst Complex, South Africa*".
3. 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. Kanyisa Sicwebu (2014) Honours student, Rhodes University, "*Petrogenesis of the Taylor's Koppie Dyke contact with Karoo sediments, Eastern Cape, South Africa*". Cosupervised with Dr P. Horváth.
5. 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).
6. 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. Gregory Viljoen (2012) Honours student, Rhodes University, "*Genesis of the lower zone of the River Valley Complex, Canada, and implications for sulphide mineralisation*".
8. 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.
9. Salome Ashiwana (2007) Honours student, Rhodes University, "*Emplacement mechanics of Koperberg intrusions, O'okiep area, Northern Cape*".
10. Alan Johnson (2007) Honours student, Rhodes University, "*Origins and metal potential of the Southern Cross Intrusion, Namibia*", sponsored by Remote Exploration Services (c/o Mr Dale Verran).

Clay mineralization in the Makhanda / Grahamstown region

End-Cretaceous kaolinitisation of upper Cape Supergroup and Lower Karoo Supergroup rocks, formalized as the "Grahamstown Formation", has been the subject of reconnaissance study more than 20 years ago. More detailed assessment of clay mineral distribution and its controls is of use to local clay mineral exploration and exploitation. Application of XRD facilities at Rhodes has allowed for more detailed evaluation of clay mineralogical variation and its relation ship to primary rock type

and depth from surface. Additional method developmental work is needed, in collaboration with the Dept of Chemistry at Rhodes and with Makana Brick.



1. Ms Gcinile Makhoyane (2023) Honours student, Rhodes University. "Assessment of XRD analysis of clays by glycolation: a study on Karoo tillite weathering".
2. Ms Anam Vuthu (2022) Honours student, Rhodes University, "*Transformation of the Dwyka tillite (Karoo Supergroup) into kaolinitic equivalents in the Grahamstown Formation, Makhandha area*".
3. Ms Anaye Pepu (2022) Honours student, Rhodes University, "*Transformation of Cape Supergroup (Lake Mentz Subgroup) rocks into kaolinitic clays in the Grahamstown Formation, Makhandha*".

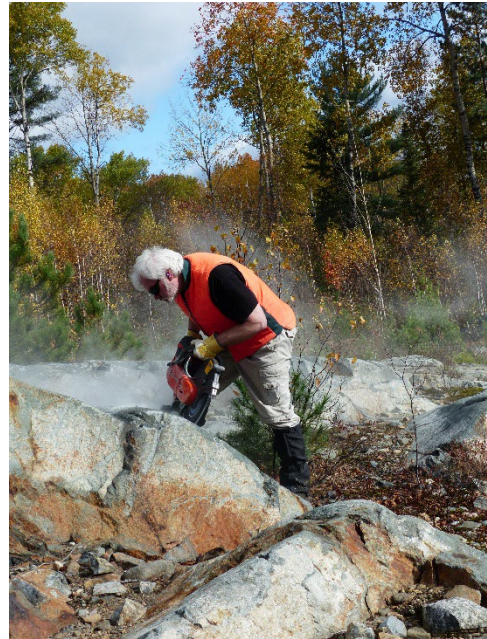
Other recent/ongoing projects with no current loose ends

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 leucogabbroic, 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.



1. Stephen Dorbor Jr (2016) Honours Rhodes University, *"Petrogenesis of the mineralised facies of the River Valley Intrusion, Grenville Province, Canada: evidence for boninitic parent magma"*.
2. Gregory Viljoen (2012) Honours student, Rhodes University, *"Genesis of the lower zone of the River Valley Complex, Canada, and implications for sulphide mineralisation"*.
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).
2. Bukelwa Nxesi (2011) Honours student, Rhodes University, "*Origins of pseudotachylitic breccia from the Sudbury contact aureole, and relevance to associated sulphide mineralisation*".