

# DEPARTMENT OF GEOLOGY

## CONTACT DETAILS

Prof Bisrat Yibas  
Department of Geology

Faculty of Natural and Agricultural Sciences  
University of the Free State  
PO Box 339  
Bloemfontein  
9300 South Africa

T: +27 51 401 3080  
E: yibasbabsob@ufs.ac.za  
W: www.ufs.ac.za/geology

## OVERVIEW OF 2019

The Department of Geology is responsible for teaching and research in the geological sciences at the University of the Free State (UFS). The Department offers six undergraduate, three Honours, and four MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management [MRM]), as well as the PhD by research.

In 2019 the Department awarded a total of 75 degrees which includes 23 Honours, 10 MSc and one PhD. The Department enrolled 50 undergraduate students, 25 Honours students, 53 MSc students (36 in MRM, 17 in Geology, Geochemistry and Environmental Geology), and 7 PhD candidates in 2019.

## ACHIEVEMENTS

### Staff Achievements

Dr Matthew Huber was allocated a Y2-rating from the National Research Foundation (NRF). He also received a certificate of completion from the Planetary Science Engagement Institute after attending a workshop on 22 and 23 March. *Rosestad Radio* interviewed Dr Huber regarding the work that the Geophysical Research and Analysis of the Vredefort Impact with Timely Anthropological Studies (GRAVITAS) research group has undertaken. During the interview, Dr Huber responded to questions concerning the nature of the Vredefort Impact Structure, including how the impact itself formed, as well as how humankind utilised the structure through time, in particular the San people who engraved the Daskop Granophyre Dyke.

Ms Rinae Makhadi was awarded her MSc degree with a project titled 'Assessment of groundwater quality near two municipal solid waste landfill sites in Bloemfontein, South Africa'.

Ms Makhadi was also recognised for the inspirational work she is doing in the classroom as part of the Khotatsa project, which aims to appreciate the good work of UFS lecturers. Her recognition followed the nomination by one of her second-year Environmental Geology students for her extra effort in her lectures.

## TEACHING

The Geology Department offered six undergraduate programmes for the BSc majoring in Geology, Environmental Geology, Geochemistry, Geology and Geography, Geology and Chemistry, and Geology and Physics. The Department offered 17 undergraduate and 13 Honours modules, including a new module introduced in 2019 on 'Skills development and ethics for geoscience professionals' to equip our graduates with an industry-relevant practical edge. The Department's Honours programmes offer specialisation degrees in Geology, Geochemistry and Mineralogy, and Environmental Geology.

The modules presented by the Department attempt to integrate theory, laboratory and geological field investigations, and most include visits to mines and mineral processing plants, geoscientific laboratories or research centres. At the undergraduate level, the first-, second- and third-year students visited various geological sites to study the different geological aspects pertinent to the respective modules.

In the first semester, first-year undertook field excursions to Austin's Post (Edenburg district) as part of the Introduction to Geology module, and to Bankfontein (Jagersfontein District) in the second semester as part of General Geology and South African Stratigraphy module. The field school provided students with first-hand exposure to a variety of sedimentary structures as well as an introduction to stratigraphic relationships.

Second-year students attended the field school under the supervision of Adriaan Odendaal and Wayne Nel, during which they were involved in practical lessons in stratigraphic relationships, occurrences and origin of rocks, and the development of fieldwork skills such as the use of the geological compass, the mapping of rocks in the field and the construction of geological profiles and traverses.



Adriaan Odendaal explaining sedimentary aspects associated with channel deposits on the farm Bankfontein to second-year students

As part of their Environmental Geology module, second-year students undertook a field excursion in the second semester to the two municipal waste disposal sites in Bloemfontein. The field excursion provided students with practical lessons on some of the aspects that have to be considered when selecting solid waste disposal sites as well as some of the waste management issues that the city is currently facing.



Second-year students investigating the stratified nature of cross-bedded units associated with the Musgrave Member, south of Bloemfontein

Third-year students in the Economic Geology and Exploration Geology modules took part in a field trip to the Vredefort Dome and Tshepong Gold Mine. The students, supervised by Matthew Huber, Jarlen Beukes and Martin Clark, practiced field mapping, performed mining geology exercises in an open-pit mine, and went underground to observe the process of the mining of gold.



Economic and Exploration Geology students on a field trip in the Vredefort Dome

Third-year students in the Igneous Petrology module, under the supervision of Prof Frederick Roelofse, visited the Big Hole Museum in Kimberley to learn more about the geology of diamonds, diamond mining and diamond processing.

## RESEARCH

A US\$1.5-million grant was secured from the International Continental Scientific Drilling Programme (ICDP) for scientific drilling on the Bushveld Complex. The proposal was submitted by a group of international scientists coordinated by researchers from the GFZ German Research Centre for Geosciences, the University of the Witwatersrand, the UFS (Prof Frederick Roelofse), and the Friedrich-Alexander University in Germany.

An Interdisciplinary Grant was awarded for the research project titled 'GRAVITAS', which is run by the Impact Research Group that was formed by Dr Matthew Huber, Dr Elizaveta Kovaleva and Dr Martin Clark of the Department of Geology, together with Dr Francois Fourie from the Institute for Groundwater Studies (IGS) and Ms Liezel Blomerus from the Department of Anthropology. The GRAVITAS research team visited the Vredefort Impact Structure twice in 2019 as part of the group's intensive field investigation of the structure. From these two field trips, the research group have generated a number of manuscripts,

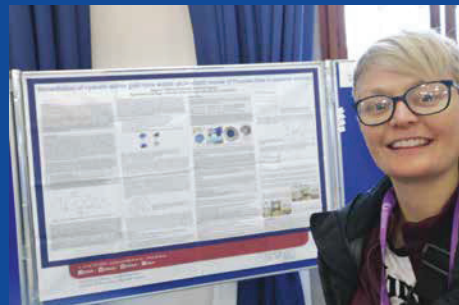
publishing two papers in 2019. They also created a webpage <https://www.ufs.ac.za/giving/donate-here-to-ufs/ia-projects/gravitas-grv>. Research related to GRAVITAS was published on numerous international forums, including *Fox News*, *Newsweek*, and *Sputnik France*, as well as in national news agencies such as *The Citizen* and *Rapport*.

Dr Robert Hansen researched the nucleation and precipitation of secondary minerals in sulfidic tailings facilities. The purpose of this research was to determine the required super saturation of these mineral salts, which are not in most cases taken into account in environmental risk assessments, but which can have a significant influence on the mobility of hazardous substances from the tailings into the surrounding environment. Dr Hansen submitted a paper to the *South African Journal of Geology*.

A project was initiated to determine the effect of climate cycles and weathering bedrock influences on the hydrogeochemistry of the natural streams in the Drakensberg. Samples were collected from the area and analysed. Environmental geology and geochemistry research projects were mostly focused on the determination of the geochemical processes responsible for environmental risks in sulfidic tailings facilities. Kinetic geochemical and process network (systems) modelling formed the cornerstone of this research.

A collaborative project with SAENSE (a biochemistry platform funded by the Technology Innovation Agency [TIA] and located at UFS) to roll out water treatment technologies, has been ongoing.

As part of her PhD study, Ms Megan Welman-Purchase undertook research on the stability of Prussian blue and Turnbull's blue with implications for Witwatersrand sulfidic Au-tailings environment and on the behaviour of cyanide in Au-mine tailings.



Megan Welman-Purchase at the 15th Biennial Society for Geology Applied to Mineral Deposits (SGA) meeting in Glasgow, Scotland

Following negotiations between the UFS and the University of Johannesburg (UJ) in 2018, the Department of Geology continued to collaborate with the DSI-NRF Centre of Excellence for Integrated Mineral and Energy Resource Analysis (CIMERA), jointly hosted by the Department of Geology at UJ and the School of Earth Sciences at the University of the Witwatersrand. In 2019 three projects involving Prof Frederick Roelofse, Dr Elizaveta

Kovaleva and Ms Justine Magson secured funds from DSI-NRF CIMERA. This partnership will allow access to postgraduate student-funding opportunities in years to come.

Dr Hendrik Minnaar conducted research on the magmatic and crust formation processes in the Paleoproterozoic Richtersveld Magmatic Arc. Dr Minnaar also started an NRF-funded research project along with Mr Pelele Lehloenyana on the composition and evolution of the Paleoproterozoic Gladkop Suite, Namaqua Metamorphic Province. From July 8 to 19, Mr Lehloenyana attended training on mineral separation (specifically zircon) at the Central Analytical Facilities (CAF) at Stellenbosch University. He was trained in heavy liquid separation, as well as picking and mounting of zircons and also received training on cathodoluminescence (CL) imagery acquisition.



Pelele Lehloenyana during training on mineral separation at CAF, Stellenbosch University

As part of his PhD research project on the fluvial-lacustrine Beaufort Group of the Karoo Supergroup, Mr Adriaan Odendaal is investigating the Eccca-Beaufort contact, west of Bloemfontein, and the occurrence of large-scale mass movements in the Thaba Nchu area, which will lead to two possible articles for publications in addition to his PhD thesis.

Ms Justine Magson is undertaking research for her PhD on a project titled 'Probing magma dynamics and mineralization in the Bushveld Complex using high-resolution, multi-isotope (Fe-Cu-Zn and Sr-Nd-Hf-Pb) analysis across major compositional and mineralogical discontinuities'.

Ms Jarlen Beukes continued with research towards her PhD on deciphering the lateral and vertical variation of strontium, neodymium and sulphur isotopes of the Flatreef to understand the implications for the formation of the reef and its comparison to the Merensky Reef. From August 19 to 23, Ms Beukes performed Sr isotope analyses using the laser ablation multi-collector inductively coupled plasma source mass spectrometer (LA-MC-ICPMS) housed at the UJ Geology Department. The *in situ* isotope analyses were done on plagioclase from the Flatreef stratigraphic units.

As part of his PhD, Mr Ernest Moitsi continued work on the mineralogical characterisation and metallurgical response of various Upper Group 2 chromitite facies-types from Sibanye Still-Water in Marikana, Bushveld Complex in the Northwest Province.

The MSc projects of Ms Thendo Mapholi and Mr Justin Nel on Nkombwa Phosphate Mineralogy and on the structural geology of the Namaqualand Mobile Belt are also in advanced stages of completion.

The Department's research infrastructure was significantly improved through the acquisition of a new Rigaku ZSX Primus IV X-Ray Fluorescence Spectrometer with elemental mapping capabilities.

In an attempt to increase the research outputs of the academic staff, the Department organised a three-day Writing Retreat at the Golden Gate Highlands National Park in November 2019 with financial support from the UFS Postgraduate School. Seven academic staff, two scientific technical staff, one postdoctoral research fellow and one postgraduate student attended the workshop.



Prof Bisrat Yibas (second from the right) at the International Mine Water Association Conference in Perm, Russia (15-19 July 2019)

## ENGAGED SCHOLARSHIP

Dr Huber presented two lectures at the University for the Third Age, on 'The Development of Life through Earth's History' (7 February) and 'The Catastrophe that made South Africa Rich' (7 November). Dr Huber was also the invited speaker at the Student Affairs Research Colloquium: Moonshot Thinking Session, held on 2 August 2019.

Mr Moitsi served on the Mineralogical Association of South Africa (MINSAs) committee for the term 2019/2020.

## NATIONAL AND INTERNATIONAL COLLABORATION

The Department has excellent relationships with the industry, as exemplified by Minerals Education Trust Fund (METF) subventions to all our full-time academic staff members to date, and the increasing levels of collaboration. The feedback the Department received from mining companies on the quality of our graduates was very encouraging. As a result, student bursaries, research support such as provision of access to mine facilities and research materials such as drill cores and samples, are improving. A number of Honours, MSc and PhD research projects are supported by the industry. Staff research and interaction with the industry have also improved significantly.

Dr Huber's collaboration agreement with De Beers, which started in 2018, continued into 2019, resulting in four Honours students generating projects related to the analysis of mantle xenoliths from kimberlite pipes. These projects included 200 electron microprobe analyser (EMPA) and LA-ICP-MS points generated by De Beers.

As reported above, collaboration with the GFZ German Research Centre for Geosciences, the University of the Witwatersrand and the Friedrich-Alexander University, led to a grant from the ICDP.

The collaboration between the Department and DSI-NRF CIMERA is continuing with three projects and will continue to allow access to postgraduate student-funding opportunities in years to come.

The staff of the Geology Department also maintained active collaboration with researchers from the following institutions:

- University of Cape Town
- University of Johannesburg
- University of Pretoria
- Rhodes University
- University of the Witwatersrand
- Central University of Technology
- Council for Geoscience
- Sibanye-Stillwater Company
- McGregor Museum
- Louisiana State University, USA
- Université De Lille, France
- University of Exeter, UK
- University of Leoben, Austria
- Natural History Museum, London, UK
- Universität Hamburg, Germany
- University of Vienna, Austria
- Natural History Museum Vienna, Austria
- University of Gothenburg, Sweden
- University of Oslo, Norway
- Friedrich-Alexander University, Germany
- German Research Centre for Geosciences – GFZ Potsdam, Germany
- Museum of Natural History, Sweden
- Polish Academy of Sciences, Poland
- Zavaritsky Institute of Geology and Geochemistry, Russia

## POSTGRADUATE STUDENTS

The Geology Department offers a variety of postgraduate programmes including Honours, four different MSc programmes (Geology, Geochemistry, Environmental Geology, and Mineral Resource Management (MRM)), and the PhD degree by research. In 2019, the Department enrolled 85 postgraduate students – 25 Honours, 46 MSc and 7 PhD candidates.

Thirty-four (34) postgraduate degrees, which includes 23 Honours, 10 MSc and one PhD, were awarded in 2019.

Mr Marvin Peter Nicholas completed his MSc specialising in geology with the project titled 'Assessment of the applicability of the South African waste classification legislation on geological mine waste with special reference to gold mine tailings in the Witwatersrand – a geochemical perspective'. Mr Louis Naude attained his MSc after successfully completing a project titled 'Geochemical model of adsorption behavior of uranium on mine soil impacted by Witwatersrand gold tailings facilities'. Dr Robert Hansen supervised both Mr Nicholas and Mr Naude. Mr George du Plessis completed his MSc with a dissertation titled 'The parageneses of sulphide minerals in transgressive carbonatite of the Palabora Complex, South Africa' under the supervision of Prof Roelofse, Prof Gauert, Mr Giebel and Mr Rentel.

Seven MRM MSc degrees were awarded to George B Kabaso, Bittah Gorgozcynski, Ndinelao N Kashidinge, Barend F Steenkamp, Simon L Riekert, Annelizle Botha and Venkile Cindrella Mkasi, who successfully completed the two-year intensive modules and mini-dissertations required for the fulfillment of MRM MSc qualification.

The doctoral awardee was Dr Robert Johannes Giebel, with a thesis titled 'Petrogenesis of carbonatites: Mineral variations and effects on the REE mineralization'. His main promoter was Prof Chris Gauert.

As part of the Department's intensive Honours programme, the 2019 Honours students undertook a number of field investigations and site visits. Applied and Advanced Mineralogy students visited the Sibanye-Stillwater Platinum Processing Plant (formerly known as Lonmin) and the Gold One Processing Plant located in Springs, as well as Mintek and SGS laboratories.



Mineralogy Honours students visiting the Gold One Mine Processing Plant

The Honours students also undertook field excursions to gain advanced structural geological mapping skills, as part of the Advanced Structural Geology module under the supervision of Dr Hendrik Minnaar.



Dr Hendrik Minnaar explaining structural features in the field to the Honours class

The Honours Advanced Economic and Exploration Geology students, accompanied by Dr Matthew Huber, Dr Martin Clark, Ms Jarlen Beukes, and Ms Motlatji Molabe, attended a field course that mainly took place in Mpumalanga. The students visited an exploration site of Harmony Gold Mine where active drilling was going on, Sheba Gold Mine, Dorstfontein East Coal Mine, and Nkomati Nickel Mine, as well as the Barberton Geotrail, the Kaapsehoop Escarpment, and Lone Creek Falls to see historical mining areas and the regional geology. The Golden Gate Highlands National Park was visited on the return trip to Bloemfontein.

The third annual Honours Debate was held on 15 October 2019. The event featured all 25 of the Honours students, who were divided into two teams to propose and oppose the motion, 'Resolved that the value of mining polymetallic seafloor nodules is greater than the environmental cost of mining activities'. Prof Bisrat Yibas, Dr Robert Hansen, and Dr Matthew Huber formed the judging committee. After intense debate with valid and interesting points raised by both teams, the judges agreed that the outcome should be a draw.

## POSTDOCTORAL RESEARCH FELLOWS

The Department hosted two postdoctoral research fellows – Dr Elizaveta Kovaleva (Russia) and Dr Martin Clark (Canada), until the employment of Dr Kovaleva as Senior Lecturer in the Department in August 2019.

Dr Clark competed in the Entrepreneurship Development in Higher Education (EDHE) competition, presenting a business concept outlining that by initiating a business arm of a project,



students who develop unique skillsets can be placed in the business arm to begin their career delivering drone-analysis services to industry. He was selected as one of the four UFS student entrepreneurs to proceed to the regional competition hosted at the Central University of Technology (CUT).

## STAFF MATTERS

Three academic appointments were made in 2019. Mr Ernest Matome Moitsi was appointed as a Lecturer in January 2019 and Dr Elizaveta Kovaleva was appointed as a Senior Lecturer in August 2019, respectively. Prof Bisrat Yibas was appointed as a Professor and Head of the Department and assumed duties on July 2019. This brings the academic staff complement of the Department to 13.

Mrs Rina Immelman, who served the Department for 39 years as the financial and administrative officer, retired in October 2019.



Department of Geology staff (2019)  
Front from the left: Ms J Beukes, Ms R Immelman, Ms P Swart, Ms T Maphah, Mr E Moitsi and Ms M Purchase  
Middle from the left: Mr D Radikgomo, Mr P Lehloenyia, Mr A Odendaal, Dr H Minnaar, Mr A Felix, Dr M Huber and Dr E Kovaleva  
Back from the left: Mr W Nel, Ms C van der Vyver, Ms J Magson (Programme Director), Prof F Roelofse (HoD to June 2019), Dr R Hansen and Dr M Clark (postdoctoral research fellow)  
Absent: Ms R Makhadi and Prof B Yibas (HoD from July 2019)

## RESEARCH OUTPUTS

### Research Articles

Fourie, F., Huber, M.S. & Kovaleva, E. 2019. Geophysical characterization of the Daskop Granophyre Dyke and surrounding host rocks, Vredefort Impact Structure, South Africa. *Meteoritics and Planetary Science* 54:1579-1593.

Goderis, S., Soens, B., Huber, M.S., McKibbin, S., Van Ginneken, M., Debaille, V., Greenwood, R., Franchi, I.,

Cnudde, V., Van Malderen, S., Vanhaecke, F., Koeberl C., Topa, D. & Claeys, P. 2019. Cosmic spherules from Widerøefjellet, Sør Rondane Mountains (East Antarctica). *Geochimica et Cosmochimica Acta*. DOI: 10.1016/j.gca.2019.11.016.

Göllner, P.L., Wüstemann, T., Bendschneider, L., Reimers, S., Clark, M.D., Gibson, L., Lightfoot, P.C. & Riller, U. 2019. Thermo-mechanical interaction of a large impact melt sheet with adjacent target rock, Sudbury impact structure, Canada. *Meteoritics & Planetary Science* 1-18.

Huber, M.S., Koeberl, C., Smith, F.C., Glass, B.P., Mundil, R. & McDonald, I. 2019. Geochemistry of a confirmed Precambrian impact ejecta deposit: The Grønnesø spherule layer, South Greenland. *Meteoritics & Planetary Science* 54:2254-2272.

Huber, M.S. & Kovaleva, E. 2019. Microstructural dynamics of central uplifts: Reidite offset by zircon twins at the Woodleigh impact structure, Australia. *COMMENTS. Geology* 47: e465.

Kovaleva E. & Habler, G. 2019. Spatial distribution of zircon with shock microtwins in pseudotachylite-bearing granite gneisses, Vredefort impact structure, South Africa. *Journal of Structural Geology* 129: 103890.

Kovaleva, E., Huber, M.S., Roelofse, F., Tredoux, M. & Prækel, H. 2019. Reply to the comment made by W.U. Reimold on "Pseudotachylite vein hosted by a clast in the Vredefort granophyre: characterization, origin and relevance" by E. Kovaleva et al., South African Journal of Geology, 2018, 121, 51-68. doi:10.25131/sajg.121.0002. *South African Journal of Geology* 122(1): 109-115.

Kovaleva, E., Zamyatin, D. & Habler, G. 2019. Granular zircon from Vredefort granophyre (South Africa) confirms the deep injection model for impact melt in large impact structures. *Geology* 47: 691-694.

Kusiak, M.A., Kovaleva, E., Wirth, R., Klötzli, U., Dunkley, D.J., Yi, K. & Lee, S. 2019. Lead oxide nanospheres in seismically deformed zircon grains. *Geochimica et Cosmochimica Acta* 262: 20-30.

Miller, D. & Killick, D. 2019. Non-Ferrous metal artefacts from the northern Lowveld, South Africa, ca. 1000 CE to ca. 1880 CE. *Journal of Archaeological Science: Reports* 24: 913-923.

Ololade, O.O., Mavimbela, S., Oke, S.A. & Makhadi, R. 2019. Impact of leachate from Northern Landfill Site in Bloemfontein on water and soil quality: Implications for water and food security. *Sustainability* 11: 4238. DOI: 10.3390/su11154238.

### Conference Contributions

#### Conference Papers/Posters

Fourie, F., Kovaleva, E. & Huber, M. 2019. *Geophysical surveys across the Daskop Granophyre Dyke*. Paper delivered at the 16<sup>th</sup> SAGA Biennial Conference and Exhibition, Durban, South Africa. 6-9 October 2019.

**Gomez-Arias, A., Yesares, L., Castillo, J., Welman-Purchase, M.D. & Vermeulen, D.** 2019. *Limitations of current protocols to predict groundwater contamination from alkaline mine waste.* Paper delivered at the 46<sup>th</sup> Annual Congress of the Internal Association of Hydrologists (IAH2019), Malaga, Spain. 22-27 September 2019.

**Huber, M.S. & Kovaleva, E.** 2019. *Was the Vredefort melt sheet similar composition to the Sudbury melt sheet?* Paper delivered at the 50<sup>th</sup> Lunar and Planetary Science Conference, The Woodlands, Texas, USA. 18-22 March 2019.

**Huber, M.S., Kovaleva, E., Clark, M. & Fourie, F.** 2019. *Geophysical analysis of Granophyre dykes at the Vredefort impact structure.* Paper delivered at the 11<sup>th</sup> Igneous and Metamorphic Studies Group Meeting, Johannesburg, South Africa. 14-15 January 2019.

**Kovaleva, E., Huber, M.S., Clark, M. & Fourie, F.** 2019. *Timing of emplacement of Vredefort granophyre dykes.* Paper delivered at the Large Meteorite Impacts and Planetary Evolution VI Conference (LPI Contrib. No. 2136, 5080), Brasilia, Brazil. 20 September-3 October 2013.

**Kovaleva, E., Zamyatin, D. & Habler, G.** 2019. *The oldest evidence of reidite presence on Earth: Vredefort impact structure,*

Abstract Volume, 21. Paper delivered at the 11<sup>th</sup> Igneous and Metamorphic Studies Group Meeting, Johannesburg, South Africa. 14-15 January 2019.

**Kovaleva, E., Zamyatin, D. & Leroux, H.** 2019. *Twisted kink bands: New shock deformation microstructure in zircon from the Vredefort impact structure.* Paper delivered at the Large Meteorite Impacts and Planetary Evolution VI Conference (LPI Contrib. No. 2136, 5056), Brasilia, Brazil. 30 September-3 October 2019.

#### Conference Proceedings

**Oke, S.A., Purchase, M.D. & Mokitlane, L.** 2019. Laboratory remediation of iron-sulphate contaminant in acid mine waters using waste rocks. In: *Proceedings of the 5th World Congress on New Technologies (NewTech'19)*. Paper No: ICEPR'19 162. Lisbon, Portugal. 18-20 August 2019.

**Welman-Purchase, M.D. & Hansen, R.N.** 2019. Remediation of cyanide with iron-gold mine waste: an in-depth review of Prussian blue in aqueous solutions. In: *15th Biennial SGA Meeting Proceedings 4*. pp. 1555-1557.

## STAFF (2019)

**Head of Department:** Prof Bisrat Yibas

**Associate Professor:** Prof F Roelofse

**Senior Lecturers:** Dr R Hansen, Dr M Huber, Dr E Kovaleva and Dr H Minnaar

**Lecturers:** Ms J Beukes, Ms J Magson, Mr ME Moitsi and Mr A Odendaal

**Junior Lecturers:** MS R Makhadi, Ms T Mapholi and Mr J Nel

**Affiliated Professors:** Prof DE Miller, Prof R Schemers and Prof Ayla Scooch

**Affiliated Associate Professors:** Prof CD Geert, Prof GJB Germs, Prof L Jacobson and Prof RP Schouwstra

**Affiliated Senior Lecturer:** Dr A Bisnath

**Affiliated Lecturers:** Mr AC Dunne, Mr PJ Grobler, Mr I Hunt, Mr PG Laurens, Dr H Prinsloo, Mr PJ Viljoen, and Mr MJAR Vrijens

**Research Fellows:** Prof WP Colliston, Dr PG Meintjes, Dr L Nel, Dr HE Praekelt and Prof WA van der Westhuizen

**Affiliated Researchers:** Dr JO Claassen, Ms HCF Pretorius and Dr MJ van der Merwe

**Research Associate:** Dr Johan Look

**Programme Director:** Ms J Magson

**Senior Assistant Officers:** Mr A Felix, Ms R Immelman, Ms P Swart and Ms C van der Vyver

**Technical Officers:** Mr P Lehloeny, Ms M Purchase and Mr D Radikgomo

