



## Department of Geology

### Overview

The Department of Geology's vision is the transformation of lives through a focus on quality rather than quantity in geoscience education and research. The Department hopes to achieve this vision through the development of our staff to provide high-quality, confident geoscience graduates that are capable of making positive contributions to the South African and international labour markets and who can act as drivers of change, through excellence in teaching, research and community service, and through relevant exposure of students to the world beyond the confines of the classroom. The permanent academic staff of the Department collectively has more than 200 years of relevant industry, research, and teaching experience. This collective experience is augmented by the utilisation of a number of affiliated industry experts

to ensure that students are provided with some of the best, most relevant and up-to-date geoscience education on offer in South Africa and on the continent. The Department offers undergraduate and postgraduate programmes up to PhD level in Geology, Geochemistry, Environmental Geology and Mineral Resource Throughput Management; the latter starting at NQF level 9 with our flagship MRTM degree that is offered to experienced industry professionals from a variety of backgrounds relevant to the mining and mineral beneficiation industries.

The year 2013 was a year characterised by continued high student numbers, an increased focus on research, and a number of staff changes. A total of 97 students enrolled for first-year modules taken as part of the undergraduate

programmes in Geology, Environmental Geology, and Geochemistry. Corresponding numbers for second-year and third-year modules were 106 and 112, respectively. Forty students enrolled for honours modules. A total of 55 students enrolled for modules as part of their MRTM studies in 2013. The Department additionally supervised one doctoral candidate and 12 research master's candidates over the course of the year. One hundred and seven degrees were conferred by the Department over the course of the year; with 65 students receiving BSc degrees, 33 honours degrees, four MSc degrees, and five MRTM degrees. The number of scientific articles and peer-reviewed conference proceedings generated by the Department increased significantly from previous years and we trust that this trend will continue through a focus on the recruitment of quality postgraduate students and the utilisation of scientifically productive research collaborators and affiliated researchers.

Staff changes included the appointment of Dr Frederick Roelofse as Head of Department in August and the retirement of Prof Marian Tredoux at the end of 2013. Prof Willem van der Westhuizen is thanked for his contributions to the Department throughout the 15 years as Head of Department and for having built the Department to what it is today. Prof Tredoux will continue to contribute to both teaching and research in the Department on a full-time contractual basis in 2014 and hopefully beyond. Mr Peet Roodt, control technician with more than 30 years' service in the Department, retired at the end of 2013. The Department wishes him well in his retirement. Mr Andries Felix was promoted to senior assistant officer in December 2013.

One of the highlights of 2013 was the handing over of the Department's new core storage facility in August, which was erected on the Main Campus at a cost of R1,4 million and that will be used to house drill core material for both teaching and research. The 472 m<sup>2</sup> building was made possible through donations received from the Minerals Education Trust Fund (METF) and AngloGold Ashanti Ltd. The continued support from both the METF and mining companies in general is a reflection of the contributions made by the Department to the mining industry through the education of geologists capable of making positive contributions to the industry and through research endeavours focused on solving problems facing the industry.

## Activities and Achievements

There was a busy start to the year, with the Department playing host to 60 scientists and students from seven of the country's geology departments attending the 5<sup>th</sup> Igneous and Metamorphic Studies Group Meeting that was held over the period 21 to 23 January. A total of 53 talks covering a wide range of topics were presented as part of the

conference. A number of delegates attended the conference field trip to Kimberley's Big Hole and to the Roberts Victor mine under the expert guidance of Dr Jock Robey.

From 7 to 8 March 2013, 18 honours students took part in an applied mineralogy excursion that included a visit to the Gold One Modderfontein East processing plant and Anglo American research laboratory, as well as an afternoon seminar at the University of Johannesburg with a number of invited speakers mostly from the industry. This forms part of the honours mineralogy module and a similar excursion has been arranged for this course since 2009.

The annual MRTM workshops were held in March and September 2013 in Pretoria. A new module, Virtual Mining Simulation, was introduced and was accepted well by the students. The number of students enrolling for the course is increasing despite a downturn in the mining industry. At the end of 2013 there were just over 70 students enrolled in the programme.

Honours students enrolled for the structural geology module attended a week-long short course in the Vredefort Dome over the period 18 to 22 March, presented by Prof W Colliston, where the students received practical training in structural mapping and geometric analysis.

First-year students visited Austins Post in the Edenburg district on 27 April, where they were introduced to a variety of sedimentary, igneous and metamorphic features occurring within the Beaufort group. They also visited the Jagersfontein district on 31 August, where additional instruction was given on the sedimentological interpretation of fluvial and deltaic deposits.

The MRTM team in association with the Southern African Institute of Mining and Metallurgy hosted and presented the first "Optimisation of mine value chain from resource to market" symposium during 7 to 9 May 2013 in Pretoria. The MRTM team comprising lecturers and affiliated lecturers presented eight papers during a very successful symposium.

The annual economic geology field trip for honours students took place in June under the guidance of Prof C Gauert, with students being exposed to eight mines and mineral processing facilities in KwaZulu-Natal over the duration of the seven day long field trip. The following commodities were focused on: dimension stone, cement/colour additives, coal, iron/steel, heavy minerals, and diamonds. In October, third-year economic Geology students visited the No. 2 and 3 shafts at Beatrix Gold Mine, where they were exposed to the realities of underground gold mining.

Ms J Magson visited Dr Iain McDonald at Cardiff University in July in order to perform PGE determinations as part of her Impala Platinum-sponsored MSc project aimed at quantifying variations in PGE tenor across the Merensky Reef in the Western Limb of the Bushveld Complex.

The Department of Geology hosted its second winter school for students in the MRTM programme from 8 July to 10 July 2013. Twenty-five students and delegates from the industry attended the school, which included practical workshops and a mini-symposium. Case studies on mining optimisation, change management in the mining environment, and report writing presented by Dr L Bergh were some of the topics covered during the school.

Dr F Roelofse was invited to attend a field conference in the Kiglapait intrusion, Labrador, Canada, between 27 July and 2 August. The conference was attended by a number of scientists and students active in the field of layered intrusions under the expert guidance of Prof Tony Morse (University of Massachusetts, USA), the “father” of the Kiglapait intrusion.

During the period September 2013 to November 2013 the MRTM team visited Total Coal Operations in Mpumalanga. The visits allowed an opportunity to introduce the MRTM methodology to the company.

Second-year students visited the Barkley East district over the period 21 to 25 September, where they underwent instruction on the principles of geological mapping and fieldwork techniques. They were also introduced to aspects of physical volcanology, sedimentology, stratigraphy, and structural geology as present in the upper parts of the Karoo Supergroup (Drakensberg, Clarens, Elliot, and Molteno formations).

Third-year students undertook a visit to the Vredefort Dome on 4 and 5 October as part of their metamorphic petrology module, where students were able to see the effects of tectono-thermal and impact metamorphism on a variety of protoliths.

Mr Al Odendaal was responsible for the organisation of a mini-congress aimed at undergraduate and honours students entitled “Geology at work”, which was held on 4 October. Several guest speakers delivered talks aimed at exposing students to a variety of aspects related to the geological profession.

Mr Al Odendaal, Dr H Praekelt and Profs W Colliston and A Schoch conducted a two day long reconnaissance field work trip to Namaqualand on 10 and 11 October as part of their research agendas and in order to prepare for the arrival of two new MSc students expected to join the Department in 2014.

Ms Megan Purchase (teaching/research assistant and MSc student) visited the German Research Centre for Geosciences (GFZ) in Potsdam from 19 October to 9 November in order to receive training on their newly-acquired Cameca 1280-HR secondary ion mass spectrometer. The Department continued negotiations with GFZ for the establishment of a remote node on the Main Campus from where users will be able to produce publication quality results without the need to travel to Germany to do so.

Mr Al Odendaal conducted field work in the Sutherland and Merweville districts on a number of occasions during 2013 as part of his MSc degree, which is aimed at elucidating the stratigraphic relationships of the Karoo Supergroup along the Great Escarpment. He also attended a number of Shell-sponsored short courses at Rhodes University where he was introduced to aspects of biostratigraphy and seismic interpretation applied to the analysis of sedimentary basins.

Prof C Gauert visited the Nkomati Nickel Mine in Mpumalanga twice to further his research efforts aimed at gaining a better perspective on the downdip geology of the deposit and the contact aureole of the deposit. He was also asked to present a lecture on the geology of the Uitkomst Complex to geologists working for the mine and also took the time to market the master’s degree in Mineral Resource Throughput Management. Prof Gauert was also invited to present a short course on the geology of the Uitkomst Complex to honours students at the University of Pretoria in October. He also attended a short course on the geology of India at the University of Pretoria.

Prof M Tredoux spent two weeks at the Eugen Stumpfl Electron Microprobe laboratory at the University of Leoben in August with her collaborator, Dr F Zaccarini, studying microscopic mineral phases present in the Bon Accord NiO body (Barberton Mountainland).

### Achievements of Students

Ms Bianca Kennedy, MSc student of Prof M Tredoux, was honoured as one of the best student presenters at the 5<sup>th</sup> Igneous and Metamorphic Studies Group Meeting that was hosted by the Department in January with a talk entitled “PGE nano structures in natural Ni-Cu-S systems”. Ms Jarlen Beukes, MSc student of Prof CDK Gauert was a recipient of a prestigious Erasmus Mundus scholarship, which allowed her to spend five to six months at the Karl-Franzens University of Graz in Austria, where she took advanced level courses in petrology and environmental geology and furthered her research into the petrology and geochemistry of the “brown sugar” norite at Two Rivers Platinum Mine, Mpumalanga, South Africa. Mr Pelele Lehloeny, who completed his honours degree with the Department in 2012, published the results of his honours project in the international journal, *Chemie der Erde*, an uncommon achievement for an honours student.

### Special Achievements

Prof M Tredoux was a collaborator on a paper entitled “Noble metal nanoclusters and nanoparticles precede mineral formation in magmatic sulphide melts” that was accepted for publication in the eminent journal, *Nature Communications*. Prof WA van der Westhuizen was invited to deliver a keynote address entitled “Mineral resource throughput management and the ‘zone’ ” at a conference of the Southern African Institution of Mining and Metallurgy held in May. Dr F Roelofse was selected onto the Vice-Chancellor’s Prestige Scholars

Programme, a programme aimed at accelerating the scholarship of young academics. He was also elected a co-opted committee member of the Mineralogical Association of South Africa.

## Community Service

The Department once again hosted the Free State leg of the Minquiz National Science Competition that was held on 8 May 2013. A total of 29 schools (mostly from the Free State), each represented by three learners, took part in the competition. The learners were also afforded the opportunity of visiting the departments of Chemistry, Physics and Geology in order to showcase what these departments have on offer for prospective students. Prof M Tredoux successfully raised funds from the Geological Society of South Africa Research, Education and Investment Trust Fund for an EarthWise intervention planned for 2014, which will see local teachers receiving geoscience appreciation and enrichment training.

## National and International Collaboration

The Department is active in the search for both national and international collaborators interested in addressing research questions relevant to both the South African and international contexts. Collaborative efforts are, however, not only focused on research, but also excellence in teaching and the exposure of students to some of the best analytical facilities the world has to offer. The Department currently has active collaborations with the following institutions and mining companies:

- University of California, San Diego, USA: Cr-isotopic investigations;
- University of the Witwatersrand, South Africa: Bushveld Complex research; and X-Ray-computed tomographic studies of vesicular basalts for palaeobarometric reconstruction;
- Natural History Museum (Berlin, Germany): Gold fingerprinting, Bushveld Complex research;
- GFZ (Potsdam, Germany): Bushveld Complex research;
- Institute of Geology (Czech Academy of Science, Czech Republic): Bushveld Complex and Uitkomst Complex research;
- Karl-Franzens University (Graz, Austria): Provisioning of joint postgraduate degrees;
- Council for Geoscience, Pretoria: Geochemistry of Hg in igneous rocks; geophysics of the Namaqua mobile belt;
- University of Gothenburg (Sweden): Geochronology of the Namaqua mobile belt;
- Harmony Gold: Rock mechanics;
- Impala Platinum: Bushveld Complex research;
- University of Leoben, Austria: Mineralogy of microscopic phases in the Bon Accord NiO body (Barberton Mountainland);

- Bonn University, Germany: PGM research; and
- Martin-Luther University of Halle-Wittenburg, Germany: Joint research/master's projects and mutual student internships.

## Postgraduate Students

Five students, four at MSc level and one at PhD level, participated in Phase 3 of the Inkaba ye Africa programme. Financial support to the tune of R121 000 was received to fund their research in 2013, to add to the R150 000 which was received in 2012.

## Research

Staff and students of the Department continued research in virtually all of the major sub-disciplines of the subject area. The major current research foci of the Department are: i) petrology, geochemistry, and mineralisation of the Bushveld Complex and associated intrusives (e.g. the Uitkomst Complex); ii) geology, sedimentology, and stratigraphy of the Karoo Supergroup; iii) stratigraphy, geochronology, and structural geology of the Namaqualand province; iv) gold fingerprinting; v) the geochemical behaviour of mercury in magmatic systems; vi) PGE geochemistry and mineralogy; vii) the Bon Accord NiO Ore body; viii) emerald gemmology; ix) experimental petrology in the system Ni-Cu-S-PGE; x) the relationship of pseudotachylite and its host rocks within the Vredefort Dome; and xi) soil geochemistry as a way to infer pollution vectors in urban areas.

The Department and MRTM students are also actively engaged in research related to the optimisation of mining value chains through the application of mineral resource throughput management principles.

Staff of the Department, most notably Prof Christoph Gauert, contributed to a successful bid towards an International Continental Drilling Programme (ICDP) workshop on the Bushveld Complex that will be held in Johannesburg in September 2014. The focus of the workshop will be the delineation of potential drilling targets in the Bushveld Complex, which, if funded, will see major research spinoffs being generated.

The Department is currently equipped with the following analytical infrastructure: i) JEOL JSM-6610 scanning electron microscope (SEM) with Thermo Scientific Ultradrly energy-dispersive and Magnaray wavelength dispersive X-ray spectrometers; ii) Panalytical Axios wavelength dispersive X-ray Fluorescence spectrometer; iii) Panalytical Empyrean X-ray diffractometer; and iv) a variety of light microscopes including a gemmological microscope and one set up for fluid inclusion microthermometric work that is equipped with a Linkam heating-cooling stage. The Department also has access to a variety of analytical instruments housed within the departments of Chemistry and Physics.



Mr Al Odendaal highlighting an upward coarsening cycle typical of deltaic environments to first-year students in the Jagersfontein district.



Third-year students examining pseudotachylite occurring within granitic gneisses of the Vredefort Dome, the largest known terrestrial meteorite impact site.



Excavations for the Department's new core storage facility. Prof W van der Westhuizen can be seen inspecting the excavations (middle, back).



Honours students on the annual economic geology field trip organised by Prof C Gauert at Richards Bay Minerals.



*Participants at the 5<sup>th</sup> Igneous and Metamorphic Studies Group meeting that was hosted by the Department in January 2013.*

# Research Outputs

## Research Articles

**Claassen, J.O.** 2013. Yield improvement at a mid-sized coal mine. *The Journal of the Southern African Institute of Mining and Metallurgy* 113: 761-768.

**Colliston, W.P. & Schoch, A.E.** 2013. Wrench shearing during the Namaqua Orogenesis – Mesoproterozoic late stage deformation effects during Rodinia assembly. *Precambrian Research* 233: 44-58.

**Gauert, C.D.K., Van der Westhuizen, W.A., Claassen, J.O., Viljoen, S. & Grobler, J.** 2013. A progress report on ultra-high-pressure waterjet cutting underground: The future of narrow reef gold and PGE mining. *The Journal of the Southern African Institute of Mining and Metallurgy* 113: 441-448.

**Helmy, H.M., Ballhaus, C., Fonseca, R.O.C., Wirth, R., Nagel, T. & Tredoux, M.** 2013. Noble metal nanoclusters and nanoparticles precede mineral formation in magmatic sulphide melts. *Nature Communications* 4: 2405.

**Lehloeny, P.B. & Roelofse, F.** 2013. Mercury distribution amongst co-existing silicates

within the Bushveld Complex. *Chemie der Erde* 73: 261-266.

**Mathur, R., Gauert, C.D.K., Ruiz, J. & Linton, P.** 2013. Evidence for mixing of Re-Os isotopes at <2.7 Ga and support of a remobilized placer model in Witwatersrand sulfides and native Au. *Lithos* 164-167: 65-73.

**Prinsloo, H.B. & Claassen, J.O.** 2013. The use of change management and behaviour-based training in an improvement project aimed at creating organizational sustainability in a multicultural mining environment in Zambia. *The Journal of the Southern African Institute of Mining and Metallurgy* 113: 747-759.

**Roelofse, F.** 2013. Comments on the paper 'Mineralogical and geochemical analyses of the healing elements in clayey soils from Isinuka traditional spa in Port St Johns, South Africa'. *Transactions of the Royal Society of South Africa* 68(3): 175-176.

**Roelofse, F. & Saunders, I.** 2013. A first report on meteor-generated seismic signals as detected by the SANSN. *South African Journal of Science* 109(5/6): Art. #0022.

## Chapter in book

**Coetzee, H., Kotoane, M., Atanasova, M. & Roelofse, F.** 2013. Interactions between dolomite and acid mine drainage in the Witwatersrand basin – Results of field and laboratory studies and the implications for natural attenuation in the West Rand Goldfield. In: *Reliable mine water technology, Volume 1*. Edited by A. Brown, L. Figueroa and C. Wolkersdorfer. Publication Printers: Denver, Colorado. pp. 307-312

**Gauert, C.D.K., Kotze, E., Beukes, J.J. & Giebel, H.** 2013. Reef disturbances of Critical Zone rocks of the eastern Bushveld Complex in the vicinity of the Steelpoort fault, South Africa – petrogenetic implications. *Proceedings of the 12<sup>th</sup> Biennial SGA Meeting: Sweden Mineral Deposit Research for a High-tech World Volume 3*, edited by E. Jonsson. Uppsala, Sweden, 12-15 August 2013. pp. 989-992.

**Guenther, C. & Gauert, C.D.K.** 2013. The spatial distribution and geochemical characteristics of the talc-carbonate alteration of the Uitkomst Complex. *Proceedings of the 12<sup>th</sup> Biennial SGA Meeting: Sweden Mineral Deposit Research for a High-tech World Volume 3*, edited by E. Jonsson. Uppsala, Sweden, 12-15 August 2013. pp. 993-996.

## Staff

**Professor:** Prof WA van der Westhuizen.

**Associate Professors:** Profs WP Colliston, CDK Gauert, and M Tredoux.

**Senior Lecturers:** Drs JO Claassen, HE Praekelt, and F Roelofse.

**Junior Lecturers:** Mrs J Magson, HCF Pretorius, and Mr AI Odendaal.

**Affiliated Academic/Research Staff:** Profs GJ Beukes, DE Miller, R Scheepers, and AE Schoch, Drs JC Loock, L Nel, PJ Pretorius, and H

Prinsloo, Messrs AC Dunne, PJ Grobler, PG Laurens, and MJAR Vrijens.

**Secretary:** Mrs PS Swart.

**Administrative Officer:** Mrs R Immelman.

**Technical Support Staff:** Messrs J Choane, A Felix, D Radikgomo, and PH Roodt.



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