

# Research in mineral sciences contributes to the country's wealth

One of the key research areas identified in the Faculty to address national, regional and global challenges is research into mining and minerals beneficiation. Two departments that conduct complementary research in the mineral sciences supply chain are Mining Engineering (related to the extraction and exploitation of the country's mineral reserves) and Materials Science and Metallurgical Engineering (related to processing and refining mineral resources into viable materials, and the performance of the materials in service).

## Mining Engineering

Research focus areas that receive particular attention in the Department of Mining Engineering include those of rock mechanics and underground mine design, rock breaking and surface mining, mine management and leadership, mine ventilation engineering, risk management, mineral economics, and underground mining methods and mine design. With the support of industry, the Department has established two research chairs, as well as an innovative research institute, to conduct research into some of the pertinent issues facing the mining industry both in South Africa and internationally.

### Harmony Chair in Rock Engineering and Numerical Modelling

Mining at depth or mining highly stressed areas commonly occur in the South African gold mining industry due to the age of operations and the extent of mining conducted over the last century. The safety concerns related to mining these areas, especially in terms of seismic activity, have the potential to limit future gold production, unless methods are found to select and manage mining within acceptable risk levels.

The Harmony Chair in Rock Engineering and Numerical Modelling

conducts research into rock engineering, and specifically the impact of mining sequences and mining rate on seismic activity in deep-level mines or highly stressed areas such as remnants or shaft pillars. This research will initially focus on seismic and mining-related parameters that have historically been used to measure the risk involved in mining these areas. It will ultimately search for more appropriate parameters, and even methods of determining these parameters.

This will include the use of numerical modelling packages and the potential to develop a constitutive law that could simulate strain softening, or a stress drop in areas where stress fracturing has occurred, normally ahead of the mining faces. The potential constitutive law could allow for the dissipation of a portion of the energy available to generate seismic activity within the model, and could assist in the comparison of different mining sequences to decide on the lowest risk option for implementation.

Research outcomes will be applied to specific sites for mines for which sufficient seismic data exists, in an attempt to correlate results or at least indicate the applicability of the findings to date. Research will be conducted by external rock engineering practitioners within the industry as part of their

individual postgraduate study programmes, with the help of postgraduate students at UP and under the leadership of Prof Francois Malan and Prof John Napier. The research outcomes not only have the potential to affect the safety of deep-level mine workers, but will also be used to expose undergraduate and postgraduate students to the potential impact on the safety and profitability of well-designed and well-managed mining practices.

At the same time, the value of a team approach in mining is emphasised, where the mine manager should use all the skills available to him (in this case, high-level rock engineering skills) to facilitate safe and profitable mining practices.

### Sasol Chair in Safety, Health and Environment

The Sasol Chair in Safety, Health and Environment aims to improve the health and safety performance of the mining industry, mainly through the Executive Certificate in Safety, Health, Environment and Community (SHEC) Resilience for managers in the mineral resources industry.

This comprehensive online programme is exclusively designed for the mineral resources sector, and covers critical issues related to safety, health and the environment. By improving their knowledge



→ *The Mining Resilience Research Institute will examine some of the underlying causes of the underperformance of mining.*

and application ability, the programme enables mine managers to move from being reactive and compliant, to becoming resilient in issues regarding safety, health, the environment and community management.

The establishment of this chair has created new research opportunities, including a noise-induced hearing loss research project. This project is aimed at reducing the noise exposure associated with a scrubber, which is mounted onto a continuous miner. Further research needs in the industry will be identified, and the research focus will be directed as required.

### **Mining Resilience Research Institute**

It is widely acknowledged that mining in South Africa should be a source of economic growth and

social transformation. During informal discussions held with a large number of heads of department at the University of Pretoria in 2013, the general perception was that, for a number of complex reasons, mining in South Africa was not meeting the full expectations of investors, government, employees, organised labour, communities and other stakeholders.

The view was expressed that the University could be instrumental in improving the resilience of the mining industry in South Africa by researching some of the underlying causes of the underperformance of mining, and to do so in collaboration with other organisations working on related topics.

This led to a decision to establish the Mining Resilience Research

Institute (MRRI), which was officially launched in August 2015.

The MRRI is a multidisciplinary research initiative that will, through rigorous integrated scientific research, contribute practical, implementable solutions, which will, in turn, lead to the increased resilience of the mining industry, and establish the University as a leading international contributor to solutions for complex mining industry problems.

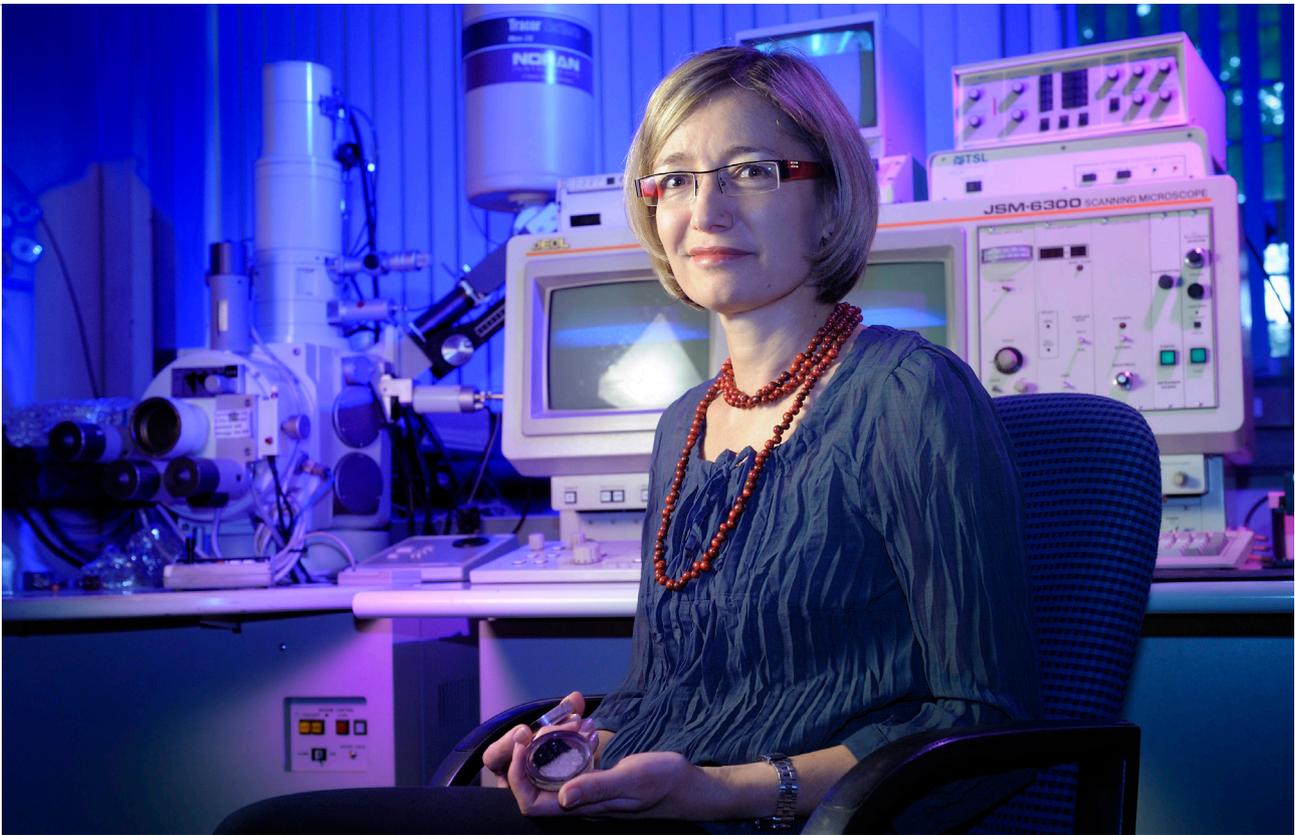
The MRRI forms part of the Sasol Chair in Safety, Health and Environment, and collaboration with the Department of Materials Science and Metallurgical Engineering is envisaged to ensure improved safety, not just during the mining of mineral resources, but also during the subsequent processing of the mined material.

### **Materials Science and Metallurgical Engineering**

The Department of Materials Science and Metallurgical Engineering focuses on research in six key areas in fields related to the processing, refinement and application of mineral resources and the metals extracted from them: pyrometallurgy, welding engineering, minerals processing, hydro-metallurgy, corrosion engineering and physical metallurgy. Four industry-sponsored chairs and an established research institute that conducts contract research for industry enable globally relevant research.

### **Anglo American Research Chair in Pyrometallurgy**

With the establishment of the Anglo American Chair in Pyrometallurgy



→ Prof Andrie Garbers-Craig, incumbent of the Anglo American Chair in Pyrometallurgy.

in 2009, the concept of a Centre of Excellence in Pyrometallurgy was born. This centre was officially launched on 30 May 2011. The key aim of this Centre is to perform internationally competitive research that is relevant to the local pyrometallurgical industry, thereby bringing the Pyrometallurgy research group at the University of Pretoria and the South African pyrometallurgical industry closer together. Communication, cooperation and support between academia and industry can be strengthened through this collaboration, and expertise in pyrometallurgy can be further developed.

The Centre for Pyrometallurgy is now well established, with ongoing research being conducted in aspects of pyrometallurgy such as ore, sinter and pellets, reductant and flux characterisation,

process thermodynamics and mechanisms, process optimisation and development, refractory materials performance characterisation and by-products valorisation.

The group is closely linked to industry with a focus on industry-driven projects. There is a strong focus on experimental studies. It also collaborates with the Glencore Chair in Pyrometallurgical Modelling to address the direct needs of the South African pyrometallurgical industry. These research groups boast well-equipped, high-temperature laboratory facilities and software tools.

#### **Glencore Chair in Pyrometallurgical Modelling**

The Glencore Chair in Pyrometallurgical Modelling aims to support local industry with basic and applied research

to promote knowledge transfer in the field of pyrometallurgical processes and related materials with a specific focus on the measurement and modelling of material physiochemical properties, computational thermochemical analysis, process modelling, multiphysics modelling and techno-economic modelling.

The research programme is closely linked to industry needs and boasts excellent equipment, hardware and software.

Multiphysics models of high-temperature smelting and sintering furnaces are being developed to improve process understanding and ultimately enhance performance in the ferrochrome and platinum industries. Multiphysics models require high-quality material property

data at high temperatures to provide accurate modelling results. Such data is often not available. For this reason, an electromagnetic levitation cell is being developed to determine the physiochemical properties of various materials at high temperatures in a non-contact environment. The thermochemical properties of vanadium-containing oxide solutions are also measured and modelled to make it possible to study South Africa's vanadium extraction processes using thermochemical modelling techniques.

The Pyrometallurgy Modelling research group aims to provide highly skilled engineers and develop world-class computational facilities to support the South African pyrometallurgical industry so that it can maintain and enhance its international competitiveness.



→ *Materials science research examines the processing and refining of mineral resources into viable materials.*

### **South African Institute of Welding Chair in Welding Engineering**

This chair focuses on postgraduate research in welding engineering and the postgraduate training of welding engineers and technologists according to fully accredited international programmes. Welding engineering is a scarce skill, and the industry relies on the delivery of graduates who are qualified according to the requirements of the International Institute of Welding (IIW) and are accredited as international welding engineers and technologists.

The training programme of the IIW is the only system recognised by training and accreditation entities worldwide such as the International Systems Organisation (ISO) and the European Committee

for Standardisation (CEN). Locally developed course material is supplemented by internationally approved web-based multimedia distance learning material developed in Germany.

About 15 full-time and part-time postgraduate students conduct research in the on-campus welding laboratory and at the facilities of various industrial partners. This includes research on the welding of industrially important base metals, mainly carbon steels and stainless steels, and the characterisation of the welded joint. Some undergraduate students also conduct welding research.

### **Tenova-Bateman Chair in Minerals Processing**

The Tenova-Bateman Chair in Minerals Processing was established in 2012. Its key aim is to

perform internationally competitive research that is relevant to the local minerals processing industry, thereby bringing the Minerals Processing research group closer to the minerals processing industry in South Africa.

### **Industrial Minerals and Metals Research Institute**

The Industrial Minerals and Metals Research Institute (IMMRI) was founded as a partnership between the University of Pretoria and the then Iscor to provide high-level support to the steel industry and to support research and education by making sophisticated equipment and expertise readily available to researchers and students in the Department of Materials Science and Metallurgical Engineering. The successful partnership with industry has been maintained and

built over the years and today IMMRI serves as one of the specialised service providers for Arcelor Mittal with a focus on supporting production at Arcelor Mittal South Africa.

The focus of the service and research activities of IMMRI is on physical metallurgy, fabrication processes and protective coatings. IMMRI has established itself as a service provider of choice in these fields for the local industry. It also contributes to the development and application of microalloyed steels through participation in international development programmes and local skills development through research, publications and seminars. Funding from industry partners is leveraged to support and align university research at both undergraduate and postgraduate levels. ➔