June 2011

UNIVERSITY OF JOHANNESBURG

Faculty of Science NEWSLETTER

The Department of Geography, Environmental Management & Energy Studies

This Department actually houses three different, but very much related, scientific disciplines. The Department originated as Geographers in 1967. Today some staff members are still focusing on expanding their knowledge in this discipline. When serious environmental awareness and legislation started in the early 1990s in South Africa, a programme was implemented in Environmental Management at Master's degree level in 1994, and later (2000) at undergraduate level. Since then the Master's programme in Environmental Management has been the core stone of the output with 10-15 students graduating annually with this qualification. A number of Doctoral candidates also completed their studies in Environmental Management. Many of them presently run their own consultation companies, and many are employed as senior staff at Metro, Provincial, and National Government positions. The past eight years a substantial growth was experienced in Energy Studies, with the inter-disciplinary SeTAR Research Centre being established with multiple stake holders. A large number of Masters and a number of Doctoral candidates have gone through these focused programmes. A very successful re-launch of an Honours programme in Energy Studies was implemented in 2010.

THE NEXT ISSUE FOCUSES ON THE ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING, THE DEPARTMENTS OF APPLIED MATHEMATICS, MATHEMATICS AND STATISTICS

THIS ISSUE FOCUSSES ON THE **DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT & ENERGY STUDIES** AND THE **DEPARTMENT OF GEOLOGY**

RESEARCH AND TEACHING STRENGTHS IN THE DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT AND ENERGY STUDIES

- GIS and satellite remote sensing • Environmental management
- Urban geographical studies, such as housing, economic geography and sustainable cities
- 800 undergraduate students from both the Faculties of Science and Humanities
- Enrolment of 40-50 honours students annually • This year 42 Masters students and 19 Doctoral candidates
- Prof Annegarn and Prof Kotze lead the way with international collaborations
- Seven out of ten of the academic staff have PhDs
- All academic staff members have many years of teaching, research and postgraduate supervision experience.

Sustainable Energy Technology and Research (Setar) Centre

The University of Johannesburg's Sustainable Energy Technology and Research (SeTAR) Centre is located at the Bunting Road Campus Research Village. It started life as a single advisory position at regional level at the Programme for Basic Energy Conservation (ProBEC), a SADC government programme active in almost all 14 SADC countries. Initially it was a technical advisory position occupied by Crispin Pemberton-Pigott, at that time based in Swaziland. ProBEC developed and funded cooking stove projects from Tanzania to Lesotho. Pemberton-Pigott's home base is New Dawn Engineering in Swaziland, a broad-ranging appropriate technology firm well known in the region, where stove prototypes were developed and tested.

Starting from this single advisory post, the SeTAR Centre was conceived as a repository of expertise for domestic energy projects in the region which could be drawn on as needed. The intention was to overcome the long-standing problem of outsiders having to repeatedly be introduced to the materials, economy, habits and energy requirements. An agreement was made between ProBEC as the funder and the UJ as the host, to form the SeTAR Centre with a long term view to create a university-based Energy Institute. At present the SeTAR Centre's stove testing laboratory is located at FADA and their prototyping workshop is next to the Industrial Design Department's student workshop.

The need to develop realistic and scientifically sound stove testing protocols was immediate. The failure of most cooking stove projects around the world can often be traced to the inability to tell whether a new stove is actually improved or not. A new stove may produce less carbon-monoxide than the old one, but not cook properly, or have increased particulate emissions, or only perform well at a certain power level. The way emissions are expressed internationally was found to be inconsistent, making meaningful comparisons between prototypes impossible.

The development of the SeTAR Centre Test Protocols was a major step forward in the field of stove science. Measurements are made using an approach that tracks the chemically balanced real-time emissions profile and expresses the performance in a way that allows the comparison of performance between stoves burning different fuels of different compositions, in different pots, and at different power levels. This multivariate testing approach uses the *Heterogeneous Test Protocol (HTP)*. It can measure and rate the gaseous and particulate emissions of stoves whether burning ethanol gel, wood, charcoal, paraffin, coal, or semi-coked briquettes – in fact just about anything.

In 2010 a similar laboratory based on the one at UJ was established in the city of Ulaanbaatar, the capital city of Mongolia. The residents of Ulaanbaatar suffer from the same air quality problems as those of our Highveld coal-burning cities. The primary cause – domestic combustion of coal – is the same and so is the

solution: dramatically improving the technology that burns the coal.

Daily time-series analysis of the airborne particulate matter in Ulaanbaatar showed that the problem was not burning coal *per se*, but the ignition of the coal and the inappropriate refuelling method, both of which yield huge amounts of smoke. We have a similar situation regarding the preparation of cooking fires in the ubiquitous *mbaula*. Work concentrated in 2010 on getting the ignition emissions reduced. This, combined with the HTP quickly led to the development of several cooking and space heating coal stoves with less than 1% of the PM emissions of the baseline traditional ones. A paper[1] describing the whole process from the PM emission characterisation to the development of the low emission stoves was presented at the DUE 2011 conference in Cape Town by Prof S Lodoysamba (Nuclear Research Centre, National University of Mongolia), and C Pemberton-Pigott (SeTAR Centre, University of Johannesburg). It was the recipient of the *Best Paper Award*. Altogether another 9 presentations were made by UJ and SeTAR Centre staff and students.

[1] *"Mitigation Of Ulaanbaatar City's Air Pollution – From Source Apportionment To Ultra-Low Emission Lignite Burning Stoves"*, Prof S Lodoysamba, C Pemberton-Pigott, 2011, presented at Domestic Use of Energy Conference, South Africa, 11-13 April 2011.

The Geothermal Springs Research Project

Dr Isaac Rampedi collecting data on p H value, electrical conductivity and temperature on another site by means of portable instruments in the Venda area of the Limpopo province.

The Limpopo province has a number of geothermal springs which have recently become a subject of interesting scientific research. Whereas most of the thermal springs around and in former white areas have been developed optimally for multiple uses, those lying in former *homelands* areas have not been developed to their full potential. In many countries worldwide, the use of geothermal springs is intimately linked with recreation and tourism development, thus ensuring sustainable management of natural resources. To date, research on South African thermal springs remains scant and very fragmented and consequently a research project led by Professor Emeritus Jana Oliver has been funded by the Water Research Commission (WRC) during the 2010-2011 period.

This research project is aiming at examining the characteristics of thermal springs occurring in the Limpopo province by investigating their geological background, bio-physical attributes, environmental perceptions around their use and their potential for tourism and local economic development (Olivier, 2010). Given the multidisciplinary nature of the research project a number of researchers from diverse backgrounds are involved. For instance, the photos below show some of the researchers who undertook a field trip around November 2010 to collect water quality data pertaining to about six thermal springs in various areas of the province. In the figure below, data is collected by the research team, including Dr Isaac Rampedi who has recently joined the Department of Geography, Environmental Management and Energy Studies. In addition, one student, namely Linda Sheppard, in the same Department has recently completed a research proposal with a focus on how geothermal springs around the Naboomspruit area and other areas of the province are utilised for various uses.

Undeveloped geothermal springs in the Limpopo province with water emanating from a groundwater source.

Dr Memory Tekere (Unisa), Isaac Rampedi (UJ) as well as Nelia Jonker (Unisa) collecting data on total dissolved solids, electrical conductivity and temperature at one of the developed thermal springs in the Limpopo province.

THE TRANSPORTATION PLANNING RESEARCH GROUP

Zach Simpson, Naeem Patel, Alutious Sithole, Ruan van den Berg, Whitney Pailman, Tracey McKay

The Transportation Planning Research Group is a collaboration between the Department of Geography, Environmental Management and Energy studies and the Department of Civil Engineering Science. It is supported by the Gauteng City-Region Observatory, which is itself a joint enterprise between the University of Johannesburg, the University of the Witwatersrand and the Gauteng Provincial Government.

The aim of the research group is to conduct high quality research into the planning of transportation systems within Gauteng. The purpose of which is to promote and facilitate social development and economic activity within the province. It is thus concerned with issues of access, reliability, affordability, and quality of transport. The research group was convened in March 2011.

Members not shown in photo: Dr Julia Mambo, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand. Kerry Chipp, Gordon Institute of Business Science, University of Pretoria. Prof Christo Venter, Dept of Civil Engineering, University of Pretoria.

Research being done by Masters Students of Professor Tertius Harmse

- Assessing the effects of different land uses on water quality at the Upper Wilge River Catchment. Different land uses in the upper Wilge catchment are studied using water quality indicators and land use maps to assess the impacts they may have on water quality. Master student Jess Verheul.
- The pollution load contribution of the tributaries of the Vaal River Barrage Reservoir. The aim is to determine the pollution load contribution of the tributaries (Klipspruit, Suikersbosrand River, Rietspruit and the Leeu-Taaibosspruit) of the Upper Vaal River, specifically the Vaal River Barrage Reservoir area, and to calculate the required water release from the Vaal Dam to dilute the pollution in the Barrage Reservoir to acceptable levels in the event that the required Total Dissolved Salt standard of 400 is not being met. Master student Tim Blignaut.
- An evaluation of the environmental performance of the Shareblock Reserves in the Umbabat Private Game Reserve, and ways in which their ecological footprint can be minimized. The key areas to be addressed will include:
  - ~ Waste management
  - ~ Water consumption/usage
  - ~ Fragility and sensitivity towards ecosystems and biodiversity
  - ~ Management of waste-water
  - ~ Management of chemicals and cleaning agents.

  M-Student Chad Cocking.
- A quantitative study of different land use effects on water quality in the North West Region of the Limpopo

Province. The aim of the study is to determine how different land use types have impacted on the water quality of the area over a period of ten years. The tributaries that are be studied all drain into the Crocodile River. A ten year period is used in order to adequately cover any changes in the water quality. Master student Paul Rabiega.

- A comparative study of chemical and physical water quality along the Crocodile River in the Gauteng and North West Provinces, South Africa. This study aims to compare the changes in chemical and physical water quality (by means of ten chemical and five physical variables) along the Crocodile River over a period of 10 years (1997-2007), including the influence that primary categories of land-use and major tributaries have on water quality along the river's course. Master student Margaret Lowies.
- The effect of floods on water quality in sections of the Vaal river catchment. A study on the impact of floods on the water quality of the Vaal river catchment is conducted by determining if floods in South Africa have had a significant impact on the level of certain pollutants in the Vaal river catchment. South Africa has experienced two significant floods over the last five years, namely the floods of 2006/2007 and the more recent floods of 2010/2011. There is a school of thought that is of the opinion that floods increase runoff and consequently cause an increase in certain pollutants in water bodies. Master student Sonia Oldacre.
- The effect of legislation on informal solid waste salvation and salvagers on official landfill sites in Gauteng. This study will make analytical overview of informal waste salvation globally and on the African continent and finally focusing on South Africa's Gauteng Province; make an analytical identification of all relevant legislation, including policy documents and directives pertaining to solid waste salvation on municipal landfills in Gauteng; critically outline the extent to which informal waste salvagers on Gauteng's municipal landfills are economically weak, politically marginal and socially isolated; make a critical identification of the challenges that Gauteng municipalities encounter when enforcing solid waste legislation on official municipal landfills. Master student Richard Thaba. Supervisor Dr Godfrey Chikorowe. Co-supervisor Prof Tertius Harmse.
- An investigation into the cyanobacteria and related cyanotoxins in the Vaalkop Dam. Cyanobacteria like Cylindrospermopsis sp. and Microcystis sp. are known to form blooms in the Vaalkop Dam, which is the source to the Magalies Water Vaalkop Water Treatment Plant (MWVWTP). The cyanotoxins produced by these cyanobacteria are known to be harmful to humans and therefore the removal capacity of these cyanotoxins is of utmost importance to the consumers of water produced by the MWVWTP. This investigation will focus on the occurrence of cyanobacteria and cyanotoxins in the raw, as well as the purified water. Due to the fact that the MWVWTP makes use of advanced treatments options (like ozone oxidation and granular activated carbon filters), it is expected that the MWVWTP is able to remove all cyanotoxins from the source water, provided that the treatments are administered appropriately. Master student Nelanie Bezuidenhout. Supervisor Prof Hein du Preez (Rand Water & UJ Zoology Visiting Professor), Co-supervisor Prof Tertius Harmse.

Prof Tertius Harmse HOD and Jess Verheul, a master student of Prof Harmse

NEWS FROM THE DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL MANAGEMENT AND ENERGY STUDIES

International students visited Prof Harold Annegarn at the SeTAR Centre, Bunting Road

SANPAD THEMATIC CONFERENCE IN MUMBAI INDIA

Dr Clare Kelso participated in a South Africa Netherlands Research Programme on Alternatives in Development thematic conference entitled *Climate Change and Alternative Energy Technologies* in Mumbai India. The conference was designed to provide an exchange of knowledge between South African, Indian, Chinese and Netherlands researchers involved in the fields of climate change and energy studies. The aim of the conference was to identify priority areas for shared research and knowledge exchange between the four participating countries. The output of the conference was a research funding application for an ongoing research project delivering opportunities for knowledge exchange within the field of alternative energy sources for countries experiencing rapid economic growth in the context of social inequality and within the limits posed by climate change imperatives. Dr Kelso presented a paper contextualizing South Africa's position within the global carbon economy as well as its current progress in climate change policy. The next meeting of the delegates is planned to precede COP 17 to be held in Durban in December.

COLLABORATIVE RESEARCH WITH CHINA

Prof Nico Kotze from the Department conducted collaborative research with the colleagues from Dalian on Housing satisfaction within the city. It was supposed to be only a pilot study but they gathered all the data (200 questionnaires) within 5 days with the help of the staff of the University of Dalian

Professor Kotze also presented a paper entitled *Problems associated with the production of bio-fuel in SA at that University.*

At the moment, negotiations for funding are being undertaken in order for Prof Kotze to collaborate with Dalian in his on-going research on housing quality and satisfaction.

Professor Nico Kotze lecturing in 2011

SNIPPITS

- The Department boasts with five post-doc fellows doing various research on pollution and energy issues. Dr Chikowore is working on the economic sustainability of the SADEC states.
- Dr Godfrey Chikowore, Director of the University of Zimbabwe's Institute of Development Studies, as well as an honorary professor at the University of Ghana, is currently pursuing research in development studies with a bias in socio-economic geography and regional economic cooperation and integration. He and Professor Annegarn are co-authoring a book entitled: *Theory and Practice of Regional Economic Cooperation and Integration in Developing and Developed Countries.*
- Liz Block, lecturer in the Department has been invited to contribute an encyclopedia article for the new Springer International Encyclopedia of Quality of Life Research.
- Dr June Meeuwis retired on 30 April 2011, after 23 years in the Department. We trust that she has a peaceful retirement.

DEPARTMENT OF GEOLOGY
Research Activities

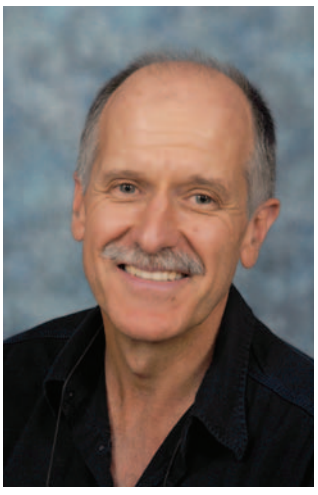
Departmental Overview

Much of the research undertaken by UJ Geology relates to Economic Geology and Geometallurgy, undertaken under the banner of the PPM Research Group with Professors Nic Beukes and Fanus Viljoen as co-leaders, although there is also a strong research component on other geological topics that have importance in understanding Earth history. The Department has a professorial Chair of Geometallurgy funded by the South African Department of Science and Technology where Professor Fanus Viljoen and his group investigate metallurgical aspects of important geological deposits including gold, platinum, chrome, coal and diamonds. The PPM Group (PalaeoProterozoic Mineralization Group) also has a strong economic geology niche and undertakes projects in geological formations containing commodities such as iron ore, manganese, gold, platinum, chrome and coal. In 2010, the University recognised the importance of the PPM research group by awarding it Research Centre status with a 3-year cycle of funding to be used for research and for building research capacity via training of post-graduate students and employing postdoctoral researchers. The Geology Department has five post-doctoral staff members and plans to recruit another three during 2011. There are currently 25 Master's and Doctoral students in the Department. Most of this research is logistically and financially supported by industry, the University and the NRF. Other important research projects not related to economic geology includes research on southern African geology in general including the Limpopo and Namaqualand regions, geoheritage and investigating early life on Earth and the origin and formation of some of the oldest rocks in South Africa. New techniques are also being formulated for analytical procedures in instruments in the UJ's Central Analytical Facility and these have important applications for geological research in general.

In 2010, some staff were involved with organising official symposia and international conferences and field excursions. In January 2011, the Department of Geology organised a very successful international conference on African geology (CAG23).

UJ Geology has a very strong international collaboration component and staff members regularly work with and visit research collaborators in Australia, Brazil, Cameroon, Canada, DRC (Congo), Finland, France, Germany, Iceland, India, Italy, Japan, Namibia, Russia, Scotland, Sweden, UK and Zimbabwe,. There is also extensive national collaboration within South Africa, between UJ Geology and the Council for Geoscience, NECSA, various national museums and universities.

Bruce Cairncross, Head of the Department of Geology at UJ.



Harry Brown, Deputy Head of the Department of Geology.

The staff and postgraduate students of the Department of Geology, University of Johannesburg.

UJ hosts an International Conference on African Geology: *The 23rd Colloquium of African Geology (CAG23)*

The Colloquium of African Geology is a major international biennial conference first launched in 1964 and organized every second year, under the auspices of the Geological Society of Africa (GSAf). This conference has now been hosted in South Africa for the first time.

No less than 500 geoscientists representing 58 countries worldwide were gathered at the University of Johannesburg – Auckland Park and Soweto Campuses from the 7th to the 15th of January 2011 under the theme: *Together in Africa for a Leading Role in Geoscience*. The event was organised in collaboration with the University of Witwatersrand, the Nuclear Energy Corporation of South Africa (NECSA), the Geological Society of South Africa (GSSA) and the Mineralogical Society of South Africa (MINSA). **Professor Hassina Mouri** of the Geology Department was the Chairperson of the Conference Organising Committee.

CAG23 was a unique opportunity to present and discuss on-going research work on all aspects of African geosciences. It offered a rich scientific program comprising 14 scientific symposia, of which some were dedicated to outstanding geoscientists for their remarkable work and contribution to African geology. Six plenary lectures on the most salient topics that have direct or indirect implication on African geosciences and society were presented by world class scientists, amongst them Professor Phillip Tobias, a South African palaeoanthropologist and Professor Emeritus at the University of the Witwatersrand, who addressed the topic of *Human Evolution in Africa*. The programme included 25 keynote and invited talks, 6 workshops, 6 excursions, 4 business meetings and 2 short courses. 17 national and international exhibitors were present. All this took place at the very well equipped lecture halls (D-Labs and Auditorium) of the Auckland Park Campus of the University of Johannesburg. Up to 20 postgraduate and doctoral students from the Geology Department contributed to the running of the event.

The opening ceremony of the event took place at the Soweto Campus of the University of Johannesburg, where the Minister of Science and Technology, Mrs Naledi Pandor, delivered the opening address in which she highlighted the importance of geosciences. This was the first time an international conference was opened in Soweto. Delegates were also offered a very special social program through tours around the city and 5 evening functions. During three of these functions delegates were entertained by a group of students from the UJ Choir. The event was indeed a great opportunity for African geoscientists in general and South African ones in particular to build links and strengthen the networking and research collaboration in the field of geosciences.

CAG23 in South Africa at the University of Johannesburg is certainly one of the most successful events on African Geology so far. Since the inception of the Colloquium in 1964, it was the largest one to have taken place on the African continent, and equal to the two largest colloquia held in Europe (Berlin, 1987 and Nancy 1990 both attracted about 500 delegates). Furthermore, CAG23 is the largest meeting in geosciences that was organised in South Africa since the International Geological Congress (IGC 15) held in Pretoria in 1929. Hosting this event, with its unique multi-disciplinary nature, has been a great opportunity to showcase our country and connect to African geology, which knows no international borders.

The official opening of CAG23 at the UJ's Soweto Campus. Left to right: Professors Ihron Rensburg (Vice Chancellor UJ), Angina Parekh (Deputy Vice-Chancellor: Academic), Bruce Cairncross (HOD Geology), Hassina Mouri (CAG23 Chairperson) and Kinta Burger (Dean of Science).

Geological Society of America Memoir 207:

Origin and evolution of Precambrian high-grade gneiss terranes, with special emphasis on the Limpopo Complex of Southern Africa, March 2011.

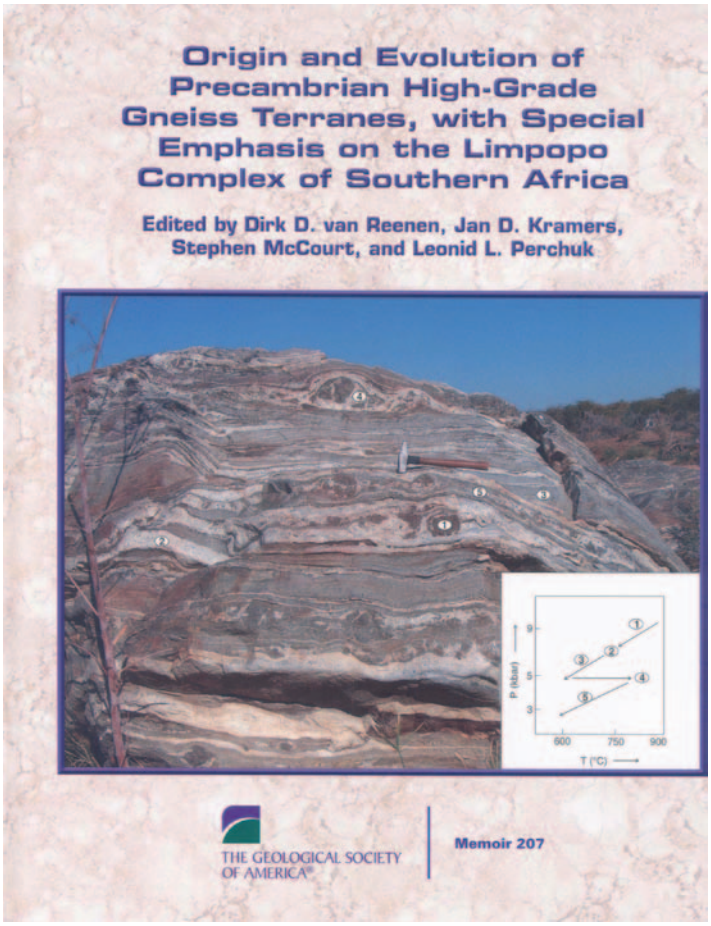
In July 2008 an international field workshop was held in the Limpopo Complex, a complex Precambrian terrain straddling the borders of South Africa, Zimbabwe and Botswana – believed by many to be one of the oldest paradigms of a continental collision episode. Geology probes the remote past of our planet, all the way back to its origin 4.55 billion years ago, and one of its important tenets is the principle of uniformitarianism, which states that geological observations on old rocks and old rock provinces may be interpreted via the study of processes as they happen today. Mountain belts are formed today by continental collision, as India colliding with Asia produced the Himalayas. The Limpopo Complex, although flattened over time by erosion, represents a Himalayan equivalent half the age of the Earth and could therefore provide clues on whether uniformitarianism holds that far back.

The workshop was organized by **Profs DD van Reenen** and **CA Smit** (UJ Geology Department), who have both worked many years in this geological province, and was entitled *Limpopo International Field Laboratory*. The idea was to get an international group of experts together to examine and discuss not just this particular geological province, but the issue of plate tectonics and continental collisions (and the associated thickening of the continental crust and high-temperature metamorphic processes) in the early Precambrian in general – and ultimately, produce a Volume of research and review papers on the subject. This should transcend mere regional geology and address core issues.

Almost three years later, the Volume has now come out as a Geological Society of South Africa Memoir. The editors are Dirk D van Reenen, Jan D Kramers (both UJ), Steve McCourt (UKZN) and Leonid L Perchuk (UJ and Russian Academy). Sadly Leonid passed away before the book was published; it was dedicated to his memory as one of the founders of modern thermodynamic approaches in metamorphic geology. It is a fitting tribute.

The sixteen chapters of the book range in subject from detailed mineralogy and petrology and fluid phase studies, to structural work, thermodynamics and pressure-temperature determinations, geochronology, questions of radioactive heat production, continental crust formation and tectonic models. It has come out surprisingly close to what was originally intended: not to be a mere regional record, but a treatise on Precambrian high grade metamorphic terranes in a more general sense. UJ staff are authors or co-authors of nine of the chapters.

As to the question of uniformitarianism, the contents of the book tend to favour the answer that plate tectonics did operate in the late Archaean (about 2.6 billion years ago) in a similar way to today, but there is a strong suggestion that in detail, the nature of processes has changed due to many factors, prominently the decrease in internal radioactive heat production in the Earth since that time. Modern uniformitarianism means that, although the laws of nature remain unchanged, parameters gradually change and affect the way in which they work.



Geological Society of America Memoir 207.

STAFF RESEARCH ACTIVITIES

Nic Beukes, Hegde (SDM College of Engineering and Technology, Dharwad) and Michiel de Kock drilling orientated samples for palaeomagnetic studies in a rock quarry near Dharwad, India.

Professor Beukes has an A1 rating from the NRF and is recipient of the President's Award of the NRF, the Draper and Jubilee Medals of the Geological Society of South Africa, the UJ Alumni Dignitas Award 2006, the UJ Vice-Chancellor's Medal for Research Achievement and the *Eeufeesmedalje van die Suid Afrikaanse Akademie vir Wetenskap en Kuns.*

Professor Nic Beukes was appointed on contract as Research Professor in 2011 after retiring at the end of 2010 with 41 years of full-time appointment in the Department. He is primarily a field geologist, specializing in sedimentology and stratigraphy, with emphasis on understanding the origin of iron and manganese ore deposits and the nature of surface environments on early earth which includes the history of atmospheric oxygen and climate changes in the middle Archaean to early Palaeoproterozoic. He has worked extensively on iron and manganese formations all over the world and also studied the genetic and sequence stratigraphy of siliciclastic strata of the Witwatersrand and Pongola basins, depofacies in early Precambrian carbonate platform successions, early Precambrian laterite profiles and paleosols and the nature of post-Gondwana land surfaces and associated soil profiles.

CURRENTLY HE IS INVOLVED WITH FOUR RESEARCH PROJECTS:

- Manganese deposits that developed prior to the rise of atmospheric oxygen at approximately 2350 million years ago and the information these deposits may hold for the history of atmospheric oxygen and oxygenic photosynthesis in the earliest part of Earth History.
- An evaluation of the iron ore potential of the Asbesheuwels area in Northern Cape Province. The project focuses mainly on medium to low-grade iron ore resources that could possibly be upgraded when the time arrives that the high-grade ores that are currently mined become exhausted.
- The provenance or source terrains of selected sedimentary successions in southern Africa that, in combination with palaeomagnetic studies, could assist in palaeogeographic reconstructions of ancient continents as far back as the Archaean. Such reconstructions are not only important for unravelling Earth History but also for Exploration Geology in the quest to predict extensions of important known ore deposits in southern Africa that may have become fragmented through plate-tectonic movement and may now be located on other continents and vice-versa.
- A comparison of the geology and genesis of iron formations and associated high-grade iron ore deposits in southern Africa, India and Brazil. The main focus is to try and develop improved exploration models for finding covered (*blind*) new iron ore deposits.

Nic Beukes (standing behind the chair), Fanie Kruger (left) and Herman van Niekerk (third from left) with their research group of postgraduate students and post-doctoral staff in the SEM facility

The UJ Geology Honours class during a visit with Prof Cairncross to an operating coal mine in Witbank Coalfield. Bruce Cairncross photograph.

Bruce Cairncross visiting artisanal fluorite mining operations at Riemvasmaak, Northern Cape Province.

Rhodochrosite specimens from the Kalahari manganese field, one of the UJ Geology Department's research areas. The front-left stone is 17.5 carats. Bruce Cairncross photograph.

The research interests of **Professor Bruce Cairncross** encompass coal geology and southern African geoheritage. His coal research involves investigating the origin and formation of South Africa's coal deposits from the standpoint of how the coal seams formed 280 million years ago and what sort of environments were associated with the ancient peat swamps that ultimately gave rise to the coal. Understanding these issues not only helps to unravel geological processes at that time, but it also gives a better understanding of the quality and distribution of the coal itself. These are important practical issues that can assist in exploiting the coal seams. It has been shown that knowing whether the ancient peat swamps were associated with, for example, ancient delta deposits versus ancient river deposits, effects the thickness, later distribution and to a degree, the quality of the coal seams. This research has been supported for a number of years by the coal mining industry, particularly Anglo Coal who has often provided postgraduate students and data for research. One such project involves Master's student Byron van der Walt who is researching anomalous stratigraphic formations in the northeastern Karoo basin coalfields. Another is the PhD project of consultant Peet Meyer who is researching the stratigraphy and structure of part of the Tete coalfield in Mozambique. The multimember COALTECH organisation that comprises most of the major coal mining companies in South Africa also financially supports this research from time to time.

The geoheritage side of Professor Cairncross' research involves researching and documenting the regions rich mineral and gemstone deposits. Why publicize South Africa's mineral heritage? It is non-renewable, it has scientific value (type-locality species, parageneses, geometallurgical value), it has beauty and diversity and mineral collections can be draw-cards at museums. Promoting geology, in general, to the public has always been a challenge because high school learners do not have formal courses in geology. There are some aspects of Earth Science in school curricula but these usually form part of other subjects. Therefore, any work that strives to present geology and minerals to the general public will raise public awareness, understanding and appreciation of South Africa's geological and mineral wealth.

Professor Cairncross has published six books and innumerable journal and magazine articles that are available to the general public. He is a regular invited speaker at local and international meetings and speaks to non-geological audiences on the subject of southern Africa's rich mineral heritage. He is an internationally recognised mineral and gemstone photographer and his photos have featured in most print and electronic media. Two company-sponsored books, one dealing with the minerals and geology of the Northern Cape manganese fields, were well received. More recently, three books on rocks, minerals and gemstones published by Struik Randomhouse, have sold very well to the public and two of these have been reprinted several times during the past 5-6 years. This research has garnered some local and international recognition and awards including the following:

- Finalist in the 2011 NSTF (National Science & Technology Forum) awards for *Science Communication for Public Awareness.*

- First prize winner at the 2009 (25th) and the 2011 (27th) Annual Tucson Gem and Mineral Show photographic competition held in Tucson, Arizona, USA. The award was made for the best photograph of a mineral specimen or gemstone.
- Best article award in the South African Lapidary Magazine 2010.
- Geological Society of South Africa Presidential Award 2009. This award was made in recognition of his contribution to the advancement of mineralogical knowledge through his involvement as Chairman of the Johannesburg Geological Museum Association (GMA). The Johannesburg Geological Museum was in dire straits in recent years and through the Prof Cairncross' efforts, and with support from the GMA committee and museum staff, resurrected one of the largest and most important geological mineral, gemstone and rock collections, such that the new display, opened in mid-2010, is now the most modern display of its type in South Africa.
- The *Friends of Mineralogy*, USA, Best-Paper Award in The Mineralogical Record 2006, for a monograph on the Minerals of the Erongo Mountains in Namibia.
- Nomination for the 2002 Carnegie Mineralogical Award, Carnegie Museum of Natural History, Pittsburgh, USA.

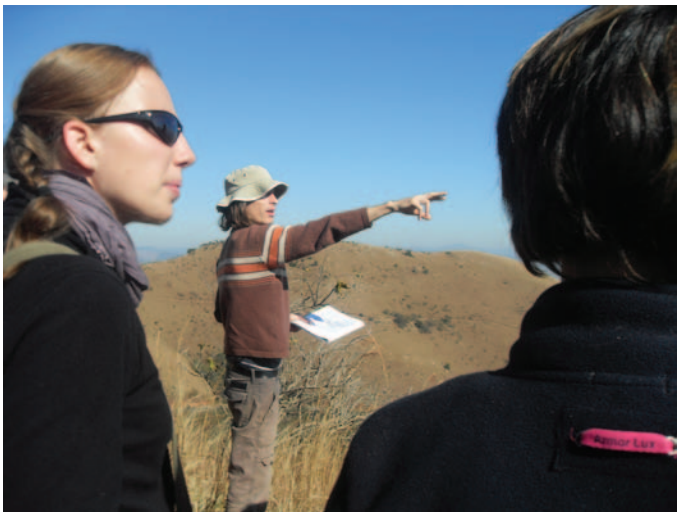
Dr Michiel de Kock's Paleomagnetic studies are used to trace the *paths of drift of continents* through time. Measurement of the magnetic directions in rocks enables us to determine the orientation and latitude of the rock mass at the time of its formation. It allows the reconstruction of the components of ancient continents, now fragmented by plate tectonics, and can also be used to date rock successions indirectly.

The lack of an accessible, modern palaeomagnetic facility in southern Africa served as motivation for the planning and construction of a magnetically shielded room, which can house such a facility. Recent acquisition of a computer controlled automated sample changer and a *helium-free* superconducting rock magnetometer now makes the UJ Palaeomagnetic Laboratory one of the most modern laboratories in the world and the only such facility on the African continent. The automatic sample changer, which allows for the rapid measurements of large amounts of samples, is a first for the southern hemisphere.

The Palaeomagnetic Laboratory is being developed into a national and African facility that will be available to students and staff of other South African and African universities as well as research institutes. South Africa is under-sampled for palaeomagnetic data largely due to a lack of modern facilities in recent years. Well-defined and precisely dated palaeomagnetic poles are crucial for testing palaeocontinental reconstructions, to provide tectonic context for major ore deposits, to trace metallogenic belts between continental fragments, and to identify new prospective areas for mineral deposits. The broad goal of the laboratory will be to update and expand the palaeomagnetic record in order to assist in reconstructing the ancient continental core of southern Africa – the Kaapvaal craton. Within this framework, Dr de Kock's research centres on pre-Rodinian supercontinents and major changes of the Earth system through time (eg, the oxygenation of the atmosphere, climate change, and dramatic changes in the biosphere). Specific projects are focused on the oldest glacial rocks in the world (ie, the 2.9 billion year old Klipwal diamictite); the 2.8 billion year old Hlaghoti Complex and related dyke swarms of the south eastern Kaapvaal Craton; palaeomagnetism of the Johannesburg Dome; palaeomagnetism and geochronology of 2.05 billion year old Bushveld Complex related satellite intrusions; palaeomagnetism of 1.4 billion year old carbonate rocks of India and its implications for global ocean chemistry and the configuration of supercontinent Nuna; and thermal maturity of rocks of the Karoo Supergroup.

One MSc project, and two PhD projects are currently in progress. Jim and Mary Taylor Trust recipient Mr Ashley Gumsley spend time at the University of Lund in Sweden at the end of 2010. There he did baddeleyite separation and age dating of rocks from the Hlaghoti Complex in Natal in order to further his studies on Hlagothi magmatic event and dolerite dyke swarms of the south eastern portion of the Kaapvaal Craton.

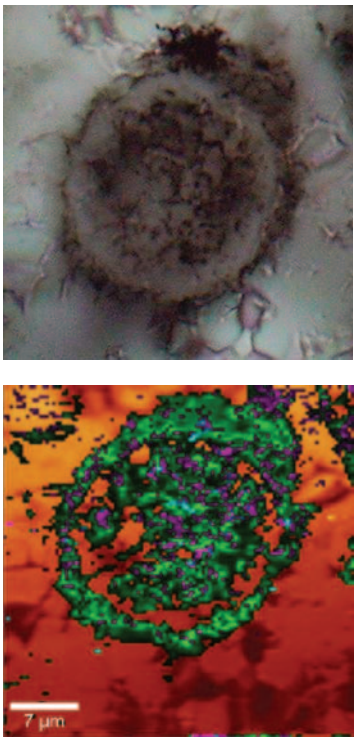
Michiel de Kock (Left) in the palaeomagnetic laboratory with his students who are working on the apparatus.



Axel Hofmann, pointing the way to students in the field.

Professor Axel Hofmann is a relatively new staff member in the Department of Geology. He joined in August 2010 to take up a position as Associate Professor. His main interests revolve around the geology of the Archaean era, the most ancient part of Earth history for which rocks as old as 4 billion years are preserved. Under the umbrella of the Palaeoproterozoic Mineralisation Research Group he is in the process of establishing a research project entitled Early Earth Life and Mineral Systems Science. This interdisciplinary study of biogeochemical systems through time focuses on the impacts of the evolution of life on surface processes, geochemical cycles and the formation of mineral deposits using modern geochemical concepts and techniques.

During the Archaean, the Earth surface was a place very different from today. Magmatic and hydrothermal processes were widespread, as the Earth interior was hotter. Continents were free of vegetation and subject to intense chemical weathering. The oceans and atmosphere were anoxic, and UV radiation intense. Large impacts occurred frequently. It was under such conditions that life emerged and evolved. Research has shown that primitive life existed already 3.5 billion years ago, from studies of volcanic greenstone successions like those preserved in the Barberton Mountainland in South Africa. Fossil bacteria are preserved in rocks that formed close to submarine hot springs, and were thus specifically adapted to life in extreme environments. In somewhat younger rocks, like the 3 billion year old rocks of the Pongola Supergroup, evidence exists that life had colonised sunlit, shallow-marine environments producing oxygen as a by-product of the newly established process of photosynthesis. Many



Photomicrograph (left) and Raman compositional map (right) of a spherical carbonaceous structure, possibly representing a fossil bacterium, from 3.3 Ga old hydrothermal precipitate from the Barberton Mountainland. In the Raman map carbon is shown in green and quartz in orange (Hofmann and Foucher, unpublished data).

of these Archaean successions contain important mineral deposits, specifically gold, nickel, antimony, uranium and many others, whereby mineralisation processes were operating at or close to the ancient Earth surface.

Early Earth Life and Mineral Systems Science explores the relationship between surface processes, evolution and habitat of life and the formation of mineral deposits on the early Earth. It combines classical geological methods of field mapping, sedimentological and structural studies with analytical techniques for detailed petrological, geochemical and geochronological analysis. Geological field work currently focuses on largely unexplored terrains in southern Africa and India. It is in these areas that volcano-sedimentary rocks of exceptional age are well preserved, having escaped the mountain-building processes that have largely destroyed or modified the record of ancient surface processes elsewhere. Comparisons will be drawn with modern hydrothermal systems active in the East African Rift and the more ancient volcano-sedimentary successions preserved on Mars.

Mike Knoper and Ashley Gumsley standing at their vehicle at White sands in New Mexico, USA. The white sand consists of gypsum. Bryony Richards photograph.

The research of **Mike Knoper** is broadly focused on Earth's lithosphere. The lithosphere is the outer 100-150 km portion of Earth that consists of the crust and uppermost mantle. The lithosphere comprises a number of distinct tectonic plates, and it is possible to measure their movements on the surface of Earth using GPS technology. The interactions between these lithospheric plates through geological time, together with processes originating from the underlying convecting mantle, result in numerous physical phenomena that may be studied from a geological perspective. Such phenomena include development of new lithosphere, rifting of old lithosphere, mountain building, and the assembly and break-up of supercontinents. In the context of applied geology, Mike's research of these phenomena will aid in the search for economic ore deposits.

Ashley Gumsley is pursuing an MSc study of ancient mafic dikes and sills found in northeastern KwaZulu-Natal. His research activities involve determining the geochemistry and ages of these mafic intrusions, as well as their palaeomagnetic properties, and comparing these data to similarly aged intrusions found on other continents. Ashley is using the well-equipped analytical laboratories at UJ, but to acquire U-Pb ages on the intrusions, he recently travelled to Sweden to use the mass spectrometer at the Natural History Museum in Stockholm. Ashley's research results will allow him to not only devise new theories but also to test existing theories regarding ancient continental configurations. One such configuration is the connection of the Pilbara craton found in Western Australia with that of the Kaapvaal craton in southern Africa.

Both the Zimbabwe and Kaapvaal cratons have long been considered a single entity for close to 2.7 billion years. Yet some geologists interpret recent research work to indicate that the two cratons might not have reached their present configuration until much later. MSc student Nicholas Stylianou will use the noble gas mass spectrometer at UJ to determine ages of potassium-bearing minerals, such as amphibole, that will be separated from rocks found in the ancient suture between the two cratons. Nicholas will define target areas and collect rock samples in the

The XRD machine with Mike Knoper (left), Fanie Kruger (centre) and post-graduate student Brandon Zacharopoulos.

suture, known as the Limpopo Belt, by using remote sensing techniques. The potassium-bearing mineral phases from these rock specimens will then be measured for their isotopes of argon, which will allow Nicholas to determine ages of the structural fabric forming events. These data will test recent theories regarding the juxtaposition of the Kaapvaal craton with the Zimbabwe craton.

Brandon Zacharopoulos is an MSc student investigating the occurrence of a lithium-bearing rock, spodumene pegmatite, found in the Vredefort area of the northern Free State. Spodumene is lithium pyroxene, which is an ore mineral of lithium. It is well known that spodumene pegmatite is associated with sodium-rich granitic rocks. Although most lithium today is recovered from brines, increased global demand for lithium batteries will likely require hard rock mining of spodumene in the future. Brandon will use geochemical and mineralogical data from the spodumene pegmatite to construct partial melting models of the crust, leading to a better understanding of how spodumene pegmatite develops from sodium-rich granitic rocks. Such modelling will explore the possibility that TTG granitic rocks, a common constituent

Spodumene is lithium pyroxene, an ore mineral of lithium. In this photo of a spodumene pegmatite from the Kaapvaal Craton, the ash-colored lath-shaped crystals are spodumene, here with their long axes parallel to the rock hammer handle. Tantalite and columbite are two other minerals sometimes found in such pegmatites. Mike Knoper photograph.

Much of the world's platinum is found associated with the basal chromitite layer of the Merensky Reef in the Bushveld Complex. The basal chromitite is the thin dark band about 0.5 cm thick at the base of the pen, between the dark Merensky Pyroxenite and the light-colored footwall anorthosite. Platinum group minerals often found here include PGM phases such as isoferroplatinum, maslovite, sperrylite, cooperite and braggite. Mike Knoper photograph.

of ancient crust such as that found on the Kaapvaal craton, partially melt to form sodium-rich granite, which in turn undergoes fractionation to form spodumene pegmatite. Such research work will assist in the discovery of potentially new ore deposits of lithium in southern Africa.

In terms of economic geology, studying the distribution of platinum group minerals (PGM) within the Merensky Reef is a very important research topic because of the importance of the platinum group elements (PGE) to the South African economy. The Merensky Reef is a mineralized horizon in the world's largest layered intrusion, the Bushveld Complex. Because the textural association of PGM with other minerals in the Reef is one factor that affects recovery of PGE during processing of the ore, Derek Rose studied the PGM from the Merensky Reef at the Two Rivers Mine located near Steelpoort using the mineral liberation analyser (MLA) at UJ. Results from Derek's recently completed MSc project are a contribution towards increasing the viability of mining and processing ore from the Merensky Reef, leading to improved recovery of PGE. Even a small improvement in PGE recovery results in significantly higher revenues for the platinum mines. Another study focused elsewhere on the stratigraphy of the Bushveld Complex and the resultant publication led to the Draper Medal to be awarded to Mike by the Geological Society of South Africa.

Rare earth elements (REE) are often associated with green technologies, such as wind generators and electric cars. Monazite is an ore mineral of light REE such as cerium and neodymium.One research area of interest to Mike Knoper is the Steenkampskraal monazite ore deposit located in the Western Cape near Vanrhynsdorp. Monazite at Steenkampskraal was first mined for its thorium content from 1950 to 1963. Presently there is considerable interest in reopening the mine to extract REE. Research work recently completed by Mike was focused on structurally mapping the distribution of the ore body, as well as determining the emplacement ages of the surrounding granitic host rocks and of the monazite itself. The result of thisresearch lends support to models that predict a down-dip extension to the monazite ore body.

Professor Jan Kramers is involved with several research projects relating to isotopic dating. *Uranium-lead dating of cave deposits in the Cradle of Humankind*. Following the unveiling, in April 2010, of the Australopithecus Sediba fossils and their unusually precise dating based on uranium-lead geochronology of a flowstone (calcium carbonate precipitate) layer within the cave deposit (carried out separately by Dr Robyn Pickering and Prof Jan Kramers, see Dirks *et al*, Science, 328, 205-208), two further publications have come out that provide new dates on cave deposits in this important region of hominin fossil sites, just 40 km NW of Johannesburg. These also relate work done by Ms Robyn Pickering in her PhD project in Bern, Switzerland, supervised by Jan Kramers. They are: Pickering, R, and Kramers, JD, 2010, Journal of Human Evolution. 59, 70-86, and Pickering *et al*, 2011. Earth Planet Sci Lett, 306, 23-32. The first of these reports flowstone dates of the Sterkfontein deposit and presents a revised stratigraphy for this cave site, whereas the second gives new chronological data for the adjacent Swartkrans deposit, and notes that flowstone development can be correlated in time between a number of cave sites in the Cradle area. The oldest flowstone layers so far dated in the region are in Sterkfontein and were formed

Jan Kramers (centre) with Mike Knoper (left) with their post-graduate students in the Ar-Ar facility.

about 2.8 million years ago. The flowstone just overlying the Mrs Ples fossil locus is 2 million years old, the same age as that underlying the *A Sediba* fossil locus 15 km further to the north east. The *Paranthropus Robustus* fossil bearing layer at Swartkrans is topped by a 1.7 million year old flowstone, whereas that in Coopers Cave lies above a 1.5 million year old layer. Some of these data were used in a Faculty of Science public lecture by Jan Kramers in April, which also contained a speculation that they document a gradual drying up of the climate after 2 million years ago, which may ultimately have had consequences for human evolution.

Uranium-lead dating of zircons. Initially good progress has been made on the uranium-lead dating of individual zircon grains by laser-ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) in the Spectrau Analytical Facility. This development is being spearheaded by Ms Clarisa Vorster who will use the technique to get data on the areas of provenance for sandstones in the uppermost Cape and lowermost Karoo Supergroups, information which will be used in the refined reconstruction of Gondwanaland. While instrument performance has been intermittently very good, technical problems have made it necessary for the laser unit to be shipped to the UK twice in the last two years – hopefully to now provide lasting performance for years to come. Although there are comparable instruments operating at Stellenbosch and at UCT, the UJ facility will be the only other one in South Africa and is likely to lead to cooperative research with Wits and UKZN in addition to our own projects.

Argon dating facility. Apart from this development, the noble gas mass spectrometer and laser extraction line, also at the Spectrau AF, has been put back into operation after some minor repairs, as well as modifications and additions. The first batch of samples for $^{40}Ar/^{39}Ar$ dating is to be dispatched to Pelindaba for irradiation in the SAFARI research reactor within days of the time of writing, and includes diverse material, ranging from the Limpopo Complex to the Transvaal Supergroup in the northern Cape, and the Pilanesberg Intrusive Complex (in which Sun City is located). This dating method is the modern equivalent of ^{40}K-^{40}Ar dating, with the difference that by fast neutron irradiation, a portion of ^{39}K is transformed into ^{39}Ar which eliminates the need for a separate K-analysis (on a separate lot of sample) and enables a geological age determination from argon isotope analyses alone. The proximity of the NECSA research institute at Pelindaba presents an ideal situation for this type of geochronology. One MSc project (Mr Nicholas Stylianou) co-supervised with M Knoper is currently being initiated and a number of cooperative projects are in the pipeline, whereby Mr George Belyanin is involved as a Postdoc in this laboratory. Interest is not likely to wane, as this will be the only $^{39}Ar/^{40}Ar$ facility operating on the African Continent.

Establishing uranium-thorium-helium dating. Modifications and additions made to the gas extraction line, in part through the help of our excellent glassblower Mr René Buker, and using material generously donated by Heidelberg University in Germany, will enable the noble gas instrumentation to be used for uranium-thorium-helium dating as well. This venerable dating method was first used by Rutherford around 1906 on uranium ore, but can, given the sensitivity of the machine, be used to provide absolute ages on tiny grains of ordinary, rather uranium-poor minerals such as goethite (Fe-hydroxide) and aragonite or calcite, (calcium carbonates) that can form in cave deposits and soils. Using this methodology for dating such minerals is a pioneering effort, and it will, among other things, be used to attempt further dating of cave deposits in the Cradle of Humankind, particularly targeting mineral matter that is not accessible to the uranium-lead dating method used up to now and mentioned above. A PhD project to be supervised jointly with Prof Lee Berger of Wits University is planned and will be initiated as soon as the technical development is completed.

Professor Hassina Mouri joined the Geology Department, University of Johannesburg (UJ) in August 2008. Before joining UJ she had the opportunity to study and work at several institutions (University of Pretoria, University of Minnesota, University of Paris 7, Muséum National d Histoire Naturelle de Paris, Geological Survey of Finland, University of Helsinki and the Swedish Museum of Natural History).

She is a metamorphic geologist, one of the very few experts in this field in the country. Her research work focuses on the

Hassina Mouri seated on high grade metamorphic rocks in the Limpopo Metamorphic Belt.

(Back right to left) Fanus Viljoen, Mike Knoper and Hassina Mouri, and Lauren Jolly (left) with their respective post-graduate students.

Rajesh, not far from the Eyjafjallajökull glacier, Iceland.

At the 13th Conference of the Geological Society of Africa, held in Tunisia on the 6th of November 2008 Prof Mouri was elected Secretary General of the Geological Society of Africa (GSAf) for a period of four years. In addition, during the last 3 years she was leading the organization of the international conference on African Geology (CAG23) (www.cag23.co.za) organized at the University of Johannesburg in January 2011.

Archaean crustal evolution using classical and modern techniques and multidiscipline approach essentially mineralogy, petrology and radiogenic isotope geology. In particular, Prof Mouri is interested in understanding the so-called *Ultra-high temperature granulites rare rock suites in nature that record still unexplained events when regions of the Earth s crust reached temperatures approaching, even excess 1000°C. These rocks preserve in their textures and minerals, snapshots* of the Earth's past geological history, which are necessary to understand how mountain belts form and how the Earth's crust evolved during early times. More recently she developed interest in medical geology through observations related to the distribution of the so called NORM (Naturally Occurring Radioactive Materials) which seems to be quite common in some high to ultra-high temperature granulite terranes, such as the Namaqualand and the Limpopo Metamorphic Belts in South Africa. Professor Mouri is involved with two PhD and two Master's projects together with Professor Fanus Viljoen and Dr Michiel de Kock.

Over the last 15 years, Prof Mouri has gained extensive research experience in the field of metamorphic geology in various geological environments such as the Archaean Hoggar Shield in Algeria, Svecofennian Belt in Finland, Eastern Ghat Belt in India and British Columbia in Canada. She is currently investigating possible occurrences of these rocks in the Limpopo and Namaqualand Metamorphic belts in South Africa. Most of the results of Dr Mouri's work have been published in international journals and presented at international conferences. She has served as chairperson, committee member and session convener as well as guest speaker at many international workshops and conferences.

Prof Mouri received a number of recognitions including a Research Fellowship by the University of Pavia (Italy) in 2007 and an award for the Best Presentation at an International Congress organized under the International Geological Cooperation Program (IGCP), Australia (1993). In 2008 she was invited as *Studio Guest* for the *Women in Science* television program of the South African Broadcasting Corporation (SABC). More recently, she was awarded the AU-EU Regional Award for women in science, 2010 Edition.

Primarily an igneous petrologist, **Professor Rajesh's** research interests have varied over the years. He was initially involved in studying fluid inclusions in minerals in metamorphic rocks. Recently, fluid inclusions studies have resurfaced again in the form of Masters and PhD students using this technique (instrumentation available in the Department) to study the nature of fluid involved in mineralization in alkaline rocks (eg, Pilanesberg alkaline complex), as well as those involved in dehydration process in the Limpopo Complex.In the field of metamorphism, Prof Rajesh is further interested in characterizing mineral assemblages considered to have formed at extreme temperature conditions (ultrahigh temperature metamorphism) in metamorphic rocks. Together with a doctoral student, currently this study is focussed on the rare Mg-Al granulites occurring in the different sub-zones of the Limpopo Complex.

To igneous petrology and geochemistry, which form Prof Rajesh's prime research interest, there is a basic focus on characterizing the petrographic, geochemical and isotope characterization of granitoids. Current study areas, from where granitoids are studied include Bushveld Complex, Barberton Greenstone Belt, Limpopo Complex, Johannesburg Dome, Vredefort Dome - all occurring within the Archean Kaapvaal Craton. Outside the craton, granitoids studied include those from the Northern Cape Province (eg, Keimoes Suite) and those from the Natal Province (eg, Margate Terrane). Among granitoids, a number of Prof Rajesh's research publications have involved the detailed characterization of orthopyroxene-bearing granitoids, popularly known as charnockites.

Lisborn Mangwane (left) and Baldwin Tshivhiahuvhi (right) preparing samples for microscopy.

Petrographic, geochemical and isotope characterization of granitoids continues into other igneous rocks, primarily mafic to ultramafic rocks as part of layered intrusions (eg, Bushveld Complex- this work is primarily carried out with Mike Knoper and Fanus Viljoen) as well as greenstone belts (eg, Barberton Greenstone Belt). Several of these mafic/ ultramafic rocks are volcanic in origin, especially those from the Barberton Greenstone Belt. Proper characterization of these Archaean mafic/ultramafic volcanic rocks is important to understand the nature of Earth in its infancy. Prof Rajesh is also involved in characterizing younger volcanic rocks too – this include Mesoproterozoic volcanic rocks from the eastern margin of Namaqua Province (eg, Areachap Group, Koras Group) and the youngest of all –volcanic rocks from Iceland. Regarding Icelandic rocks, his study focuses on gabbroic to granophyric rocks occurring within the volcanic rocks – especially along the zone along which Iceland is splitting apart – one half moving towards North America and the other towards Europe.

Remote Sensing and GIS forms two important tools that often aid Prof Rajesh's research activities. In the early 2000s, Prof Rajesh was primarily using Remote Sensing and GIS to map uranium mineralization in Northern Territory, Australia. Recent usage of these techniques involve mapping in the Limpopo Complex and Barberton Greenstone Belt. He has used both active and passive (multispectral and hyperspectral) remote sensors for various purposes (eg, mapping of dike swarms, alteration mineral mapping, to understand pre- and post-eruption movement underneath volcanoes). Together with Mike Knoper, a master's student is currently involved in using GIS and Remote Sensing in characterizing the vast amount of mafic dikes and sills that crisscross southern Africa. Prof Rajesh is also supervising a master's student together with Bruce Cairncross. The student is currently involved in characterizing altered and unaltered dikes associated with coal seams.

The tool of geochemistry has taken Prof Rajesh into the field of sedimentary rocks too. Over the last five years, he has been involved in characterizing the provenance of sedimentswith the intent to reconstruct and interpret the history of sediment from the initial erosionof parent rocks to the final burial of their detritus. Together with a doctoral student he has been using a multitude of tools from traditional point counting analysis, heavy mineral analysis, mineral chemistry, major and trace element whole-rock geochemistry, whole-rock isotope chemistry and radiometric dating of detrital minerals for the purpose.

Freeman Senzani is conducting research into how lime and cement production plants can be customised for use by small-scale operators in South Africa. Large-scale operations are the norm, and in Malawi, where, although there has been a long history of small scale operations, these have been inefficient and environmentally unfriendly, especially with regard to deforestation. The goal of this project is to determine and provide technical interventions which will enable the small-scale miners to overcome the above challenges in both countries and enable them to exploit resources close to areas where they live. The objective is to provide opportunities for entrepreneurs with low technical knowledge and meagre financial resources to enter the industry.

On successful completion, this research will provide opportunity to increase numbers of individuals of the countries involved in the industry in general, but, in particular, where local carbonate resources and labour can be utilised. This has the added advantage that it offers a vehicle for creation of employment opportunities in the communities close to the deposits and projects, which also helps in poverty reduction, widening participation in the mining sector and triggering off of support industries.

UJ Professors Dirk van Reenen (second from left) and André Smit (second from right) with collaborators from Russia. Left to right they are Dr Elena Dubinina, Professor Leonard Aranovich and Professor Oleg Safonov. Professor's Aranovich and Safanov are Visiting Professors in the UJ Geology Department.

Professor André Smit has been involved in geological research since the early 1980's in his capacity as co-leader of the Limpopo Research Group with **Professor Dirk Van Reenen**. His research interest mainly focuses on the structural aspects of the geodynamic evolution of orogenic terranes with particular emphasis on that of the Limpopo Complex. During this lengthy period of time they attempted to establish, with the help of local and international co-workers, a working model for the geodynamic evolution of this well-known tectono-metamorphic terrane. Since the late 1990's, the research team from UJ was systematically bolstered by the addition of new specialists in different sub-disciplines such as the world famous metamorphic petrologic the late Professor Leonid Perchuk from the Moscow State University, Russia, Professor Jan Kramers from Bern University, Switzerland, now a member of UJ staff, Professor Richard Armstrong from ANU in Australia and Professor Taras Gerya from the ETH in Switzerland supported by several local co-workers. Most of the results of the working group have been published in international journals and presented at numerous international conferences. The research project resulted in an International Field Conference in 1990 followed by a special volume *The Archaean Limpopo Granulite Belt* authored by Van Reenen *et al*, in Precambrian Research in 1992. The progress during the following 10 years culminated in 2008 in a second Limpopo International Field Workshop in the Limpopo Complex finally published as the GSA Memoir 207 again edited by Van Reenen *et al,* 2011. Most of the papers in this Memoir were written by staff of the Department of Geology at UJ. Professor Smit was involved in five papers as first, or co-author.

International collaboration has also lead to studies of similar terrains abroad. Professors Van Reenen and Smit visited the Fenoscandian granulite belt (part of the Lapland Granulite Terrane) and the Belamoran Craton in the Cola Peninsula, Russia and The Yenisay Range in central Siberia during the mid- 1990's as part of the South African-Russian collaboration project with Professor Leonid Perchuk. Both these research projects resulted in publications in international journals and generated important geological information that was cross-fed to the Limpopo Complex study.

Since 2008, two more scientists from the Department of Geology at UJ became involved in the Limpopo Complex research, namely Professors Rajesh Hariharan, a geochemist and Hassina Mouri, a metamorphic petrologist.

Many MSc and PhD students studied within this project since the early 1980's one of the latest being René Boshoff who did both her MSc (2005) and PhD (2009) on the structural and metamorphic evolution of the Central Zone of the Limpopo Complex under the supervision of Professors Van Reenen and Smit.

Two new research projects have been launched in 2011 that will be overseen by some members of the Limpopo Research Group.

The first project involves investigating fluid composition and propagation modes in deep crustal shear zones. This project that is planned for three years (2011-2013) and sponsored by local and Russian funding will be undertaken by several local and international researchers:

- Department of Geology, UJ (Profs DD Van Reenen, CA Smit, C Roering).
- Institute of Ore Deposits, Russian Academy of Science Moscow, Russia (Prof LY Aranovich).
- Institute of Experimental Mineralogy, Russian Academy of Science, Chernogolovka, Russia (Proff O Safanov, MA Novikova).
- Department of Petrology, Geological Faculty, Moscow State University, Moscow, Russia (Dr OY Yapaskurt).

One of the outstanding problems of granulite facies metamorphism relates to the role of a fluid phase in the process. The *dryness* of granulites has been actively debated for several decades and resulted in two schools of thought: (i) granulites resulted from high temperature metamorphism in the absence of a fluid phase, or (ii) granulites formed in the presence of a free fluid phase. Following the above considerations, the project will be a multidisciplinary study of the fluid channelling along high-grade shear zones from different parts of the Central Zone of the Limpopo Complex, with emphasis on the fluid regime.

The second project is a one-year study of high-temperature gold deposits in the Southern Marginal Zone of the Limpopo Complex under supervision of Profs DD Van Reenen and CA Smit. Lode-gold deposits usually occur in granite-greenstone terranes of low- to medium-grade of metamorphism. Such deposits are well studied in terms of their petrogenesis, ore mineralogenesis, and structural control. High-temperature (>400°C) gold deposits are fairly rare and have only recently being found in the Yilgarn block in Australia, in Canada, and the Renco Mine in Zimbabwe. A small gold deposit, the Doornhoek deposit that was surface trenched and drilled by Shell Co during the 1990's has been studied by PhD student Laurenco Stefan of our Research group and described as one of the very first high-temperature gold deposits in the world. Recently the same company started mining the deposit as an open pit mine, opening many new possibilities for investigating this rather unique geological phenomenon and solve the problem regarding gold deposits and high-grade fluid flow during the exhumation stage of orogenic terranes.

The research interests of **Bertus Smith** encompass geometallurgy and chemical sedimentary geology. Geometallurgy involves quantifying the variability of an ore deposit in terms of its processing behaviour. This requires the usage of numerous geological, mineralogical and metallurgical investigative techniques. The ore deposit first needs to be described with regards to its size, dimensions, rock types and value. A full mineralogical investigation needs to follow to determine all the mineral phases present, what rock texture they make up and their possible influence on the separation technique to be applied to the ore. Metallurgical testing follows to determine how effectively the ore minerals can be separated from the

Bertus Smith (left) with Fanus Viljoen underground at BRPM mine.

unwanted minerals and the testing can include milling, flotation, chemical leaching, gravity and magnetic separation. Currently Bertus Smith is focussing on the Merensky Reef, one of the world's premier deposits of platinum-group minerals. The research is financially and logistically supported by Anglo Platinum, Anglo Research, Royal Bafokeng Platinum and the DAAD and comprises his PhD thesis. Results of the research have already been presented at international conferences in Hungary and Cape Town.

When it comes to chemical sedimentary geology, Bertus Smith focuses on Archaean (older than 2.5 billion years old) occurrences of iron- and manganese-rich chemical sedimentary rocks in South Africa, and more specifically in the Witwatersrand and Pongola Supergroups. The main aim of the research is to determine the conditions in the oceans from which these sediments were precipitated during the Archaean, thereby gaining insight into the environmental conditions of the early Earth. The possible involvement of primitive bacteria in the precipitation and development of the sediment is also investigated and much can be learned of the evolution of life in the early Earth's oceans. Bertus Smith's research in this field has been presented at numerous international conferences in South Africa, Germany, the USA and Australia and published abstracts and articles have followed. This field of research was also the subject of his MSc thesis and he has been presented with the following awards:

• Best MSc thesis in the Faculty of Science at the University of Johannesburg in 2008.

• The Geological Society of South Africa's Johan Handley Award for the best MSc thesis at a South African university in 2008.

• The Geological Society of South Africa's Corstorphine Medal for MSc thesis at a South African university deserving of international recognition.

- Best student speaker at the combined Society of Economic Geology and Geological Society of South Africa Student Conference in 2008.
- Second best speaker during the earth science sessions at die Suid-Afrikaanse Akademie vir Wetenskap en Kultuur Studentesimposium in 2009.

Herman van Niekerk (back left) with the UJ Geology Honours class in Mozambique.

Herman van Niekerk and Mike Knoper standing at the migmatitic gneiss basement looking towards cover rocks near Hoedspruit.

Dr Herman van Niekerk has a broad interest in the geology of the world in general. His research interests cover a wide field, from analytical techniques and analytical equipment like X-ray Diffraction and Laser Ablation Induction Coupled Mass Spectroscopy (LA-ICP-MS), to the evolution of the ancient Earth, landscape evolution in the recent past to what is happening on today regarding coastline evolution as well as the monitoring of earthquakes as they occur around the world. Dr Van Niekerk is regularly invited by the media (radio and TV) to comment on earthquake occurrences or threats of occurrences. Other research includes investigating the evolution of the landscape of southern Africa and the change in climatic conditions it experienced since the breakup of the supercontinent Gondwana from about 120 million years ago to the present. The understanding of the evolution of the landscape of southern Africa holds major implications for the distribution and preservation of some economically important mineral deposits, like diamonds.

At present, Dr Van Niekerk, who worked many years as an instrument scientist, Prof Kramers and their students are currently involved in the establishment of a facility at the University of Johannesburg for the age determination of certain minerals utilizing the U-Pb isotopic system by means of the LA-ICP-MS. Other research niches include an international efforts to understand the formation of the western margin of the ancient Kaapvaal Craton between 2000 to 1000 million years ago and how this played a role in the formation of the supercontinent Rodinia.

The evolution of the eastern coastline of Africa, is another area where Dr Van Niekerk, is involved. The rapidly evolving and continuously changing sedimentary systems of KaNyaka (formerly Inhaca) and Portuguese Islands of the coast of Mozambique are areas of interest for Dr van Niekerk and other colleagues. Not only will this bring greater insight into what might happen to Maputo bay in the near future, but it can contribute to the search for oil and the distribution of heavy mineral deposits along the coast of Mozambique. Another important part of the research on the KaNyaka island system which Dr Van Niekerk will get involved with in the near future is to study how coral reefs evolve and survive in such a rapidly changing geological system.

Research in Geometallurgy at the Department of Geology

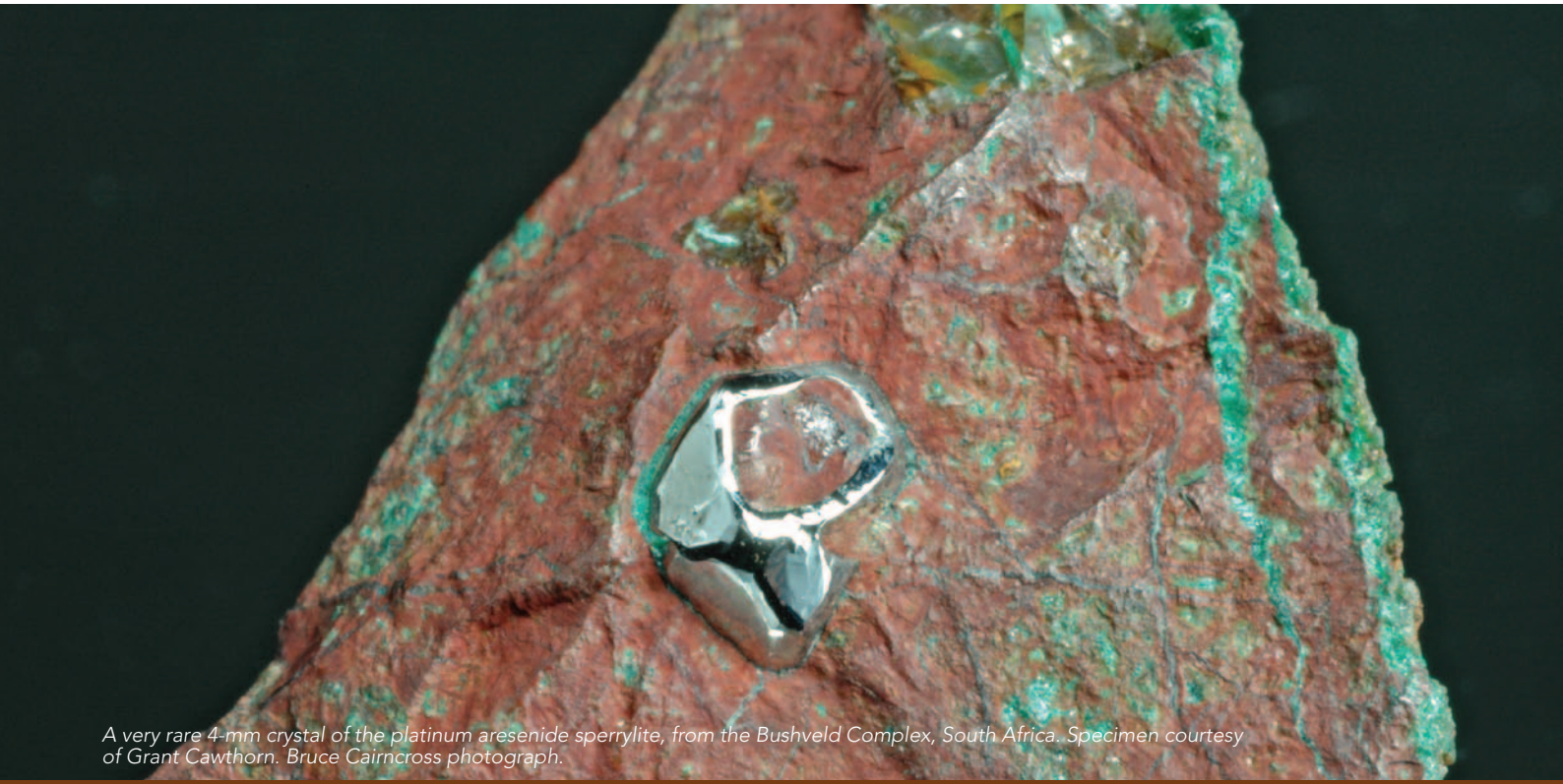
The South African Department of Science and Technology Research Chair in Geometallurgy was originally granted to Prof Jens Gutzmer, starting January 2008, and was transferred to **Professor Fanus Viljoen** in June of 2008.

As the world demand for metals increases, the focus changes to lower-grade or problematic deposits that would not have been mined in the past. Without a thorough understanding of the mineralogical constraints (ie variations in mineral compositions, size, morphology, mineralogical associations, impact of grind size on liberation and the reason for deportment of minerals in certain streams) interpretation of metallurgical test work could be flawed. This highlights the necessity for conducting in-depth mineralogical, petrographical and mineral chemical investigations in order to obtain a better understanding of the metallurgical behaviour imparted by these ores.

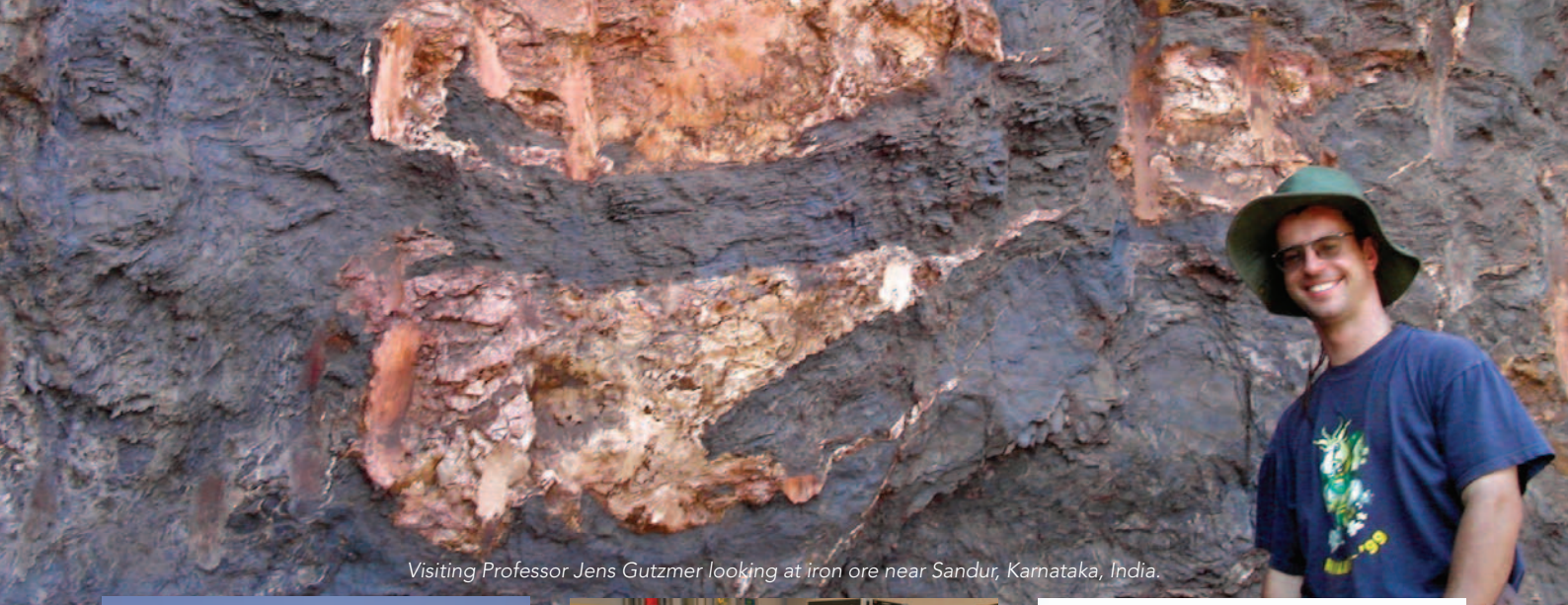
The primary thrust of Professor Fanus Viljoen's research is to develop and apply geometallurgical methods to quantify the mineralogical and textural characteristics of ore bodies, ores, concentrates and successor products in resource types relevant to the South African minerals industry.

Fanus Viljoen (beard, centre) and Hassina Mouri (third from right) with students and postdoctoral staff working in the Geometallurgy group.

Fanus Viljoen, Mike Knoper and geology Master's students underground with geologists at Lonmin mine near Rustenburg.

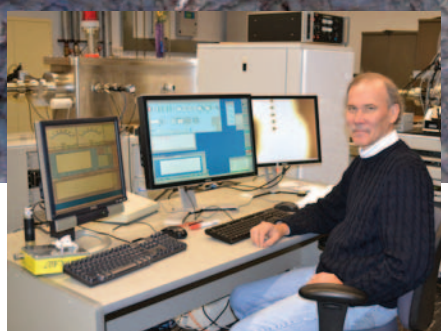


A very rare 4-mm crystal of the platinum aresenide sperrylite, from the Bushveld Complex, South Africa. Specimen courtesy of Grant Cawthorn. Bruce Cairncross photograph.



Visiting Professor Jens Gutzmer looking at iron ore near Sandur, Karnataka, India.

Visiting Professor Joydip Mukhopadhyay at Niagara Falls, Canada.



Visiting Professor Richard Armstrong at the SHRIMP at ANU, Australia.

Visiting Professor Toshiaki Tsunogae in East Antarctica during the 2010-2011 Japanese Antarctic expedition

Research is focussed on the characterisation of platinum-group element mineralisation within the Merensky Reef and the Plat Reef of the Bushveld complex, utilising mineralogical and geochemical techniques such as X-ray diffraction analysis, scanning electron microscope-based automated mineralogy, and electron microprobe analysis. Determining the mineralogy of various ores of the platinum-group elements, along with associated silicate, oxide and sulphide minerals in relation to metallurgical issues during the recovery of platinum-group elements, is an example. Research is also focussed on geometallurgical aspects of gold, diamond, nickel, the base metals (copper-lead-zinc), coal and lime, with a view on the optimisation of treatment plants and optimised metal recovery.

Research into automated mineralogy as applied to the characterisation of ores and ore bodies is conducted on a *state-of-the-art* FEI 600F Mineral Liberation Analyser at the University of Johannesburg which was successfully installed and commissioned in the first half of 2009. The new instrument is located within the Central Analytical Facility of UJ (Spectrau), was purchased late 2008 by the University of Johannesburg in support of the DST Research Chair in Geometallurgy, and was delivered in January 2009. With the Mineral Liberation Analyser, ore particle cross-sections, for example, can be analysed to better understand, optimize and predict mineral processing circuit performance.

Five MSc projects, six PhD projects, and one post-doctoral project is currently in progress. German Academic Exchange Service (DAAD) scholarship recipient Mr Bertus Smith is currently on a visit to the Technische Universität Bergakademie **Freiberg** in Germany, to further his doctoral studies into the geometallurgy of the Bafokeng Rasimone platinum mine near Rustenburg in South Africa.

Dr Cora C Wohlgemuth-Ueberwasser received her PhD in 2008 from the University of Münster (Germany) before working as post-doc at the University of Bonn (Germany). Since February 2011 she is a post-doc with the PPM group at the Department of Geology at UJ. Her research interests focus on the analysis of platinum-group elements and other trace metals in sulfides using LA-ICP-MS facilities at SPECTRAU. Current projects include the recrystallisation processes of submarine black smoker sulphides and VMS deposits.

In addition to the academic and research staff, the UJ Geology Department also has several formally appointed international **Visiting Professors**. These are individuals that collaborate with UJ staff via joint publications, research projects and post-graduate student supervision. The following Visiting Professors have been appointed: **Professor J Gutzmer** (TU Bergakademie Freiberg, Saxony, Germany); **Professor T Tsunogae** (University of Tsukuba, Japan); **Dr R Armstrong** (Australian National University, Canberra, Australia); **Prof LY Aranovich** (Institute of Geology Ore Deposits, Petrography, Mineralogy and Geochemistry, Russian Academy of Sciences, Moscow, Russia; **Prof OG Safonov** (Institute of Experimental Mineralogy, Russian Academy of Sciences, Moscow, Russia)a and **Professor Joydip Mukhopadhyay** of the Presidency College in Kolkata, India.

TOP STUDENT ACHIEVERS OF 2010 IN GEOLOGY

These are the Geology Department prize winners who were the best students in their class. Left to right: Mr DNJ Tiddy (best 1st Year), Mrs C van der Merwe and Ms MM Grobbelaar (tied best 2nd Year students), Ms L Bowden (best 3rd Year) and Mr M Barnard (best Honours student). In 2011, Mr Barnard also recently won the Geological Society of South Africa Award for the best Geology Honours student at any University in South Africa.

The granite mountains of Klein Spitzkoppe in Namibia. Bruce Cairncross photograph.

Support and Administrative Staff

Any research, in any department, relies heavily on support and technical staff within the Department. These staff members act as the interface between the researchers and the Finances and Procurement Divisions, run the administration of the department and oversee the fleet of Geology field vehicles that are vital for most research projects. In this regard, **Mrs Elsje Maritz** (Administrative Assistant), **Ms Diana Khosa** (Administrative Assistant), **Mr Hennie Jonker** (retired but still working on contract), and **Mr Herbert Leteane, Daniel Selepe** and **Seth Radzilani** are Technical Assistants. **Mr Lisborn Mangwane** and **Mr Baldwin Tshivhiahuvhi** provide the thin sections and polished sections for staff and postgraduate students. Mr Michael Chakuparira provides administrative support to the PPM group and also supplies graphic services for publications and conferences.

Departmental Administrative Assistant, Mrs Elsje Maritz.

Mr Herbert Leteane, Departmental Technical Assistant.

Ms Diana Khoza, Technical Assistant and office administrator.

Mr Daniel Selepe, Departmental Technical Assistant.

Mr Michael Chakuparira, PPM administrative assistance and graphics assistant.

Mr Hennie Jonker, administrative and technical assistant.

Mr Seth Radzilani, laboratory assistant.