

# geobulletin

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VOLUME 57 NO. 4

12th International Platinum Symposium  
A worthy trip to the Far East  
A ship wreck in the Canadian Arctic

news





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*Artist's impression of the eruption of the Rooiberg felsites at the beginning of the Bushveld magmatic event. Oxidised, red lavas succeed earlier dark-coloured lavas.*

**Artist:** Maggie Lambert-Newman



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# from the editor's desk

Chris Hatton



Most South Africans think South Africa is the best place on Earth; why else would we put up with those that are trying to mess it up? Different places on the planet have different reasons for thinking their particular place is the place to be. North Americans think they are the creators of the great new society. Europeans think they are the inheritors and keepers of Western civilisation. Indians inherit a civilisation that is even older; and so on. In South Africa we still have relics of ecosystems which civilised humans have not yet irreparably altered. If we are to believe the story that the South African basement rocks preserve a record from the Cradle of Life, then these ecosystems rest on the rocky foundations where life began. How much truth is there in this story, is it just a myth to give our little corner of the earth an illusory sense of self-importance?

A couple of observations are currently stirring up the story of life. The first is that cells far prefer dealing with potassium than with sodium. Although this observation was made a while back, the implication that cells could not have originated in the salty oceans is only recently becoming widely accepted. Cells must have originated in fresh water, in ponds on ancient continents. The Barberton Mountain Land and the Pongola-Witwatersrand basin are indisputable relics of an ancient continent.

Biologists can tell time using molecular clocks. Once they are calibrated these clocks can measure time to

better than a thousand years, apparently much better than the million year errors associated with radiometric clocks. But to calibrate molecular clocks biologists must turn to the rock record. A notorious calibration point is the diapsid (chicken) – synapsid (man) split which the rock record places somewhere between 312 and 330 million years ago. When an age of 300 million years is used to calibrate a fungal tree of life the split between fungi and animals comes out as more than 2600 million years ago, and the split between animals and plants at more than 3 billion years ago. Conventional biological wisdom regards these ages as ridiculously old, so the fungal biologists reject the 300 million year age for the chicken-man split, even although this is younger than the rock record suggests. If an age of 330 million years were taken for the chicken-man split, then the fungus-animal split would be 2900 million years ago, about the time the Witwatersrand gold deposits were forming. In 1974 Dieter Hallbauer claimed to see fungus in the Carbon Leader. The eminent scientist, Preston Cloud subsequently claimed to be able to reproduce these 'pseudomicrofossils' experimentally. Although this temporarily undermined Hallbauer's well-documented observations, the pendulum is now swinging back, as Greg Retallack has recovered similar objects from the Hekpoort palaeosol. The presence of fungus in the Wits The second observation is that the mitochondrion which drives the energy system in humans and certain other eukaryotes, seems to have originated as a bacterial parasite. This parasite originally stole energy from its eukaryote host. In time the tables were turned and now this parasite has become our slave, burning oxygen to provide us with energy. The mitochondrion is only one example of how the bacterial parasite has been transformed. In other eukaryotes, for example *Giardia*, the parasite has been transformed into an organelle which produces hydrogen. *Giardia* is particularly well-known because it induces diarrhoea in humans, but there are similar examples in many branches of the world of eukaryotes. The implication is that eukaryotes were quite capable of living in the time of hydrogen, and could happily survive long before the Great Oxidation Event, ~2 400 million years ago. This undercuts the idea that eukaryotes only originated two billion years or so ago, when the earth was becoming well-oxygenated. Eukaryotes could well have been present in the oxygen-

free, three billion year old ancient continent.

is no longer the far-fetched idea that the scientific establishment once rejected.

So does this mean that we should accept that the ancient Kaapvaal Craton was covered with eukaryotic life? Certainly not; nothing in science is ever certain. But should we be devoting more resources to investigating whether this ancient continent harboured complex life? Certainly. In this issue Guenther Brandl gives some idea of the resources that China has made available for the investigation of challenging scientific issues. One avenue would be to invite these and other well-resourced nations to investigate life in our ancient continent. This would have to be done in a balanced way, and South African would have to pay its fair share. Yes, we are a relatively poor nation, but this has not stopped us from investing heavily in an astronomical program that will maybe, just maybe, provide clues to the origin of life. With the possibility that giant steps in the evolution of life, the origin of plants and the origin of animals are preserved in the South African rock record, a similar investment in the search for ancient life is surely warranted. This investigation will require close cooperation between biologists and geologists. On pp. 17-18 Freddie Roelofse outlines plans for an International Scientific Continental Drilling Programme

to comprehensively sample the Bushveld Complex. Microbiologists will be involved in this programme, and this will hopefully further encourage cross-fertilisation of ideas between geologists and biologists.

In more modern times the links between geologists and biologists are well established. The Karoo Basin is widely recognised as the prime record of the evolution of the mammal-like reptiles, and South Africa's hominid record brings together geologists, biologists, archaeologists and anthropologists. Extending the study of life to the ancient continent on the Kaapvaal craton holds the possibility of linking these sciences to astronomy. Although Earth may be the only place in the solar system where life is present, there are a sufficient number of investigations into the possibility of extraterrestrial life for astrobiology to be a credible discipline. Bringing geology and astronomy together via biology seems to be an increasingly plausible option. Integrative science, as in the CIMERA initiative, is the way forward in modern science, and is in keeping with the South African tradition. In the words of the old South Africa, *Ex unitate vires*, "in unity is strength", and in the words of the new South Africa, *!ke e: Ixarra Ilke*, "diverse people unite".

Wishing you all the best for 2015.

**Chris Hatton**

## executive managers

The world of earth science has definitely not stagnated since the last issue of Geobulletin! A number of important issues have arisen, and some significant changes have happened. A real positive is that the GSSA membership continues to show slow but steady growth, now at 3487 members, and we continue to be engaged in a number of issues and projects for the benefit of the membership as well as external stakeholders.

Unfortunately the inability of many of you being able to receive the printed journal is the result of the continuing South African postal strike. We have posted a digital copy of the September Geobulletin for easy access on the website, and we will do the same with this issue since there seems to be no end to the strike in sight as at time of writing.



corner

Craig Smith



This has also affected your latest copy of the South African Journal of Geology. We will notify the membership as soon as the latest issue is posted on Geoscience World (through which all members have free access to the Journal). There is a sizable core of our membership who would like to see the Journal continue to be printed. But if we cannot deliver through the postal system, there is little point in having a printed copy. We are currently looking at models where the default will be digital, but print copies could be provided to those who want them. We know that access to sufficient broadband can be difficult for those outside of the major centres – but access is improving all the time.

A fundamental change concerns the Journal. Jay Barton and Lew Ashwal are the chief scientific editors who have steered the Journal for the last fifteen years; Jay has doubled as the production editor – and they are stepping down. The GSSA would like to express its gratitude and thanks to Jay and Lew, who have done an exemplary job of publishing the SAJG for the Society. These positions are honorary and non-remunerated and fulfil the extremely important task of being the corner stone and platform of the 'learned society' part of GSSA operations. They provide the vehicle for the essential input from academic colleagues pursuing research and teaching careers and without this dimension, we would not have the high quality professionals that we do have in South Africa, and indeed across the globe. There is an ad in this issue asking for interested candidates to come forward.

A most significant event in earth science occurred in October in Copenhagen, where members of the Intergovernmental Panel on Climate Change (IPCC) issued their latest reports, including a synthesis report, a report on impacts, adaptation, and vulnerability, and a report documenting mitigations. Every earth scientist should at least skim these documents, whether in agreement with the conclusions or not. The recent deal between the USA and China on greenhouse gasses should be a pretty clear indication of where the world is headed, as far as policy is concerned!

The IPCC documents have medium to long term implications for our resource industries as well as for science. (For those of you working for companies

that operate in the Arctic, there are some particularly interesting conclusions about shallow permafrost; and it is safe to say "ignore this at your peril"). Those who are on the wrong side of global policy developments are unlikely to be winners in the long term commercial space. As far as the science is concerned it's our responsibility as professionals whether in academia, industry or government to continue to research, question, verify and/or debunk. That is science; let's keep the advocacy out of the debate. See <http://www.ipcc.ch/> for the reports. This is possibly the most important earth science issue of the day; I'm afraid it probably trumps the price of gold and PGM's.

In this issue you will find an interesting article on an international biogeochemistry research program dealing with the oceans. It's important stuff; South Africa is involved – but possibly there should be more involvement.

A number of events have been successfully staged in the last couple of months. Professor Nic Beukes is the 2014 AL du Toit lecturer, and has concluded a gruelling October lecture tour which seemed to be well received everywhere he went. We are only able to do these tours with sponsorship and we would formally like to recognize Assmang as the main supporter of the 2014 lecture. In addition, there were sponsors at each venue, too numerous to mention. Nic delivered lectures in Rustenburg, Johannesburg, Durban, Bloemfontein, Polokwane, Port Elizabeth, Cape Town, Barberton, Kathu, Windhoek, and Harare. We thank Nic for agreeing to undertake this amount of travel and we wish him a well-deserved year end break.

The Fellows Dinner, with Mike Teke as the guest speaker, was successfully staged on November 5; many thanks to Gordon Chunnett and the Fellow Committee for organizing. I would also like to mention the key sponsor, Hall Core Drilling, which also sponsored last year. As a serious geologist I have to commend the sponsor for understanding the audience really well. The gift pack to participants comprised a bottle of Jack Daniels accompanied by a first aid kit. Fantastic, and really useful!

IMA 2014 (a major international conference of the International Mineralogical Association) was

successfully staged in early September in Sandton. IMA was championed by MINSA (Mineralogical Society of South Africa, a division of the GSSA) and particular thanks are due Dr's Sabine Verryn (Conference Secretary General) and Desh Chetty (Technical Chair). Prof Judith Kinnaird oversaw a successful and extensive field excursion program. Mintek was a key sponsor of the event. A Diamond Meeting was organized in Kimberley just after IMA, and thanks are due to the key organizers John Bristow, Mike de Wit and Tanya Marshall. De Beers and MSA Group were the key sponsors. We have closed out the 2014 DPP offerings with a final drilling course delivered by Colin Rice, an Africa Exploration day organized by Sifiso Siwela of MSA Group, and a Geoheritage meeting organized by Genevieve Pearson (who has taken over the VP Geoheritage role in the GSSA from Marcia Van Aswegen). The Africa Exploration day was designed for people to present the latest news on key resource projects throughout Africa, and there are some pretty amazing projects out there – despite the resource slump we find ourselves in currently. This event was so well received that we will stage annually; diarize the

second Friday in November in 2015 for the next one. The Geoheritage meeting was memorable because we hosted a representative of the Iranian Geological Survey, Dr. Alireza Amrikazemi, who manages an entire department devoted to Geoheritage in Iran, and showed that Iran has some amazing geology.

You will notice that we are trying a new concept in this issue of Geobulletin. **There is a centrefold.** Before you race to the centre section of GB with sweaty palms, please note that this is not of the Playboy variety. You have all seen the geological art of Maggie Newman, because we have featured her work on prior covers. Some of the work she does is just too detailed to get onto a cover. Have a look; give us some feedback.

This is the last issue of the year. Please have a relaxing end of year break, travel safely and come back in January ready to go. I can safely promise that 2015 will not be less hectic than 2014. All the best from staff, Council and Manco for Christmas and New Year.

**Craig Smith**

# president's column



Upfront, I would like to wish the membership a peaceful and restful Christmas and New Year break. I am sure that 2015 will be another year full of events and challenges. 2014 has been challenging; however we continue to grow despite the hardships. We have hosted a few successful meetings and this will always be a focal point of our income. GSSA with our partners are about to enter the home stretch for the IGC 2016 event and are seeking sponsorships and participation to ensure the success of this event. When I penned the previous article it was "Women's Month" and I am glad to announce that Dr Jeannette McGill has been elected President Elect and will take over from me at the next AGM in mid-2015.

I believe that the website, Geobulletin and South African Journal of Geology is the face of the GSSA. In saying this we have entered into a phase of changing the South African Journal of Geology. The 3 main aspects to be changed are:

**Avinash  
Bisnath**



1. Create an online submission process so that authors, MANCO and the editors can track the progress of submitted papers.
2. Call for nominations/applications of 3 scientific editors.
3. Once the above editors are appointed call for nominations to constitute the editorial board.

We have experienced a few challenges with the journal and are hoping that these changes will contribute to attracting more submissions thereby achieving a better citation index rating. Therefore, I urge the academic community to consider submitting more research publications to the South African Journal of Geology. I personally wish to express my sincere gratitude to Jay Barton and Lew Ashwal for their dedication to steering the Journal for the last fifteen years. I acknowledge the challenges you have experienced and commend you on your efforts.

Mike Teke provided a thought provoking talk at the Fellows Dinner. He sparked a few thoughts around the social issues, transformation and the role of majors in the South African mining environment. The

Fellows committee and always looking for new Fellow nominations, therefore I urge Fellows of the society to put forward nominations of eligible members. This is a sector of the society that is being progressively transformed, which is being indicated by the increasing number of black and female Fellows.

In the final 6 months of my term I want to drive the society in 2 areas:

1. Succession planning. This is a tough aspect being a voluntary society. Therefore I am looking at Council and members to step up and come forward so that we can ensure the future existence of the GSSA.
2. Strategy of the society. Here we will look into the aim and objective of the society to ensure that our mission of being a Learned and Professional Society is still relevant and benefits our membership.

Craig has highlighted many important aspects in his Executive Managers column, which I don't wish to dwell upon any further and therefore keep the final contribution to Geobulletin 2014 a short one.

**Happy Holidays!**

## **CALL FOR APPLICATIONS For Scientific Editors, South African Journal of Geology**

The South African Journal of Geology is the GSSA's scientific journal, is rated internationally, and has been published in one or another format since 1895 when the GSSA was founded. It is the 'journal of record' for the earth sciences in South Africa and southern Africa, and publishes peer-reviewed scientific papers concerning any aspect of African earth science.

A search is currently underway for Scientific Editor(s) of the Journal. This is an honorary position, but expenses incurred in the course of editorial duties will be covered. Applicants should be Members or Fellows of the GSSA, be recognized as active researchers with a strong publication record and Research and Development network, and be familiar with the processes involved in the publication of peer-reviewed research, as well as current global challenges facing the scientific publishing industry.

More than one editor may be appointed, and the GSSA would be particularly keen to spread the duties around to regional centres in southern Africa. The senior Scientific Editor will be required to report back regularly to the GSSA Council and Management Committee, and will serve ex officio on Council. Logistical support for attendance at meetings will be provided.

Applications should be in the form of a short note of interest inclusive of support for the above criteria, directed to the Executive Manager of the GSSA, at [info@gssa.org.za](mailto:info@gssa.org.za).



# south african committee

## for stratigraphy

The South African Committee for Stratigraphy (SACS) recently held its 44th Meeting. In response to the difficult times we are currently experiencing, and for logistical efficiency, the Committee reduced its size from ten to seven members. These are Wlady Altermann (Chair), Bob Thomas (CGS), Bruce Rubidge, Steve McCourt, Craig Smith, Michiel de Kock, and Chris Hatton (Secretary). The South African Committee for Stratigraphy also reduced the number of Task Groups from 18 to 9. The Task Groups (and Chair of Task Group) are now Biostratigraphy (Bruce Rubidge), Post-Karoo (Hayley Cawthra), Karoo (Emese Bordy), Cape (Coenie de Beer), Neoproterozoic (Alex Kisters), Mesoproterozoic (Paul Macey), Palaeoproterozoic (Freddie Roelofse), Archaean supracrustals (Michiel de Kock) and Archaean basement (Steve McCourt).

At the meeting SACS decided to abandon the local chronostratigraphic terms in favour of those used in the International Stratigraphic Chart. After feed-back from the Chairs of the Task Groups the current proposal for the map symbols is as listed below.

The Age is the currently accepted age in Ma for the base of the unit, as listed in the ICS International Chronostratigraphic Chart. Any suggestions regarding this table or other stratigraphic issues would be most welcome.

Chris Hatton



Eon	Era	Period	Age	Symbol
Phanerozoic	Cenozoic	Quaternary	2.58	Q
Phanerozoic	Cenozoic	Neogene	23.03	N
Phanerozoic	Cenozoic	Paleogene	66	PA
Phanerozoic	Mesozoic	Cretaceous	145	K
Phanerozoic	Mesozoic	Jurassic	201.3	J
Phanerozoic	Mesozoic	Triassic	252.2	T
Phanerozoic	Palaeozoic	Permian	298.9	P
Phanerozoic	Palaeozoic	Carboniferous	358.9	C
Phanerozoic	Palaeozoic	Devonian	419.2	D
Phanerozoic	Palaeozoic	Silurian	443.4	S
Phanerozoic	Palaeozoic	Ordovician	485.4	O
Phanerozoic	Palaeozoic	Cambrian	541	CA
Proterozoic	Neoproterozoic	Ediacaran	635	ED
Proterozoic	Neoproterozoic	Cryogenian	850	CY
Proterozoic	Neoproterozoic	Tonian	1000	TO
Proterozoic	Mesoproterozoic	Stenian	1200	ST
Proterozoic	Mesoproterozoic	Ectasian	1400	EC
Proterozoic	Mesoproterozoic	Calymmian	1600	CL
Proterozoic	Paleoproterozoic	Statherian	1800	SA
Proterozoic	Paleoproterozoic	Orosirian	2050	OS
Proterozoic	Paleoproterozoic	Rhyacian	2300	R
Proterozoic	Paleoproterozoic	Siderian	2500	SD
Archaean	Neoarchaeal		2800	nA
Archaean	Mesoarchaeal		3200	mA
Archaean	Paleoarchaeal		3600	pA
Archaean	Eoarchaeal		4000	eA



### Enhancing the scope of the SAJG

Dear Editor,

Over the last few years, Geobulletin has commented on the lamentable lack of papers submitted to the SA Journal of Geology which might be compounded by significant competition from other journals to extract the 'juice' of intellectual fruit into our esteemed publication. However, speaking from an economic and mining industry perspective, I would like to suggest some causes and remedies. Given the high standards and detailed research that is embodied in the average paper, it is hardly surprising that the average geologist might cower at the demands made on them for articles of a similar calibre. Moreover, most of the articles are pitched at post-graduate research fields that seldom have a direct economic application. However, I believe that the journal could have much more widespread appeal, and perhaps, even some industry sponsorship, if the SAJG harvests more articles that were tailored for more industry-focused geoscientists; from the junior geologist who may be mostly slogging in the bush to experienced geo-practitioners who have to make investment decisions at board level.

I therefore suggest the GSSA consider incorporating a second section of the SAJG devoted to purely economically related papers. I believe the GSSA should appeal to resource company staff and consultants all over Africa for appropriate material.

As long as confidentiality is not broken, these documents could be modified competent persons reports and/or summary in-house reports with somewhat more input from senior geologists and even researchers, if they are willing, that would enhance the intellectual content. I have read many NI 43-101 and JORC reports that with upgrading of the geological chapters plus some work with polished sections and a few fluid inclusion studies would make really useful reading. These could bridge the gap between dry company annual reports and high class, heavily researched articles such as those found in Mineralium Deposita and Economic Geology etc. Moreover, such articles might be far more relevant to mine geologists and thereby boost interest in the society.

Also, it's time more symposium and workshop presentations were set as documents, since so much useful detail is absent from just presentations; or, are too many geoscientists under time and management pressures?

Will the GSSA and geoscientists rise to the challenge?

Respectfully yours,

**Steffen Kalbskopf**

skalbskopf@amc-africa.com

# all the news fit to print



CIMERA-UJ-Wits

## CIMERA – A new DST-NRF Centre of Excellence

Following an announcement in mid-2013, that the Department of Science and Technology (DST) and National Research Foundation (NRF) planned to establish 5 new research Centres of Excellence in 2014, Professors Nic Beukes of the University of Johannesburg (UJ) and Judith Kinnaird of the University of the Witwatersrand (Wits) formulated an application and canvassed support nationally for a Centre of Excellence in Economic Geology that would serve as a central hub for multidisciplinary research and human resource development related to deepening our understanding of Africa's superlative mineral and energy resources. The application outlined eight focus areas for study:

1. **Metallogenesis of Early Earth Mineral Resource Systems:** Barberton Mountainland; Early biomineralization processes; Redox sensitive mineral deposits and history of free oxygen
2. **South Africa's Three Superlative Mineral Resources:** Witwatersrand gold-uranium; Northern Cape iron and Kalahari manganese; Bushveld Complex platinum and chrome
3. **Fossil Energy Resources of Sedimentary Basins:** Coal characterization; Methane gas; uranium
4. **Small Scale Mining Opportunities in South Africa:** Iron, manganese, diamonds, industrial minerals
5. **Critical Metals of the Future: Rare earth elements:** antimony; tellurium; molybdenum; cobalt; thallium; lithium; tungsten.
6. **New Bulk Mineral Resource Developments in Africa:** Iron; manganese and aluminum ores
7. **Environmental and Medical Geology:** Solving and preventing acid mine drainage; CO<sub>2</sub> capture and storage

8. **Public Awareness and Education:** Concentrate on steps required to create deeper public understanding of the need for an effective mineral resource industry in South Africa and Africa as a whole.

More than 30 geoscientists representing a range of disciplines and from many institutions indicated their willingness to be involved. The application was submitted to the NRF and a CoE was subsequently awarded jointly to UJ and Wits with Nic Beukes as Director and Judith Kinnaird as Co-Director. Named the DST-NRF CIMERA (Centre for Integrated Mineral and Energy Resource Analysis), the CoE has Rhodes University, Stellenbosch University, University of Fort Hare, University of Venda and Pretoria University as founding academic research partners together with UJ and Wits, but it is anticipated that the collaboration network will continue to expand as part of its sustainability mandate. Dr George Henry has been appointed as the Administrative Manager and Ms Viwe Koti as the administrative assistant. A part-time administrative assistant will be appointed in January at Wits.

DST-NRF CIMERA was launched at UJ by the Deputy Minister of Science and Technology, Advocate Michael Masutha, on 24th April, 2014. Prof. Ihron Rensburg from UJ welcomed more than 100 people from industry and academia to the opening of the CoE. Professor Nic Beukes gave an outline of the vision for CIMERA, while Dr Albert van Jaarsveld of the NRF paid tribute to the aims of the new CoE. Thanks were made by Professor Judith Kinnaird to the speakers and to Professor Marwala of UJ and Professor Vilakazi of Wits for their support.

A preliminary meeting on 24th April 2014 with 16 participants discussed various logistical issues and decided what the first projects should be to get the CoE started. Subsequently, a meeting of all research stakeholders took place at UJ on 6th August, to discuss the next steps in collaborative research. Theme



leaders made short presentations of the current state of knowledge and plans for future research to a group of more than 20 stakeholders. Although research is the main objective of DST-NRF CIMERA, it was emphasized at this meeting that human resource training and development, information brokerage, networking with international institutions and service rendition to Government, business and civil society are important facets of its operation. The importance of South Africa's mineral resources in a global context is well established although holistic models for the Bushveld Complex and the Witwatersrand Basin need attention. Geological research into these major deposits will be undertaken as well as on several lesser known types of deposits that could be of importance to sustain mining into the future.

Several major projects are already underway. The Karoo Research Initiative (KARIN) project is designed to undertake research into the fossil energy resources of Karoo-aged basins in southern Africa. These basins contain all of the important coal deposits of southern Africa, extending from Malawi in the north, into Mozambique, Zimbabwe, Namibia and Botswana southwards to the coal fields of South Africa. In addition, these basins contain thick successions of black carbon-bearing shales, which are a potential source of shale gas if they can be fractured at great depth. Under the leadership of Prof Annette Götz from Rhodes University, KARIN aims to explore all aspects of the 'hydrocarbon cycle' within the southern Karoo Basin by: investigating the sedimentary environments in which the potential source rocks formed; determining the likely current potential for retention of shale gas

through an investigation into the structural and thermal history of the basin; and determining the large-scale and deep structure of the shale layers and the dolerite intrusions. CIMERA has committed approximately R2 million as start-up funding and studentships for KARIN, concentrating mainly on surface outcrop studies, existing drill core and seismic information. Further funding will be sourced from other stakeholders and energy companies that are interested in taking part in the KARIN project. This additional funding will allow the extraction of deep drill cores for reconstructing the depositional history of the basin, determining the physical and petrochemical character of the rock succession, and undertaking a seismic survey for unravelling the deep structure of the basin and dolerite intrusions.

A major initiative on the Witwatersrand Basin, under the leadership of Professor Nic Beukes will integrate a variety of investigative techniques across the whole basin. Palaeomagnetism is being used to understand the setting of the Wits Basin together with sedimentological studies basin-wide. Seismic studies are being integrated with structural interpretations to provide a clearer understanding of the post-depositional history of the Basin. Experimental studies on carbon formation linked with fluid studies of mineralized material will help to show how fluid compositions changed with time, and will contribute to an understanding of the compositions and temperatures of hydrothermal fluid flow. Microprobe analysis of gold and other minerals will contribute further knowledge to the sources and ages of the mineralizing events. The first meeting of members of the group was held on 4<sup>th</sup> November. Short

*Members of the Wits gold research group at their meeting on 4<sup>th</sup> November 2014.*



presentations were made on each of these aspects of study and tasks to be achieved before the next meeting were assigned to team members. Mining companies on the Wits Basin have already shared geophysical information from their projects and it is hoped that companies will be willing to pool information with the project team in order to develop a holistic model for the basin and its mineralization.

Within the Bushveld Complex, there is a remarkably persistent variation in modal, textural, geochemical and isotopic composition of the cumulate rocks. These variations occur on a range of scales from centimetres to hundreds of metres; in some cases the cyclicity is hardly visible at outcrop scale, but becomes prominent in detailed geochemical and geophysical measurements. For many years, this layering has been explained in terms of cumulus layering where layers formed by gravitational sorting of crystallizing minerals. However, sorting by density alone does not account for the abundant evidence for reversals in mineral compositions, rock densities and initial isotopic compositions. It appears therefore that the Bushveld Complex has been constructed by the multiple emplacement of magmas that differ in crystal/liquid ratios, bulk compositions and isotopic signatures. Subsequent cumulate layering appears to be a blend of these varying magmas, but it is unclear quite where this blending occurred. A multidisciplinary team, including new post-doctoral appointees is collaborating on a Complex-wide research approach to address some of these issues on the Bushveld Complex. This theme, led by Professor Judith Kinnaird, aims to use innovative petrological, geochemical and geophysical techniques to understand magma dynamics in large chambers, the origin of layering and the implications for mineralization. In spite of the fact that the Complex has been mined for more than 80 years, there is no consensus of agreement as to its tectonic setting or on processes of mineralization, and new satellite deposits are still being discovered, such as the Waterberg Project beyond the previously known extension of the Northern Limb. Integrated use of geophysical techniques, with structural interpretations will be linked with isotopic studies and age dating, together with innovative approaches to the study of

processes of mineralization. Again, it is hoped that mining companies will be willing to share information to enable members of the team to start to construct a 3D model of the whole complex.

Research at DST-NRF CIMERA will be greatly enhanced by the recent arrival at Wits of a Cameca SX-Five Field Emission EPMA. This new instrument is the only Field Emission Microprobe on the African continent and is, in fact, only the third one of its kind installed worldwide. In addition, the NRF has recently awarded R10M to Professor Marlina Elburg towards the purchase of a multi-collector inductively coupled plasma mass spectrometer (MC-ICPMS) and UJ will contribute a further R5 million. A laser-ablation system for excavating small (10-100µm) holes will enable small amounts of material to be analysed by MC-ICPMS. This will enable age dating of minerals like zircon, laser ablation analyses of high Sr-low Rb materials (plagioclase, apatite, clinopyroxene, fluorite) for 'fingerprinting' purposes; LA analyses of Pt-group elements for Os isotope fingerprinting; and conventional dissolution + element isolation for whole rock analyses of Sr, Nd, Pb isotopes. Non-traditional stable isotopes such as Fe, Mo, Cr can be undertaken in order to track emergence of life and oxygenation of the atmosphere. Material will be prepared in collaboration with Wits for clean lab facilities. Costs of the use of the facility will be reduced for collaborating partners but will also be available to other Universities and industry.

UJ management has provided full support for DST-NRF CIMERA by the appointment of two new Associate Professors in Geology and is funding refurbishment of offices for CoE staff and students. Currently there are 34 collaborating academic geoscientists, with funding set aside for 36 postgraduates and 7 postdoctoral researchers. Human capital development will play an integral role in DST-NRF CIMERA with high-quality Masters and Doctoral dissertations a critical outcome of the CoE. The capacity-building will augment Government's objective of increasing future research capacity for our people.

**Judith Kinnaird**



## Participation of DST-NRF CIMERA at the Centres of Excellence Directors Forum 2014

This year marks the 10th Anniversary of the establishment of the Centres of Excellence (CoE) by National Research Foundation. To celebrate the occasion, a Special Forum was held at the University of the Western Cape on the 13th November 2014, with the founding nine CoEs and the six newly established ones, including the DST-NRF Centre of Excellence in Mineral and Energy Resource Analysis (CIMERA) invited to showcase their research results and future projects. DST-NRF CIMERA is hosted by the University of Johannesburg and co-hosted by the University of the Witwatersrand, with Professor Nic Beukes as the Director and Professor Judith Kinnaird as Co-director. The Honorable Minister of Science and Technology Naledi Pando was the keynote speaker at the Forum, and she visited each CoE stand to be briefed by the CoE Directors on their research. The Directors Forum was a success, with much networking amongst the different universities participating which promises much fruitful collaborative research. For further information about DST-NRF CIMERA, please visit [www.cimera.co.za](http://www.cimera.co.za).

**George Henry**



*The Honorable Minister of Science and Technology Naledi Pandor with Prof Judith Kinnaird and Prof Nic Beukes at the DST-NRF CIMERA stand*



**University of Johannesburg**

We are at the end of 2014 and everyone is asking where has the time gone? Obviously, it's gone by very rapidly and our UJ department has been extremely busy and involved this year with teaching and research.

Regarding the latter, the first item below is very good news for earth science research in South Africa.

Marlina Elburg and Jan Kramers (Department of Geology, UJ) were successful in obtaining NRF funding for a multi-collector inductively-coupled plasma mass spectrometer (MC-ICPMS) and laser ablation (LA) system through the National Equipment Program. This is state-of-the-art instrumentation, is capable of determining the isotopic ratios of elements on a microscopic scale or occurring as otherwise barely detectable traces. The laser ablation system is used to drill minute holes in solids, with the excavated material then being analyzed by the MC-ICPMS. For trace elements, solids need to be dissolved and the elements of interest isolated; for this line of work there will be close collaboration with Dr. Grant Bybee of the School of Geosciences at the University of the Witwatersrand, who is overseeing the development of a new ultraclean laboratory there.

Until now, the University of Cape Town was the only African university with this type of research capabilities. The need for a LA-MC-ICPMS centre in the Gauteng region was demonstrated by the wide support the proposal gained, with Nic Beukes of the CIMERA Centre of Excellence as an important supporter, together with another twenty-six scientists from nine different universities and companies. These include De Beers, Universities of the Witwatersrand, Free State, Stellenbosch, Pretoria, Fort Hare, Limpopo and Venda. It is worth noting that the two UJ applicants, Professors Elburg and Kramers are already international researchers of note with the former having an H-index of 24, and the later an H-Index of 37. Jan Kramers has a B2 NRF rating and Marlina Elburg is C1.

Applications for MC-ICPMS-based research are wide-ranging and include such diverse topics as unravelling the geological history of the earth's crust; helping to provide a time-line for human evolution; tracing the emergence of life and oxygenation of the atmosphere; assessing the processes involved in the generation of giant ore deposits such as those of the Bushveld complex. However, applications are not limited to the earth sciences, as the same techniques can be used for tracing the raw materials for archaeological artefacts, or for forensic studies.

The new equipment will be housed at SPECTRUM, the Central Analytical Facility of the Faculty of Science at UJ, and it is hoped that it will be operational by the beginning of 2016. The research value of this instrument cannot be overstated. Costing almost R15 million (with the NRF paying 2/3 and UJ 1/3), there are only two suppliers worldwide who manufacture such specialized equipment.

On the academic front Nic Beukes completed his tour of the southern African region delivering his Alex du Toit memorial lecture in various centres in South Africa, Namibia and Zimbabwe. In addition to his Director responsibilities of CIMERA, he has been extremely busy. Our department welcomes a new Associate Professor, Michiel de Kock, who was appointed during September. The post is new but not the incumbent as such, because Michiel was a Senior Lecturer at UJ and successfully applied for one of the two new Associate Professorship posts we were recently given by UJ management in recognition of the awarding of CIMERA.

UJ recently instituted the appointment of Distinguished Visiting Professors (DVP). These are internationally recognized leaders who are eligible to be appointed as Visiting Professors, working in collaboration with colleagues at UJ. A call was made for nominees during September and three DVP's were approved and appointed in Geology. These are salaried 5-year appointments with the incumbents required to spend a minimum of three months per year at UJ, collaborating, teaching and mentoring post-graduate students. The successful candidates are Professors Tom Andersen at Oslo University (collaborating with Marlina Elburg), Andrey Bekker at University of California, Riverside (collaborating with Axel Hofmann) and Jean-Pierre Burg, ETH/University of Zurich (collaborating with Hasina Mouri).

During November 2014, Magnus Kristoffersen, a PhD student of Prof. Tom Andersen at Oslo University, has been visiting the Department. His subject is detrital zircon studies (using U-Pb and Lu-Hf isotopes), and he has been working his way down from the Natal Group into the Pongola Supergroup. During his stay at UJ, he is targeting the Dominion and West Rand Group of the Witwatersrand Supergroup for comparative purposes.

Although officially hosted by his co-supervisor Marlina Elburg, his sampling has benefited substantially from the combined knowledge of almost the whole UJ Geology Department, with Nic Beukes, Bruce Cairncross, Axel Hofmann, Bertus Smith, Herman Van Niekerk and Michiel De Kock all contributing to his sampling strategy and understanding of the local geology.

### Bruce Cairncross

#### WITS

The School of Geosciences publishes two newsletters a year that can be viewed on our website at: [www.wits.ac.za/geosciences](http://www.wits.ac.za/geosciences). In addition to further research and student news, the latest newsletter contains information about the installation of the new R14-million Cameca SXFive Field Emission Electron Microprobe (only the third one to be installed in the world!) as well as the announcement of a new MSc by Coursework and Research Report in Hydrogeology that will commence in January 2015 and that has already attracted considerable interest. The launch of the new DST/NRF Centre of Excellence in Integrated Mineral and Energy Resource Analysis, jointly hosted by the Department of Geology at UJ and the School, is covered elsewhere in this issue.

The School marked the 110th Anniversary of the founding of the Geology Department in Johannesburg on 7th March 1904 with a birthday party to which all staff and students were invited. Although the slightly damp weather seemed to discourage some from attending the celebration in front of the Geosciences Building, curious onlookers were drawn to the sound of vigorous singing. The action is immortalized in a YouTube video that can be viewed at *SoG 110 Birthday YouTube*. All staff and students also received a commemorative memory stick. As a prelude to the big day, **Spike McCarthy** presented a Geotalk on the early history of the Geology Department to approximately 200 people. Spike's talk added further colour to his book *Born of Necessity* that commemorated the 90th birthday of the Geology Department by weaving in the stories of some interesting characters and events from Johannesburg's early days.



As the recent cycle of retirements winds down, the School welcomed 3 new staff in 2014. **Grant Bybee** officially joined the School as a Lecturer in Geochemistry and Petrology on 1 January after 3 years as an Associate Lecturer, during which he completed his PhD on the petrogenesis of Proterozoic anorthosites. Grant continues to work on anorthosites, with particular emphasis on understanding the temporal restriction of these bodies and the insights they provide for Earth evolution during the Proterozoic. His other developing projects include the petrogenesis of Alaskan-Uralian intrusions, the tectonic setting of the Bushveld Complex, and medical geochemistry.

**Paul Nex** joined the School on 1 May as the new Associate Professor in Economic Geology. A graduate of Oxford Polytechnic (BSc. Hons.), he obtained his PhD on uranium mineralisation in granitic sheets in the Central Zone of the Damara Orogen from University College, Cork (Ireland) in 1997. He has worked in the petroleum industry as an MWD engineer and, for the last 7 years, was Senior Geologist at Umbono Financial Services, responsible for exploration oversight, targeting and evaluation of a wide range of mineral deposits, particularly critical metals and rare-earth elements. His main research interests are critical metal deposits, post-collisional Proterozoic mineralization with a focus on granite pegmatites; he also still retains an interest in mineralisation processes within the Bushveld Complex.

**Robert Bolhar** joined the School as an Associate Professor in Geochemistry and Precambrian Geology on 1 August. He arrived in August from University of Queensland where he was a Research Fellow. Robert has 5 years' experience in mining. His primary research interests lie in the study of Precambrian sedimentary and igneous rocks using a variety of geochemical tools, and zircon geochronology.

EGRI Director **Judith Kinnaird** is nearing the end of her Presidency of the Society of Economic Geologists (SEG). The SEG, which has its headquarters in Littleton, Colorado, serves a worldwide membership of over 7000 geologists in more than 100 countries. Judith is the first President based in Africa and also the first female president of the 110-year old Society. In 2015, as

Past-President, she will be responsible for the Meetings and Conference Programmes. Judith has committed her Presidency to further developing SEG training courses for the African continent.

The School is celebrating several awards to staff and students this year: Allan Wilson and his co-authors won the 2014 Jubilee Medal of the GSSA; **Kim Hein** is the 2014 winner of the Wits Vice-Chancellor's Transformation Awards; Susan Webb received the inaugural Outstanding Educator Award of the Society of Exploration Geophysicists in Denver; Kgothatso Nhlengetwa was awarded a DST Fellowship in the Women in Mining Programme for her MSc (now PhD) studies on artisanal mining; and MSc candidate Siyanda Mngadi, received a leadership award from the Association of Black Securities and Investment Professionals (ABSIP).

The School has recently welcomed 5 new postdoctoral fellows. **Marta Sośnicka** joined Judith Kinnaird's ENRC-funded Katanga Copperbelt research group in June after completing her PhD in economic geology at the AGH University of Science and Technology in Cracow, Poland. She specializes in fluid inclusion studies and ore genesis. **Katharina Wulff** (PhD RWTH Aachen University) joined us in October and is working with Gillian Drennan and Judith Kinnaird on fluid evolution in the Wits Basin. **Melissa Plail** joined us in November and will be working with **Lew Ashwal** and **Grant Bybee** on arc magmatism. Melissa completed her PhD in volcanology earlier this year at the University of East Anglia in the UK. **Andriamiranto Raveloson** is working with **Ray Durrheim** on seismic tomography of AfricaArray data in southern Africa. Ranto completed his PhD at the Freie Universität, Berlin, and has recently completed a postdoc at Penn State University with Andy Nyblade. **Gaelene Kramers** is working with **Tamiru Abiye** on hydrogeological modeling of the Vaal River catchment. She completed her PhD at University College Dublin and has been working for a hydrological consultancy in Amsterdam before returning to SA.

**Sue Webb**



UCT



*Dr Trish Doyle*

**Staffing:**

UCT bids farewell to three retirees who leave the Department after a joint service term approaching 100 years. Mr George Smith joined UCT in 2000 as a senior lecturer in geophysics, having previously spent 25 years at Soekor. Mr Partrick Sieas was a laboratory

assistant in the environmental geochemistry labs for many years, before being responsible for our teaching laboratories in recent years. Mr Ernest Stout was responsible for XRF sample preparation, including rock crushing and milling. In addition, the Department also bid farewell to Dr Åke Fagereng a few months ago, when he took up a lecturing position at the University of Cardiff. It is not all bad news, though, as Mr Smith has already been replaced by Dr Beth Kahle, and Dr Alistair Sloan will join the Department from Oxford University next year as Dr Fagereng's replacement.

Dr Patricia Doyle has been awarded a Department of Higher Education and Training (DHET) Scarce Skills Development Fund Programme Postdoctoral Fellowship through the National Research Foundation (NRF). Trish joins us from the University of Hawaii where she was a NASA Astrobiology Postdoctoral Fellow investigating secondary processes occurring on asteroids. Trish is interested in early Solar System processes and will be investigating both accretion and parent body processes here at the University of Cape Town. The tools Trish uses include: electron microscopy; experimental petrology; secondary ion mass-spectrometry; X-ray and neutron diffraction; and synchrotron-based techniques (XANES; XPEEM).



*Greg Byrnes receiving his Postgraduate Research Associateship award from the Vice-Chancellor Dr Max Price, with his supervisor, Dr Johann Diener, in attendance.*



**Awards and Kudos:**

Gregory Byrnes was the only MSc student in the Science Faculty to be awarded a Postgraduate Research Associateship by the Deputy Vice-Chancellor. Greg's research examines the deformational and pressure-temperature history of rocks exposed in the H.U. Sverdrupfjella region of East Antarctica. These rocks were central to the formation of both the Rodinia and Gondwana supercontinents, and his project specifically investigates the role that the imprint of the earlier Rodinia collision had on the style of deformation and development of structures during the later Gondwana collision.

UCT was well represented by both staff and students at the recent conference of the Palaeontological Society of Southern Africa (PSSA), held at the Evolutionary Studies Institute, University of the Witwatersrand. Altogether, UCT co-authored 13 presentations and posters, and whereas the quality of all PSSA presentations was high, various UCT students took almost all the PSSA awards. Honours student Mhairi Reid won the best poster presentation award, whereas Honours student Rob Muir was rewarded for being judged the most promising student for an academic career. PhD student

Lara Sciscio received a special mention in the best student presentation category (she already won the Lystrosaurus Shield at the last PSSA conference in 2012).

UCT graduates also featured strongly at the GSSA's recent awards ceremony. MSc graduate Matthew Hodge received the John Handley and Corstorphine Awards for the best MSc thesis in 2013. Matt's thesis investigated neotectonics of the southern Cape, where he identified Neogene to Quaternary normal faulting through detailed field mapping. Matt has since taken up a job at Remote Exploration Services. In addition, Michael Hartnady received the Haughton Award for best Honours thesis in 2013. Mike's work investigated the geometry and strain localisation in the accretionary prism of the Damara Belt, Namibia, and he is currently continuing this research for his MSc thesis.

**Johann Diener**

**The UCT Geology team at the 18<sup>th</sup> Palaeontological Society of Southern Africa Conference**

Front row L to R: Lara Sciscio (PhD), Emese Bordy, Tobi Mzobe (MSc), Trello Mputle (Hons), Sanda-Sichumile Spelman (MSc), Antónia Reis De Carvalho (Hons)  
 Back row L to R: Adrian Bunge (Hons), Mhairi Reid (Hons), Rob Muir (Hons), Devon Bowen (MSc), Francisco Paiva (MSc), Adam Moodley (MSc), William Krummeck (PhD)  
 not on the picture: Kenneth Chukwuma (PhD)

# ICDP



*Participants of the ICDP workshop on the Bushveld Complex at the University of the Witwatersrand. (Photo credit: Sue Webb)*



## **International Scientific Continental Drilling Programme Workshop on the Bushveld Complex**

Fifty-nine scientists active in layered intrusion research converged on the University of the Witwatersrand over 7 to 9 September 2014 in order to attend an ICDP sponsored workshop aimed at putting forward a detailed proposal on scientific drilling targets on the Bushveld Complex. This followed the acceptance of a workshop proposal by the Science Advisory Group (SAG) of the ICDP in September last year that was coordinated by Lew Ashwal and Sue Webb of the University of the Witwatersrand and Robert Trumbull and Ilya Veksler of GFZ (Potsdam). A further 22 scientists from 8 countries contributed to the successful workshop proposal.

One of the main aims of the proposed project will be to understand why and how such an incredibly large volume of magma was generated ~2 Ga ago and how this magma was intruded into the lithosphere, giving rise to the vast reserves of PGEs, Ni, Cu, Ti, V, Cr, F and Sn of the Bushveld Complex. Geophysicists will also use the opportunity to collect additional geophysical properties on the drill cores that will be used to refine models for the three dimensional structure of the Bushveld

Complex and will also be able to perform detailed palaeomagnetic studies on sections of orientated drill core material. A team of geohydrologists will use the opportunity to study and model groundwater movement and reserves within the Bushveld Complex, which is largely uncharted territory, whilst microbiologists will study life living under the extreme conditions imposed by the deep crust and high geothermal gradients. The project is also likely to contribute significantly to human capital development through the training of competent research scientists, to local drilling technology and to the prestige of South Africa as a role player in global research collaboration.

The consensus opinion of the workshop delegates was to propose three drill targets as part of the detailed drilling proposal that will be put forward for scrutiny by the ICDP SAG in January 2016, after which the project will hopefully get the official go-ahead. The targets include i) a 500-600 m deep hole on the Northern Limb of the Bushveld Complex aimed at sampling the interval between two deep stratigraphic holes on the farms Bellevue and Moordkopje; ii) a series of three 3 km deep holes on the Eastern Limb of the Bushveld Complex aimed at sampling the entire stratigraphy of the Rustenburg Layered Suite;



and iii) a 3 km deep hole on the Western Limb of the Bushveld Complex that will sample the lower parts of the succession of the Rustenburg Layered Suite not sampled by a series of three existing stratigraphic holes (Bierkraal 1, 2 and 3). Successful completion of the proposed drilling will therefore yield three continuous reference sections through the Northern, Western and Eastern limbs of the Rustenburg Layered Suite that will enable researchers to combine their efforts on three well characterised sequences. At the same time, we will also be in a position to learn more about lateral variation throughout the Rustenburg Layered Suite and the processes responsible for it.

A number of unresolved issues will need to be addressed in the run up to January 2016, including:

- Collating and examining the seismic profiles for proposed drilling sites.
- Engaging the South African government in order to take up active ICDP membership again.

- Securing additional funding from industry and government for the costs of the project, seeing that the ICDP typically only funds about 20% of the total operating budget of ICDP funded projects.

A steering committee consisting of about 20 scientists from across the globe was agreed upon and it will be mostly up to this team to ensure a successful bid for 2016. South Africa is represented on the steering committee by Sue Webb (Wits), Cristo Craill (Council for Geoscience), James Roberts (University of Pretoria), Freddie Roelofse and Amy Allwright (University of the Free State). We are excited about the anticipated outcomes of the project and hope that the project will contribute much to our understanding of the enigma that is the Bushveld Complex.

**Freddie Roelofse**

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# diamond course

## **Diamond Short Course at the University of Pretoria, 21-24 October 2014**

The third Diamond Short Course was held at the University of Pretoria from the 21<sup>st</sup> to 24<sup>th</sup> October 2014. This short course provided a specialist and unique insight into primary and secondary diamond deposits by walking through the entire diamond pipeline from exploration, evaluation, mining, and marketing.

It was attended by the 22 honours students from the Department of Geology at the University, but also by 20 professional delegates from other parts of South Africa, Botswana and Cameroon. Professionals from De Beers, Petra Diamonds, Rockwell, Transhex, Bocom Petroleum (Cameroon), Geo-Metallurgical Services (GeMet), State Diamond Traders, Department of Minerals and Energy (DMR), University of Fort Hare and private sector were present. It provided the attendees an opportunity to learn from experts in the various fields of diamond geology, mining and evaluation of diamond deposits, and the valuation of diamonds.

The first day covered the history of diamonds, world diamond markets, origin of diamonds, kimberlites and lamproites, cratons, exploration, and geophysics (John Bristow, Fanus Viljoen, Johan Stiefenhofer, Hielke Jelsma, Mike de Wit, and Gavin Selfe). The second day was focused on mantle mineralogy, indicator minerals, and the characteristics and settings of various alluvial diamond deposits in Africa, and the offshore marine deposits (Katie Smart, Hilde Cronwright, Tania Marshall, John Ward and Mike de Wit). The third day was dedicated to mining methods and diamond recovery, rough diamond valuation and pricing, the evaluation and valuation of alluvial deposits, and financial valuation models (Bob Halvorson, Lutke von Ketelhodt, Tania Marshall and John Bristow).

The experience of the Course presenters and range and depth of topics covered in the three days of lectures and mine visit makes this course unique with its increasing popularity being highlight by the number of international participants. There is also strong emphasis on ensuring that the material presented at this Short Course is current with industry developments,



*Participants of the 2014 Diamond short course at High Performance Centre of the University of Pretoria*



and new trends impacting the diamond business are also introduced to the course on an ongoing basis. Feedback from both students and delegates was again extremely positive in all respects.

On the fourth day of the Short Course a mine visit to the surface area and underground operations at Cullinan Mine was made possible by Petra Diamonds. This visit provided the students and delegates a first-hand opportunity to see a world class diamond mine in operation.

Since the start of this program in 2012 the revenue generated from this Diamond Short Course has been used to cover the registration expenses for the Geology honours students of the University of Pretoria and for a post-graduate fund for junior lecturers in the Geology

Department at the University. The presenters of this Short Course all provide their services on a voluntary basis and their efforts are gratefully acknowledged by the Course organizers.

MSA and the Geological Society of South Africa and are thanked for their generous sponsorships and Petra Diamonds for the efforts they put in to make the mine visit for all such a special event.

The success of this course clearly highlights the need for such opportunities of continued education and the dates for next year's course are being planned and will be incorporated in the 2015 Geological Events and Short Courses calendar.

**Mike de Wit and John Bristow**

# 10th Inkaba YeAfrica conference, Matjiesfontein



## **NMMU geoscientist participation at 10th Inkaba YeAfrica conference, Matjiesfontein**

AEON staff and NMMU post-graduate students took part in a highly successful INKABA conference at Matjiesfontein, held between 27th September and 6th of October, 2014. Their attendance was boosted by spectacular outcrops of Karoo, Cape and Pre-Cape rocks of the Cape Fold Belt, encountered during several pre-, post- as well as during the conference excursions. Altogether some 70 students and their mentors from nine South African higher education institutions (as well as the Hartebeestpoort Observatory, and the Council for Geoscience) attended the conference. 54 posters of very high standard (by 1 post-Doc, 24 PhD, 23 MSc and 5 Honours students) were on display on the front porch of the Lord Milner Hotel at Matjiesfontein.

The theme of the conference was "Future Earth" and was centred on the word IPHAKADE which means, "to observe the present and consider the past to ponder the future". Diverse topics including general geology,

entomology, space geodesy, energy, ecology, geohydrology, geochemistry, geophysics, pedology, agriculture and socio-economics characterised the conference. This multidisciplinary approach to scientific challenges boosted the aims of the newly established Earth Stewardship Science Institute at NMMU.

The Matjiesfontein conference venue, a converted station on the main train lines between Cape Town and Johannesburg proved to be a challenge to presenters, especially when they had to stop and wait for the occasional train rumbling and break-squeaking noises to abate.

Maarten de Wit, Claire Geel and Bastien Linol led us on field excursions to Tarkastad, Laingsburg, Oudtshoorn, Uniondale and Steytlerville. The first leg of the pre-conference excursion focused mainly on sedimentary and structural characteristics of the Cape and Karoo Supergroups between Grahamstown and Fort Beaufort. The lower Ecca Group (Karoo Supergroup) proved to be of particular interest because of the current focus of attention given to this group by exploration companies in their search for viable shale gas in South Africa. In the Ecca Pass the carbon-rich Whitehill Formation, the geological horizon of importance as a host to potential gas deposits, is characterised by white weathering, folded and faulted black shales. Shereen Slamang is studying these rocks in this area for her Masters dissertation by analysing the sediments to interpret their

sedimentological history, and Naledi Chere, on the last leg of her Masters thesis, has been re-examining old SOEKOR cores in surrounding areas to link the sedimentology to detailed chemstratigraphy.

During the next leg of the journey we examined outcrops of dolerites and the Beaufort Group, as well as observing geomorphic profiles in the Karoo, which apparently have remained relatively unaltered since the early Cenozoic. Particular attention was given to the Golden Valley sill near Tarkastad where Thomas Muedi is analysing the structural aspects related to sill emplacement of this very thick dolerite intrusion for his PhD studies. Thomas is investigating how the fractures leading to sill and dyke emplacement may assist in assessing the economic potential of shale gas in the Karoo, whilst Master's student Vhuhwavhohau Nengovhela is doing the same by examining the extent of metamorphism and metasomatism along the margins of the sills in the Eastern Cape.

Excursions around Laingsburg were focused mainly on the Lower Ecca Group which is very favourably exposed in roadcuts for all to see the lithological sequences, style of open folding as well as thrust and normal faulting associated with these ancient deltaic deposits. The post-conference excursion from Laingsburg to Port Elizabeth took us through spectacularly folded and thrust packaged strata of the Table Mountain Group at Seweweekspoort Pass, carbonate and clastic sediments (Pre-Cape) at Oudtshoorn, and folded



*Professor Maarten de Wit explaining the glacial history of the Dwyka Group to students and mentors, near Laingsburg.*



*A prominent thrust fault in the Beaufort Group, northernmost deformation front of the Cape Fold Belt, near Fort Beaufort.*



*Professor David Bell and Claire Geel examining a large carbonate nodule in black shales of the Whitehill Formation, Mount Stewart, near Steytlerville.*

and faulted sediments of the Cape Supergroup at Uniondale and Steylerville. During the last part of our journey we called in at the Mount Stewart gypsum mine near Klipplaat to examine outcrops of the Whitehill Formation where Roberto Almanza conducted a tour of the mine and surrounding geology. Roberto is analysing sediments and structures of the Whitehill Formation to better understand the genesis of gypsum deposits for his Master's dissertation. The focus of his studies is therefore on the occurrence of pyrite and carbonate rocks in black shales of the Whitehill Formation, the latter occurring as large (up to 3m wide) dolomite nodules.

These excursions through the Cape Fold Belt were very instructive for geological and non-geological participants, with many "WOW" moments of spectacular geology experienced by all.

For more about the Inkaba Conference and program visit [www.Inkaba.org](http://www.Inkaba.org)

**Contributed by Peter Booth, Claire Geel and Maarten de Wit, Geosciences Department and AEON, NMMU, Port Elizabeth.**

*Student poster presentations on front porch of the Lord Milner Hotel, Matjiesfontein.*





# platinum symposium

## 12<sup>TH</sup> INTERNATIONAL PLATINUM SYMPOSIUM



*Part of the systematic mineralogy collection of the Ural Geological Museum.*

South Africa well represented at the 12<sup>th</sup> International Platinum Symposium, Yekaterinburg, Russia.

The 12<sup>th</sup> International Platinum Symposium hosted by the Ural Branch of the Russian Academy of Sciences and the Ural Federal University took place over the period 11-14 August 2014 in Yekaterinburg, Russia. The scientific programme included talks and posters covering a wide array of topics relevant to magma chamber processes, PGE mineralization and exploration methods, experimental petrology relevant to PGE mineralization and the behaviour of PGE in supergene environments.

The conference was attended by no less than seven representatives from South Africa including Rais Latypov, Sofia Chistyakova and Judith Kinnaird (University of the Witwatersrand), Freddie Roelofse, Justine Magson (University of the Free State), Jan Brits (Ivanplats) and MJ McCall (Stellenbosch University), with Rais chairing a session on “Magma dynamics, cumulates and ore genesis” and Judith a session on



*Polished and etched slab of part of the Seymchan pallasite. Ural Geological Museum*



*Emerald miner. Note the emerald crystal in the miner's hand and the green wiarovite "grass" on which he is standing. Ural Mineralogical Museum Pelepenko.*



*Rhodonite vase. Museum of Stone-cutting and Jewellery Art History*



"Models and exploration methods for magmatic Ni-Cu-PGE sulphide and PGE-oxide deposits from around the world". A total of thirteen scientific contributions were made by delegates from South Africa.

Pre-conference fieldtrips included visits to Noril'sk, the Kondyor massif and the Rai-Iz ophiolite complex. During the conference delegates were afforded the opportunity to visit the Ural Geological Museum of the Ural State Mining University, the Museum of stone-cutting and jewellery art history and the Ural Mineralogical Museum Pelepenko as well as a number of sight-seeing localities in and around the city of Yekaterinburg. Post-conference fieldtrips explored the Uralian Platinum Belt and the Ioko-Dovyren layered intrusion in the northern Baikal region.

During the conference, delegates were afforded the opportunity to visit a variety of museums showcasing the rich geological, mining and stone cutting heritage of the Urals, including the privately owned Ural Mineralogical Museum Pelepenko, the Ural Geological Museum and the Museum of Stone-cutting and Jewellery Art History. A banquet dinner in true Russian style (i.e. with an endless supply of Vodka) was held on the second last day of the conference. The conference organisers deserve to be congratulated on an excellently organised conference, a world-class scientific programme and true hospitality. The organisers (of which I am one) of the 13<sup>th</sup> International Platinum Symposium that will be held in South Africa in 2018 have some big shoes to fill.

**Freddie Roelofse**



# crirSCO agm 2014

## Committee for Mineral Reserves International Reporting Standards (CRIRSCO) Annual Meeting 2014

Ken Lomborg (Coffey) and Roger Dixon attended the Annual CRIRSCO Meeting held in Mongolia and China in October 2014. The meeting is attended by representatives of all the National Reporting Organizations (NROs) i.e. Australasia, Canada, Chile, Europe, Russia, South Africa, USA. The most significant event was the acceptance of Mongolia as the eighth member of CRIRSCO. In order to do this Mongolia had to develop the Mongolian code (MRC) and develop a professional organisation to register mining professionals - Mongolian Professional Institute of Geosciences and Mining (MPIGM).

The Mongolian Resources and Reserves Committee (MRC) is a committee of MPIGM and it has developed the MRC Code for the reporting of Exploration Results, Mineral Resources and Mineral Reserves, which is compatible with the CRIRSCO Template. This process has taken about three years to complete and was driven by inter alia Dr Harry Parker of the SME.

The meeting this year included a tribute to the late Dr Danie Krige whose pioneering work in geostatistics has been an integral part of the prominence of mineral reporting and evaluation.

In main purpose of the annual meeting is for each

NRO to report on the activities relating to their code as well as allowing the exchange of various ideas and responses to changes in the mining industry. The SAMREC delegation shared the progress being made to updating the code and shared some of the details. A positive response was received to these changes notably the revision of Table 1.

The JORC representatives reported that they have experienced a number of teething problems with the JORC 2012 implementation that has included in some cases the suspension of company shares on the ASX. JORC has released a revision of their coal guide which has removed the distance requirements for coal reporting and emphasised that each coal basin requires the expertise of the Competent Person rather than a blanket approach.

In 2014 the Canadian Institute of Mining (CIM) released revised standards for reporting. The Society of Mining

*The signing of the agreement to accept Mongolia as the eighth member of CRIRSCO. From left to right Mr Baterdene Dash (Mongolian NRO representative), Mr Edumndo Tulcanaza (Chairman of CRIRSCO), Mr D Damaba (President of the MPIGM), Ms Gerlee Bayanjargai (Mongolian NRO member). Note the banner from the Mongolian Professional Institute of Geosciences and Mining (MPIGM), the registration body for Mongolian Professionals.*



Engineers(SME) of USA also released a revision to their code in 2014. Notably this includes a tabulation of the various attributes required for scoping, pre-feasibility and feasibility studies. These attributes include costing of operating and capital, contingencies, level of engineering and a number of other aspects. The revised SAMREC Code will also include a similar Table 2.

A review of the CRIRSCO template is being undertaken. The standard definitions will remain unchanged until all the codes have completed their updates and are once again aligned. SAMREC is able to add significantly to aspects including the reporting of diamonds and gemstones and coal.

The CRIRSCO committee continues to look to attract more members to join the family of codes. The CRIRSCO committee were VIPs at the China Mining Conference in Tianjin and presented a session on the first day. The emphasis was on the translation of the JORC Code into Chinese, the acceptance of Chinese professionals by AusIMM as Fellows allowing them to report in accordance with JORC and the other CRIRSCO codes.

**Ken Lomborg** – Senior Principal Coffey  
Ken.lomborg@coffey.com

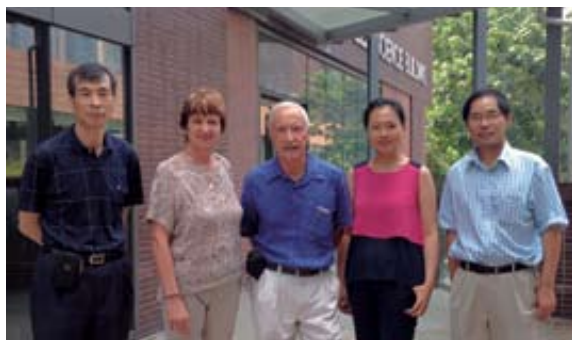
## a worthy trip to the far east



*Hong Kong skyline as seen from Victoria Peak.*

After having organized and guided a number of excursions for Chinese geologists to the Limpopo Belt, I was, together with my wife, in turn invited to visit various earth science departments in Hong Kong and Beijing with a promise of a lot of time to be set aside for sightseeing. However, the air fares were for my pocket.

Our flight to Hong Kong was uneventful; however since we arrived at midnight it was no easy task to get to our accommodation on the university campus. Fortunately taxis are cheap and available 24 hours at all major stations. Hong Kong consist of three main entities, i.e. Hong Kong island, the Kowloon peninsula and the New territories, but they measure in total just 1 000 km<sup>2</sup>.



*At The Hong Kong University: Prof. M. SUN (left), Prof. G. ZHAO (right) and Dr. H. GENG (second from right), first author of a recent paper on the Soutpansberg Group age.*

Since the terrain is hilly with often very steep slopes, potential building sites are scarce and the City was forced to develop high-rise buildings resulting in the world's most vertical city with over 1000 skyscrapers. The City is regarded to have one of the most beautiful skylines in the world, and especially the view from an aeroplane is breath-taking.

Hong Kong has two very modern universities catering for students preferring either Chinese or English as medium of instruction. Only the English language university known as The University of Hong Kong has a Department of Earth Sciences which is equipped with quite an impressive geological museum. After having given a talk at the department we enjoyed a very delicious, typical Hong Kong lunch in the company of Profs. Min SUN, Guochun ZHAO and colleagues and also a number of postgraduates, with some having arrived from France and Germany. Since we stayed for a week on the campus we noted that academic activities extend well into the evening hours.

Towards the end of our week-long stay in Hong Kong a trip to Macau was organized and we stayed there for the weekend with Prof. Min Sun and his wife Lynne. Macau which is situated some 60 km west of Hong Kong was a small Portuguese colony till 1999, and is



*Dinner with Peking University personnel: Prof. C.J. WEI (third from left), colleagues and postgrads.*

now, like Hong Kong, a Special Administrative Region of China. Over the years Macau has developed into a huge tourism centre and gambling place, and is believed to be the world's top casino market, even surpassing Las Vegas. The majority of the tourists and gamblers come from mainland China, where gambling is forbidden.

After spending a week in Hong Kong, our next destination was Beijing which is about a four hour flight away. Beijing which has a population of just over 20 Million has excellent transport systems consisting of a number of ring roads which concentrically surround this big city and an extensive subway system charging per ride with unlimited transfers for the ridiculous low price of only about Rand 3.

During our week-long stay we visited three institutions: The Department of Geology (Prof. Chun-Jing WEI) of the Peking University; the College of Earth Sciences (Prof. Chun-Ming WEI); and the Beijing SHRIMP Centre (Prof. Danyi LIU). The last two institutions are part of the Chinese Academy of Geological Sciences. Talks were delivered at all three institutions visited, and they were always succeeded by a very rich lunch or dinner, to which postgraduates were also invited.

Not unlike Hong Kong, the students in Beijing also attend lectures late in the evening (as late as 10 o'clock) and also on Saturday mornings. The most obvious proof of their presence is thousands of bicycles parked around the various institutes. Generally Saturdays seem to be almost normal working days for the academic staff.

The most interesting place we visited was the SHRIMP Centre where in 2001 the first SHRIMP II instrument was installed. A second one, an enhanced version equipped with a sophisticated multi-collector (SHRIMP IIe), was then set up shortly afterwards in 2007. The SHRIMP IIe can be run remotely over a web link, allowing remote analysis, tuning and maintenance. For this purpose the SHRIMP Centre developed the software SROS (SHRIMP Remote Operation System), with the methodology based on the principle of sharing large scientific instruments. Online access to SHRIMP is particularly useful and cost-saving for researchers who stay far away from the facility as no travelling and accommodation costs are incurred. SROS has now been established at a number of overseas facilities, including universities and/or Geological Surveys in Brazil, Canada, Italy and Australia. Going this avenue



*At the SHRIMP Centre, with the Director Dr D. LIU on the left; background is a polished slab of strongly folded marble (I wanted to steal it).*



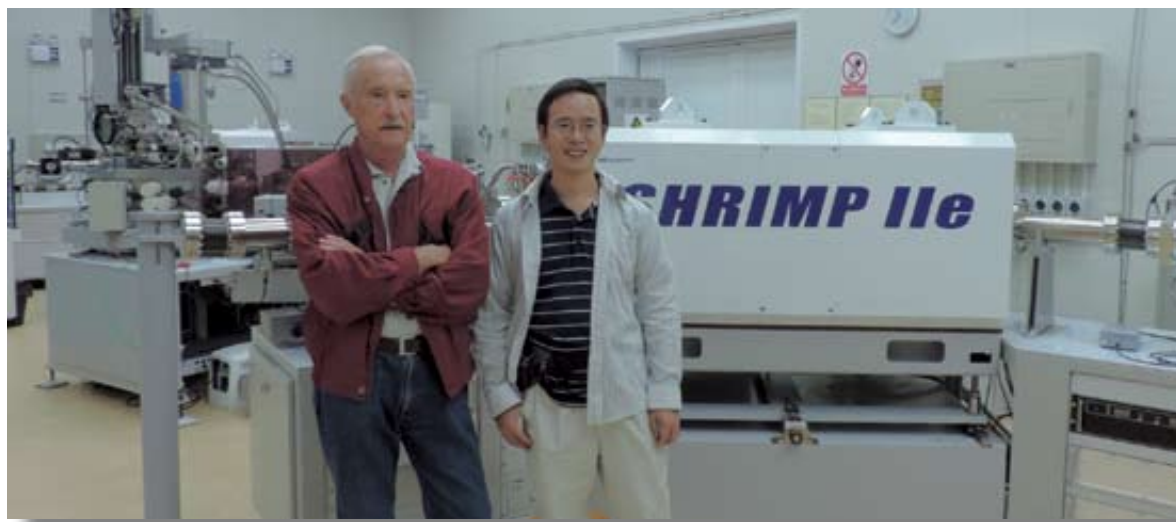
wouldn't that solve a lot of problems in South Africa???

At the moment the SHRIMP Centre is busy installing a Time-of-Flight (TOF) secondary ion mass spectrometer with an exceptionally long flight-tube.

Sightseeing was definitely not on the backburner as

promised by our hosts, and we were very fortunate to have as guides postgraduate students and especially Prof H.-Q. Xie of the SHRIMP Centre. On our program were the Forbidden City (Chinese imperial palace c. 1400-1900); the Ming Tombs (imperial mausoleums of the Ming dynasty c. 1400-1600); the Summer Palace (imperial gardens with man-made lake, pagodas and pavilions, c. 1750-1900); and the Temple of Heaven which is an extensive park with several religious buildings. Built around 1400, it was regularly visited by the emperors to pray for good harvests. Only some of the buildings dating back to the early emperors are still in their pristine condition, but most of them were destroyed or burned down during internal strife or by the colonial powers. All of the buildings, however, were meticulously restored to their original glory. Last, but not least, since a trip to the Great Wall is a must for every

*SHRIMP IIe instrument, with Prof H.-Q. XIE*



*The most beautiful migmatite sample I've ever seen at the entrance of the SHRIMP Centre (another piece I wanted to steal)*



*The Gate of Supreme Harmony in The Forbidden City*

Continued on pg 32

# origin of karoo coal

## Centre fold

The artwork by Maggie Newman depicts a scene about 300 million years ago in the region of present day Emalaleni (Witbank). The scene is of the end of the Dwyka Ice Age with the retreating ice field that covered much of the Gondwana continent in the background. The ice field overlies reddish brown sandstone of the Waterberg. A glacier with fluvial outwash channels is shown retreating in a valley flanked by relatively resistant ridges of light-pinkish coloured Rooiberg felsite. The ridge in the left foreground displays glacial striations caused by hard rock debris at the base of a glacier (now melted) that scoured the bedrock due to the enormous weight and downslope movement of the glacier. The melted glacier has deposited an ill-sorted mass of rock fragments of variable size in a fine grained matrix of ground-up rock material (tillite). Rock fragments which generally range in size from a few millimetres to half a metre consist of pre Karoo rocks derived from formations that existed at the time. These include Waterberg sandstone, flow banded rhyolite, granite, quartzite and dolomite with chert, all depicted in the right foreground of the painting.

A Karoo swamp forest flourished in the glacial valley downstream of the fluvial glacial outwash. It was in this environment, and directly on the tillite that the deciduous glossopteris flora flourished as depicted in the painting which also shows certain species about to shed their colourful autumn leaves. Sphenophytes (horsetails) are growing on the edge of the water and tree lycophods (giant club mosses), tree-ferns and a general undergrowth of various smaller ferns is shown. A feature of the glossopteris vegetation was the growth of fruit directly on the leaves. Sphagnum-type mosses and lichens probably grew on the glaciated surfaces and cypress-like conifer probably developed in the

higher elevation reaches. Flooding and deposition of clay, silt and sand eventually covered the forest. With further sedimentation and build-up of pressure over long periods of time, the vegetation was converted to coal. Four main overlying cycles of vegetation growth (coal forming episodes) and sedimentation followed. The painting portrays the origin for the number 1 coal seam (which was followed by the overlying 2,3,4 and 5 seams) of the Witbank area.

As a result of photosynthesis by algae and phytoplankton in the seas and lakes large amounts of free oxygen were probably liberated into the atmosphere well before this time, resulting in the build-up of the ozone layer. This subsequently protected the earth's surface from lethal ultraviolet radiation and allowed for animal life forms, which prior to this had largely been confined to the hydrosphere, to emerge onto the earth's surface. These started with amphibians and were followed by reptiles, mammal-like reptiles and finally mammals. The documentation of this evolutionary trend from about 290 million years to 180 million years ago is better seen in the Karoo basin than perhaps anywhere else on earth.

**Morris Viljoen and Marion Bamford**





M. LAMBERT NEWMAN



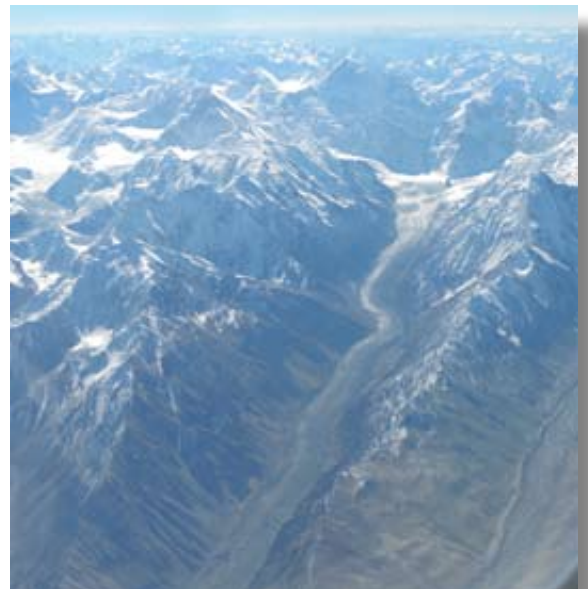


*The Hall of Prayer for Good Harvests in The Temple of Heaven*



visitor, we went to the well restored Mutianyu Section, some 100 km north of Beijing. It is fascinating, though very tiring, to walk along this impressive structure and see it sneaking up extremely steep slopes.

To sum it up, the two weeks we spent in Hong Kong and Beijing were a wonderful experience, but also an eye opener for us. The Chinese hospitality and organization were outstanding, and we enjoyed sampling their exceptionally tasty food. People are hardworking, content with their surroundings, work often long hours and apparently do not know the word strike. Also the academic institutions we have seen are apparently well-funded and their laboratories appear to have modern up-to-date equipment, looked after by competent motivated technicians.



*View of snow-capped peaks and glaciers along the northern part of the Himalayas*

**Günther Brandl** (retired),  
Council for Geoscience, Polokwane

*The Great Wall at the Mutianyu Section*



# institute for the blind



*The topography model at UPE*

GSSA members may be unaware of the rather unusual & interesting tactile Geological Museum at the Institute for the Blind at Worcester in the Western Cape.

This project was initiated by the late George van Heerden, assisted by Dr Eddie van Dijk.

If you have not yet visited this museum it is well worth a visit (even for those of us who are sighted).

An unfinished project (for which I have taken responsibility) needs specialist assistance and expert input from GSSA members and their contacts, namely the manufacture of a 1 : 5 million scale topographic model of the South African continent plus nearby oceanic floor.

The way to go is by digital 3-D printing and/or digital computer-driven milling, but this requires digital

topographic data and manufacturing technology not available to me.

The dimensions of the planned 1 : 5million scale model is around 800mm (east-west) x 500mm (north-south). The maximum vertical topographic range from deepest abyssal floor to highest continental peak in the range of the model is around 8 000m; assuming a vertical scale of 1 : 500 000. the maximum vertical dimension of the model will be around 16 mm. The model will be similar to one previously buit at UPE. Topo The topography model at UPE.

Who amongst GSSA members (and their contacts) has the know-how, access to digitised topographic data and specialist manufacturing facilities to make this model?

**Izak Rust**, Franschoek

# geoscience train



**GEOSCIENCE TRAIN: Science outreach and research in disadvantaged rural South African communities.**

Your opportunity to support a community outreach and science training tool focused on rural disadvantaged communities in South Africa.

My name is Dr. Stoffel Fourie, the project leader of the Geoscience Train, a Non Profit Organisation (NPO 139-650) project of the Pangaea Geophysics and Geodesy Working Group (PGGWG).

The Geoscience Train will be for Geoscience what the famous Phelopepa Health Train is for primary health care in South Africa. The aims of the Geoscience Train are:

- Training by experiential learning of students from mainly previously dis-advantaged communities.
- Support of science and mathematics teachers in rural areas.
- Training of rural primary and secondary school pupils in mathematics and science.
- Life skills training of rural adults.
- Community service outreach.
- Applied scientific research.

We have the rolling stock for an initial train (10 coaches). This is your opportunity to invest in the refurbishment of the Geoscience train.

Above, active “hands-on” science outreach centre inside a static train developed by PGGWG at Matjiesfontein, South Africa.

The mission of the train is to render services to improve the lives of poor rural communities in Southern Africa. A sustainable unit includes living quarters, laboratories and working areas. All required equipment and vehicles will be on the train. The planned outcomes of a mission at a particular time will determine the specific composition of the train, because the train concept is modular. The completed Geoscience Train will consist of 25 coaches. Equipping and refurbishing the complete train is very expensive. However, we can start our operations with a shorter initial train of 10 coaches, the minimum allowed by the railway regulator.

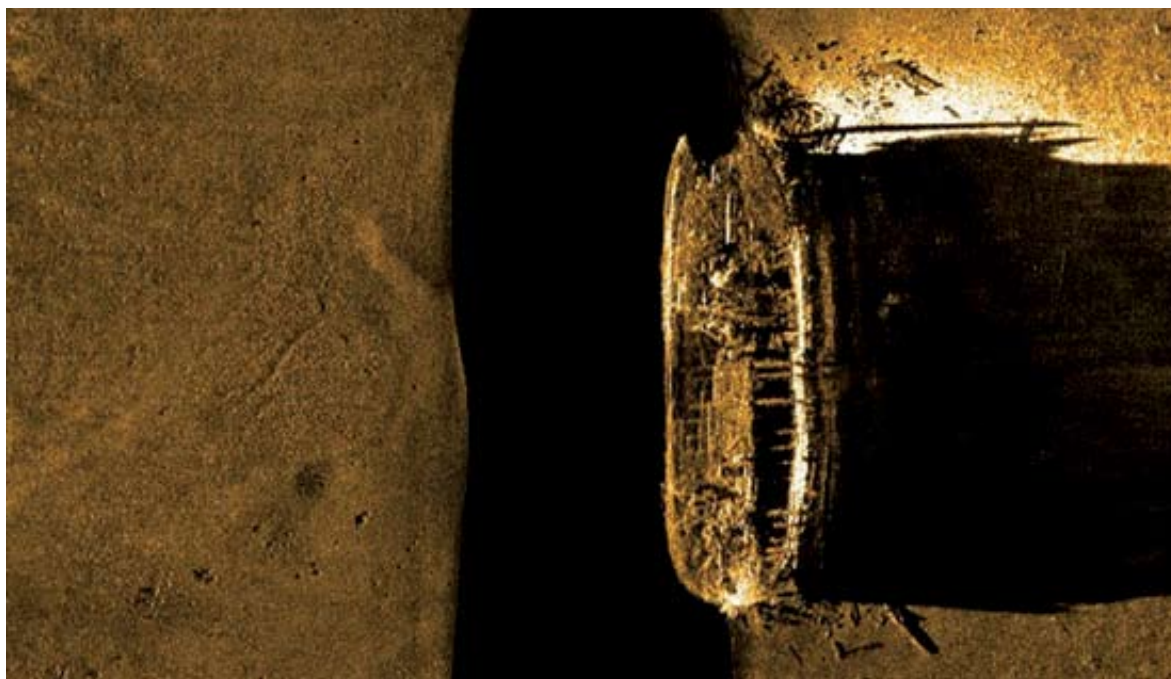
This campaign appeals to contributors to raise the funds to refurbish two sleeping accommodations coaches for the initial train of 10.

Any amount of funding will be appreciated. See <http://igg.me/p/the-development-of-the-geoscience-train-phase-1/x/9093203>

Please follow the Geo Train on Twitter: @SAGeotrain.

**Stoffel Fourie**

# a shipwreck



*Sonar image of the shipwreck on the seafloor in Queen Maud Gulf*

## **A shipwreck in the Canadian Arctic and Science in South Africa**

On 9 September 2014 it was announced that a Canadian search team had made a remarkable marine discovery, locating the wreck of one of two British vessels that vanished into the icy expanse of the Arctic with 129 men on board in search of the Northwest Passage in the late 1840s. The wreck was that of either the *HMS Erebus* or the *HMS Terror*, two Royal Navy ships that sailed from Britain in 1845 on an Admiralty expedition under the command of Sir John Franklin, a 59 year old rear-admiral who partook in the Battle of Waterloo in 1815.

These two bomb vessels have a close link to the start of geoscientific research in South Africa and Antarctica. In September 1839, with Captain James Clark Ross as overall commander on board *HMS Erebus* and Captain Francis Crozier in command of the *HMS Terror*, the two ships sailed from the UK to discover the South magnetic pole, examine Antarctica and do research according to the directions of the Royal Society. The scientific duties included the setting up of magnetic observatories and observation of the Earth's magnetic

field. James Ross had the credentials for this journey. By 1839 he was the most experienced polar officer in the world. He had successfully located the North magnetic pole (1831) and had spent eight winters in the Arctic, having been there for 17 of the previous 20 years. In the late 1830s he also assisted with the first magnetic survey of Great Britain.

On the way from England James Ross and his ships visited several ports and established a magnetic observatory on St Helena. On 17 March 1840 the *Erebus* and *Terror* arrived in Simon's Town. Lieutenant Frederick Eardley-Wilmot of the Royal Artillery and a party of three assistants, equipped with the magnetic measuring apparatus disembarked from the *Erebus*. The governor of the Cape Colony, Lieutenant-General Sir George Napier received them and agreed to provide Ross the necessary land for the observatory. Thomas Maclear, the resident astronomer, under pressure of the authorities, offered a site adjoining the Cape Observatory. Eardley-Wilmot then proceeded to supervise the erection of the magnetic observatory. Ross made some magnetic measurements during his stay in Simon's Town and he and his ships departed for Australia on 6 April 1840.



*Painting of the Erebus and Terror in New Zealand by John Wilson Carmichael*



Ross and the *Erebus* landed in Hobarton, Van Diemen's Land (now Hobart, Tasmania) on 16 August 1840. The *Terror* had arrived the day before. The two ships delivered equipment for a magnetic observatory in Hobarton. At the time the Lieutenant-Governor of Van Diemen's Land was Sir John Franklin, the same person who would be in charge of the ill-fated Arctic expedition some five years later. The two ships left from Hobarton via New Zealand to carry out their magnetic surveys in Antarctic waters. Their expedition spanned three seasons from 1840-43 during which *Terror* and *Erebus* made three forays into Antarctic waters, crossing the Ross Sea twice, and sailing through the Weddell Sea southeast of the Falkland Islands.

During 1841 the expedition discovered the Ross Sea, Victoria Land and named the volcanoes Mount Erebus and Mount Terror on Ross Island. They sailed for 400 km along the edge of the low, flat-topped ice shelf they called the Victoria Barrier, later named the "Ross Ice Shelf" in honour of James Ross. In 1842 the expedition attempted to penetrate south at about 55°W and explored the eastern side of what is now known as James Ross Island. On their way back to England Ross and his ships again docked in Simon's Town on 4 April 1843 and on 4 September 1843 they anchored at Folkestone, England after a highly

successful expedition. The voyage was completed after four years and five months. It was the last major voyage of exploration made entirely under sail.

For their next voyage, to the Arctic the *Erebus* and *Terror* were outfitted with auxiliary steam engines and had iron plating added to their hulls. Sir John Franklin sailed in *Erebus*, in overall command of the expedition and *Terror* was again under the command of Francis Crozier. The now Sir James Clark Ross declined an offer to command the voyage. The expedition was ordered to gather magnetic data in the Canadian Arctic and to complete a crossing of the Northwest Passage, which had already been charted from both the east and west but had never been entirely navigated. The fabled northern passage from the Atlantic to Pacific could have opened up great trading riches.

The Franklin expedition left England on 19 May 1845 but ice beset the *Erebus* and *Terror* as the winter of 1846 set in. It carried the helpless ships for hundreds of miles and had not released them by the spring of 1848 when, with supplies running low, the surviving crewmen set out on foot in hope of escape. They never made it. Since that time a large number of expeditions, initially encouraged by large rewards, tried to locate the crews and wrecks of the *Erebus* and *Terror*. More

ships and men were lost looking for Franklin than in the expedition itself. Sir James Clark Ross commanded one of the failed rescue missions, but he and his ships survived.

The recent discovery showed a very clear sonar image of a ship of the required shape, size and armament sitting on the seafloor just 11 metres below the surface of the near-freezing waters of the Queen Maud Gulf. Canadian Prime Minister Stephen Harper told the Commons on Wednesday 1 October 2014 that the ship had been identified as the *HMS Erebus*, the vessel that was part of the establishment of the first geophysical institution in southern Africa some 175 years ago. This ship of significance in scientific history was for all these years hidden by the Arctic ice and only recently made accessible when the warming sea water in the Queen Maud Gulf melted the ice and increased the navigability of the Northwest Passage.

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(Accessed 2/10/2014)

**Johan de Beer**

# geotraces

## GEOTRACES - Marine biogeochemical cycles of trace elements and their isotopes

Global marine biogeochemical cycles of trace elements and their isotopes (TEIs) are complex, involving a multitude of processes that regulate the supply, removal and distribution of trace elements in the ocean. Sources of TEIs include continental weathering products transported via winds or rivers, sediment-water boundary exchange along the margins and hydrothermal fluxes from mid ocean ridges. Once in the ocean, distributions of TEIs are influenced by biological uptake and regeneration and by physical transport, as well as by the chemical forms in which the individual TEIs exist. With so many factors involved, and with processes operating in many regions of distinctly different character, a comprehensive understanding of the marine biogeochemical cycles of TEIs can be

attained only by a global, coordinated, international effort. This is the aim of GEOTRACES, an international study of the marine biogeochemical cycles of TEIs.

Following nearly a decade of planning, enabling activities and pilot studies, the main field program of GEOTRACES was launched in 2009. Sampling to date has occurred aboard 57 cruises on research vessels operated by 15 nations. Financial support for GEOTRACES is provided by individual national agencies or ministries. Consequently, management of the program requires a high level of international cooperation. A Scientific Steering Committee (SSC), which has included members from 17 nations, sets research priorities and coordinates national contributions. An International Project Office (IPO) based at the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) in Toulouse,



France, provides operational support for the program. Data from diverse sources are assembled, archived and distributed by the international GEOTRACES Data Assembly Centre (GDAC) hosted by British Oceanography Data Centre (BODC), Liverpool, UK <<http://www.bodc.ac.uk/geotraces/>>. Up-to-date information about the program, including cruise information (Figure 1), research highlights, access to data, and details of the program's operation, can be found on the website maintained by the IPO <<http://www.geotraces.org>>.

As for understanding Earth's geodynamics, using geochemical tracers is essential to understand and quantify oceanic processes, including water circulation and marine life. For example, the mixing rate of the ocean of ~1000 y was determined with the first  $^{14}\text{C}$  data while the settling velocity of the marine particles could not have been estimated without exploiting radioactive disequilibrium of uranium-series nuclides. Similarly, results from GEOTRACES will be of benefit to areas of ocean research beyond marine geochemistry. For example, the vital role of trace element micronutrients in regulating the growth of marine organisms, which, in turn, may influence the structure and composition of marine ecosystems, is now well established. Conversely, marine organisms play a crucial role in regulating the biogeochemical cycles of trace elements, much as they impact the biological  $\text{CO}_2$  pump and, therefore, climate. However, progress in unraveling the complex nature of chemical-biological coupling depends critically on developing a complete knowledge of trace element distributions, along with a quantitative understanding of the sensitivity of their supply, removal and transport within the ocean to changing environmental conditions.

GEOTRACES findings also contribute to our knowledge of the transport and fate of anthropogenic contaminants in the ocean. For example, data from GEOTRACES cruises provide an unprecedented view of the distributions of anthropogenic lead and mercury in the ocean, while documenting the decline in lead concentrations following the phase out of its use in motor fuels.

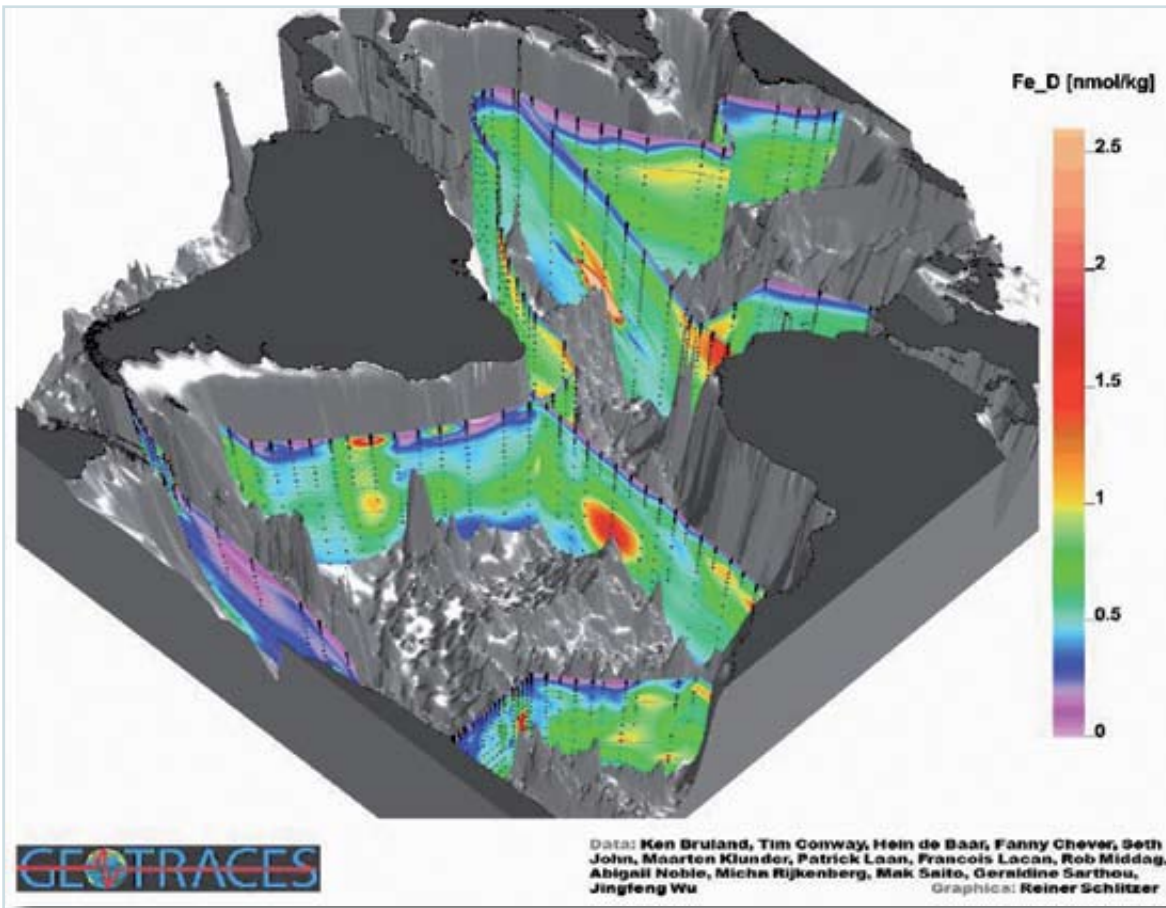
Much of our knowledge of past variability in the ocean environment, including the ocean's role in climate change, has been developed using TEI proxies archived in marine substrates such as sediments,

corals and microfossils. However, the ability to infer past ocean conditions from archived records of TEIs is severely constrained by the limited understanding of TEI biogeochemistry in the modern ocean, including the processes that link the measurable proxy to the variable that it is intended to represent. GEOTRACES is conducting a critical assessment of TEI proxies, both to develop and calibrate new proxies and to reduce the uncertainties associated with proxies currently in use. Among the key proxies under scrutiny are uranium-series radionuclides ( $^{230}\text{Th}$  and  $^{231}\text{Pa}$ ) and stable isotopes (e.g., Nd isotopes) that are widely exploited to reconstruct past changes in ocean circulation and its contribution to climate change.

Collaborating in an international program has many advantages. First, it allows for coordinated sampling at a global scale with unprecedented spatial sampling resolution. Furthermore, the various groups contributing to GEOTRACES have submitted their methods to multiple levels of intercalibration to ensure internal consistency of the global data set. More importantly, studying multiple TEIs simultaneously provides information that cannot be derived by examining a single element in isolation. Each element can be understood as a special case in a continuum of geochemical properties, where the similarities and contrasts among the elements offer insights into each individual element. In many cases, the better constrained, or more simply defined, behavior of one element illuminates the behavior of another.

Examining chemical distributions in the ocean inevitably reveals some unanticipated findings, and GEOTRACES has been no exception in this regard. One surprise has been the frequency and expansiveness of metal-rich plumes emanating from mid-ocean ridges. While the hydrothermal systems serving as sources of these plumes were discovered in the 1970's, it was previously thought that the trace elements carried by these solutions were removed by precipitation and sedimentation close to their source. Consequently, it came as a surprise to learn that virtually every section crossing a mid-ocean ridge, from the Arctic to the Southern Ocean, encountered a metal-rich plume extending hundreds and, in one case, even thousands of kilometers from the source. Implications for the global marine biogeochemical cycles of these TEIs are now under intensive investigation.

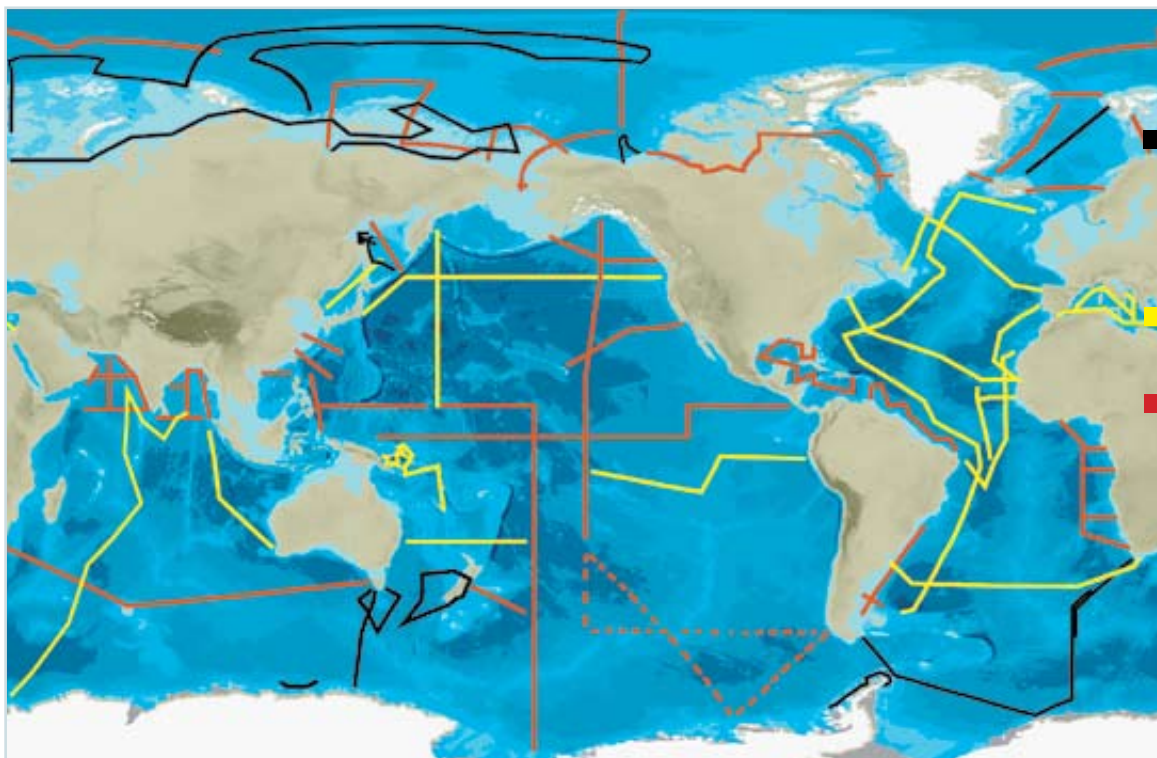




A still image extracted from the GEOTRACES animated 3D scene of dissolved iron concentrations in the Atlantic Ocean. Reproduced from Schlitzer, R., *eGEOTRACES - Electronic Atlas of GEOTRACES Sections and Animated 3D Scenes*

Rather than wait until the end of the program to issue a final data product, the GEOTRACES SSC decided to release a first intermediate data product at a time when the program remains very active. By sharing the data at an early stage, GEOTRACES seeks to

strengthen and intensify collaboration within the broader oceanographic community, including physical and biological oceanographers, marine geologists and modelers, to enable them to apply their unique knowledge and skills to marine geochemical problems.



Status of the GEOTRACES global survey.

**Black:** Sections completed during the International Polar Year (2007-2009). Many of these pilot studies provide only a partial suite of TEIs.  
**Yellow:** Full GEOTRACES sections completed by mid 2014.  
**Red:** Planned future sections. An updated version of this map is maintained on the GEOTRACES home page <<http://www.geotraces.org>>.

Information about each section is posted at <<http://www.bodc.ac.uk/geotraces/cruises/>> as it becomes available



The first data product, released in 2014 (IDP2014), consists of two parts: 1) a digital compilation of TEIs together with classical hydrographic parameters, available at <http://www.bodc.ac.uk/geotraces/data/idp2014/>, and 2) the eGEOTRACES Electronic Atlas providing section plots and animated 3D scenes of the data <http://egeotraces.org/>.

These products are freely available for non-commercial purposes. Feedback on the products is welcome, and can be sent to the IPO at [ipo@geotraces.org](mailto:ipo@geotraces.org). GEOTRACES anticipates the release of a second intermediate data product in 2017, and feedback on IDP2014 will be used to improve the next product. GEOTRACES also welcomes news about applications derived from these products, whether for research, education, policy or other purposes. Highlights can be forwarded to the IPO, and in special cases the applications will be publicized via the GEOTRACES web site.

GEOTRACES plans to expand its coverage of the global ocean throughout the remainder of the decade. An intensive multi-vessel investigation of the Arctic Ocean is planned for 2015-16. Cruises will continue in the Atlantic, while efforts to cover the Pacific and

Indian Oceans will increase throughout the decade. Planning for further work in the Southern Ocean will commence soon, as well. The scope of this ambitious program requires contributions from many nations. To encourage participation by new groups, GEOTRACES offers advice and training in contamination-free sampling procedures and in intercalibration protocols to help increase the global capacity for TEI research. Additional information can be obtained from the IPO at [ipo@geotraces.org](mailto:ipo@geotraces.org).

<http://www.egeotraces.org>, 2014>. Extensive Fe-rich plumes are seen in sections crossing the Mid-Atlantic Ridge, both in the North and South Atlantic Oceans, as well as in a section crossing the ridge SW of Africa.

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# hyperspectral core imaging

Hyperspectral core imaging is an emerging technology that allows rapid and cost effective collection of digital mineralogical information from drill cores, chips and cuttings. It is only recently that technological advances have allowed for construction of rugged transportable systems that can collect data in coresheds, and at mine or exploration sites that are often located in harsh and remote environments. The data collected are an extremely valuable addition to conventional core logging, are completely objective, and arm the geologist with a wealth of information to accelerate and improve the interpretation process. A major use of the data is for geometallurgy, where the numerical

data allow relationships with process parameters to be established. To date, these services have been provided to major and junior mining companies and national geological surveys.

Reflectance spectroscopy is a passive and non-destructive mineralogical technique in which a light source is used to illuminate a target material, and the reflected light is measured across a specified wavelength range. Interaction between the incident illumination and minerals in the target material results in absorption of energy at specific wavelengths, producing a spectrum as shown in Figure 1. The positions and magnitude of

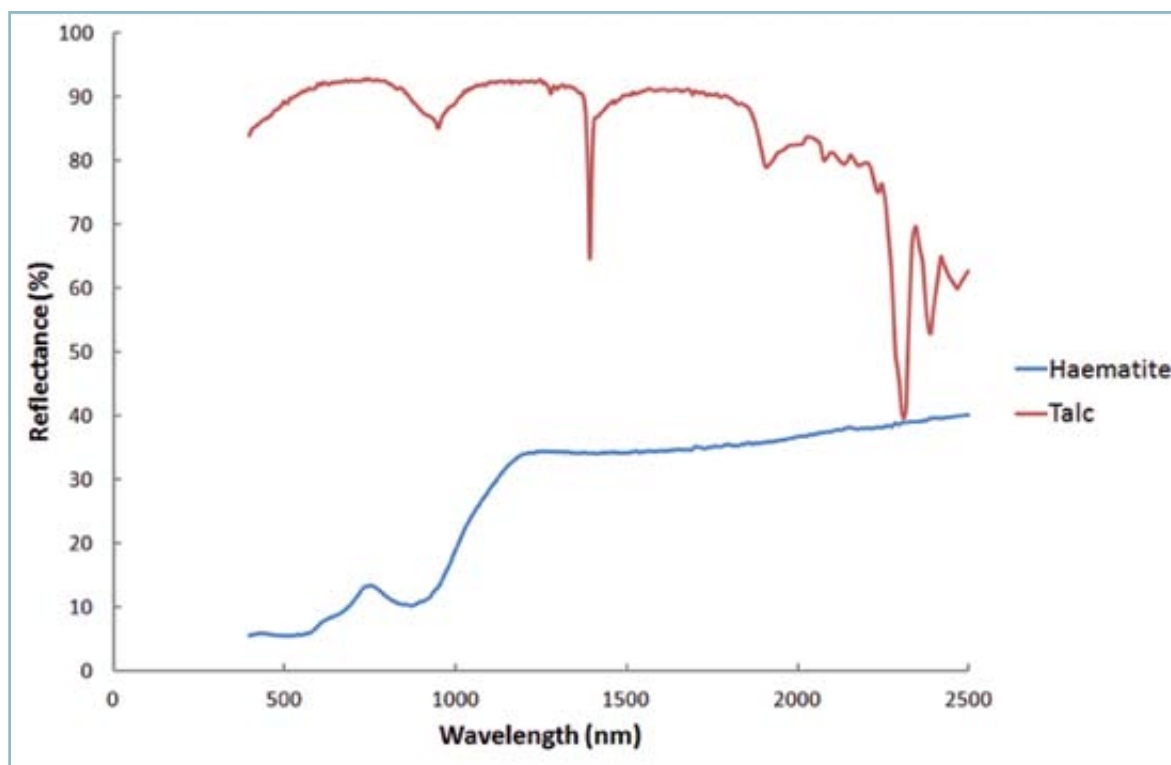


Figure 1.  
Spectra of haematite  
(black) and talc (green)  
in the VNIR-SWIR  
wavelength ranges

absorption features are diagnostic of mineral species, and in many cases can also be used to determine mineral chemistry and crystallinity.

The minerals detectable are dependent on the wavelength range/s used. Four wavelength ranges can currently be captured, the visible-near infrared (VNIR) between 400 and 1000 nm in which features related to iron-bearing minerals (especially iron oxides) are detectable, as well as features related to REE bearing minerals. The short-wave infrared (SWIR) between 1000 and 2500 nm detects phyllosilicates (including clays), hydrous silicates such as amphiboles, sulphates, carbonates and phosphates. In the case of clay minerals, spectroscopy is able to directly distinguish between clay groups and determine clay species. The mid infrared (MIR) between 3000 and 6000 nm is useful for carbonates and organic-bearing minerals, while the thermal or long-wave infrared (7000-12000 nm) detects anhydrous silicates and is especially useful for determining feldspar and garnet chemistry.

Reflectance spectroscopy has been used to capture mineralogical information from drill materials for some time. Typically the instruments used have been non-imaging devices (for example the PIMA and ASD Terraspec) and are only able to capture spectral

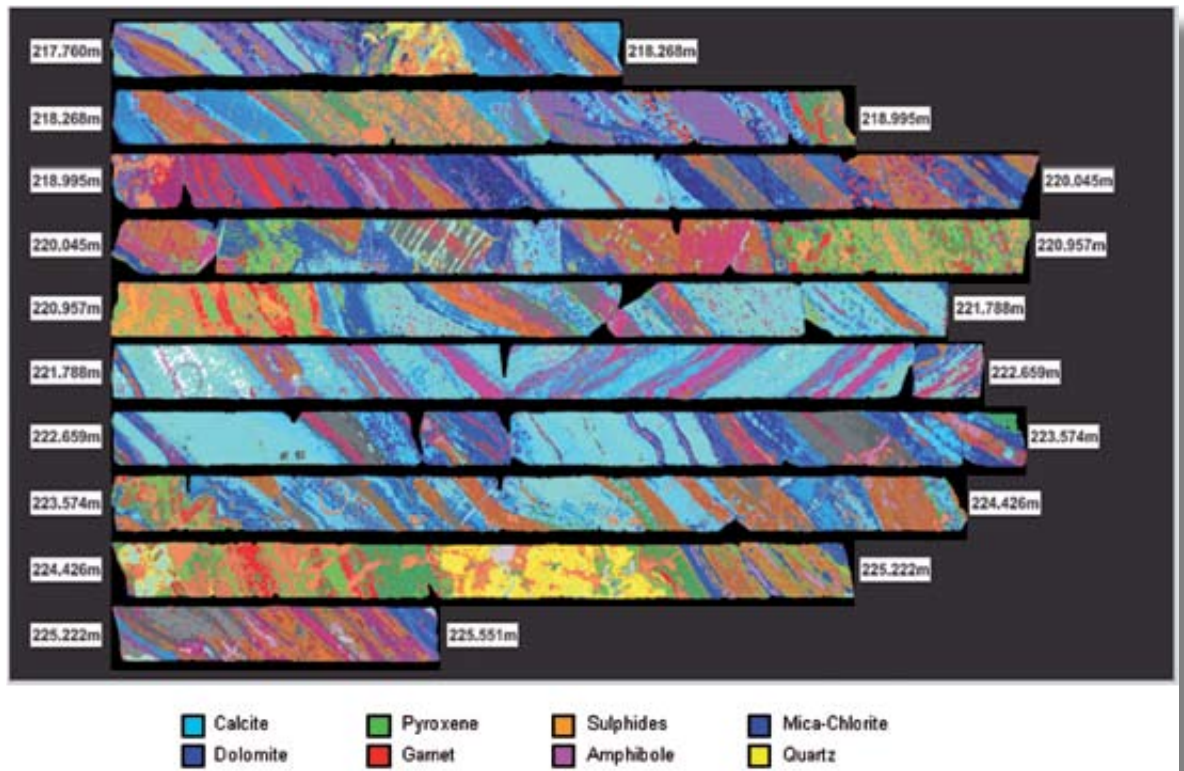
information from a single point which limits representivity of the data collected. The advent of transportable imaging spectrometer platforms now means that millions of spectral measurements can rapidly be made, producing mineral maps (Figure 2) and continuous spectral data that are completely representative. Spatial resolution ranges between 0.25 and 1.5 mm per pixel depending on instrument characteristics, measurement mode and project requirements.

Minimal sample preparation is required, and cores are imaged in their trays thus removing any handling requirements. Using the SpecIM sisu series imagers (Figure 3), a core tray can be captured in under a minute and daily production rates of between 1000 and 2000 metres are typically achieved. These instruments are usually configured to operate between one and three spectral camera systems to capture the desired range of minerals required, and in addition to the spectral information very high resolution colour imagery is simultaneously acquired. While core is the principal focus, these platforms can also be used to acquire spectral information from drill chips or cuttings.

Hyperspectral core imaging is data intensive, with a single core tray usually producing 150-250 Mb of data depending on the camera configuration.



Figure 2.  
Examples of  
mineral maps

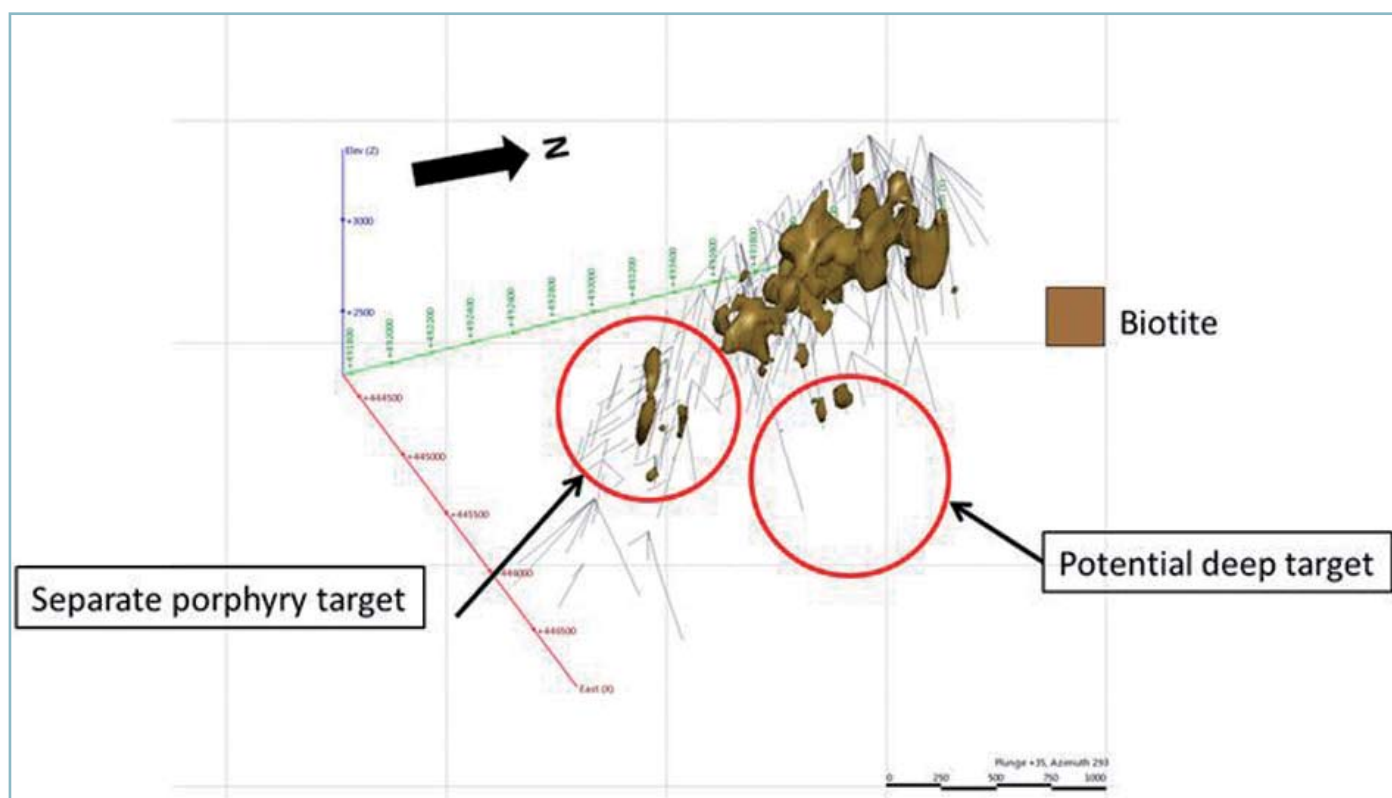


Dedicated processing software and platforms are required to process these volumes rapidly, especially for large projects such as at the Swedish Geological Survey where 200 kilometres of core is currently being captured. Processing services are therefore offered along with acquisition as a turnkey solution. A variety

of products is generally produced, including colour and false colour imagery, mineral species/assemblage maps, indices related to specific mineral species (such as spectral abundance and composition), and digital data related to the magnitudes and positions of absorption features. It should be noted that absolute

Figure 3.  
The Geospectral  
Imaging sisumobi  
system





mineral abundances cannot be directly obtained, but this can be done via calibration with a quantitative technique such as XRD or SEM.

The digital data are provided at a user-defined interval for import into modelling packages, where the information can be combined with other geological, geophysical and geochemical data. An example of modelling is shown in Figure 4, where biotite is used as a proxy for potassic alteration in a porphyry system. A potentially separate porphyry system is evident to the south of the main porphyry, as is a deep target below the main porphyry.

The simplest application is collection of a complete digital dataset for a project to aid in geological modelling and domaining. The data lend themselves to exploration via mapping of alteration that can be used to define targets or to vector towards mineralisation, which in many cases involves shifts in mineral chemistry as opposed to mineral presence. In structurally complex operations the data have proved to be useful for defining ore associated alteration, and so can be applied as a grade control tool.

An important application is for geometallurgy (or resource engineering), where the data can be used

as a proxy for mining and process parameters in the pit, through the plant, and into waste or tailings disposal. In this case, the digital data are correlated to specific process parameters (for which limited data are generally available) using multivariate statistics, allowing prediction of the process parameters at assay spacing. This permits predictive parameter modelling, as is shown in Figure 5 where a throughput block model has been produced from the relationships between spectral data and measured comminution parameters related to impact breakage and grinding. Identification and spatial mapping of very hard ores provides an early warning, and the means to develop a strategy (such as stockpiling or blending) to deal with such materials.

Hyperspectral core imaging provides the means to automatically collect continuous, representative and unbiased mineralogical data from drill materials. The data have been applied for a number of diverse applications, and as the technology becomes widely applied more applications will be identified.

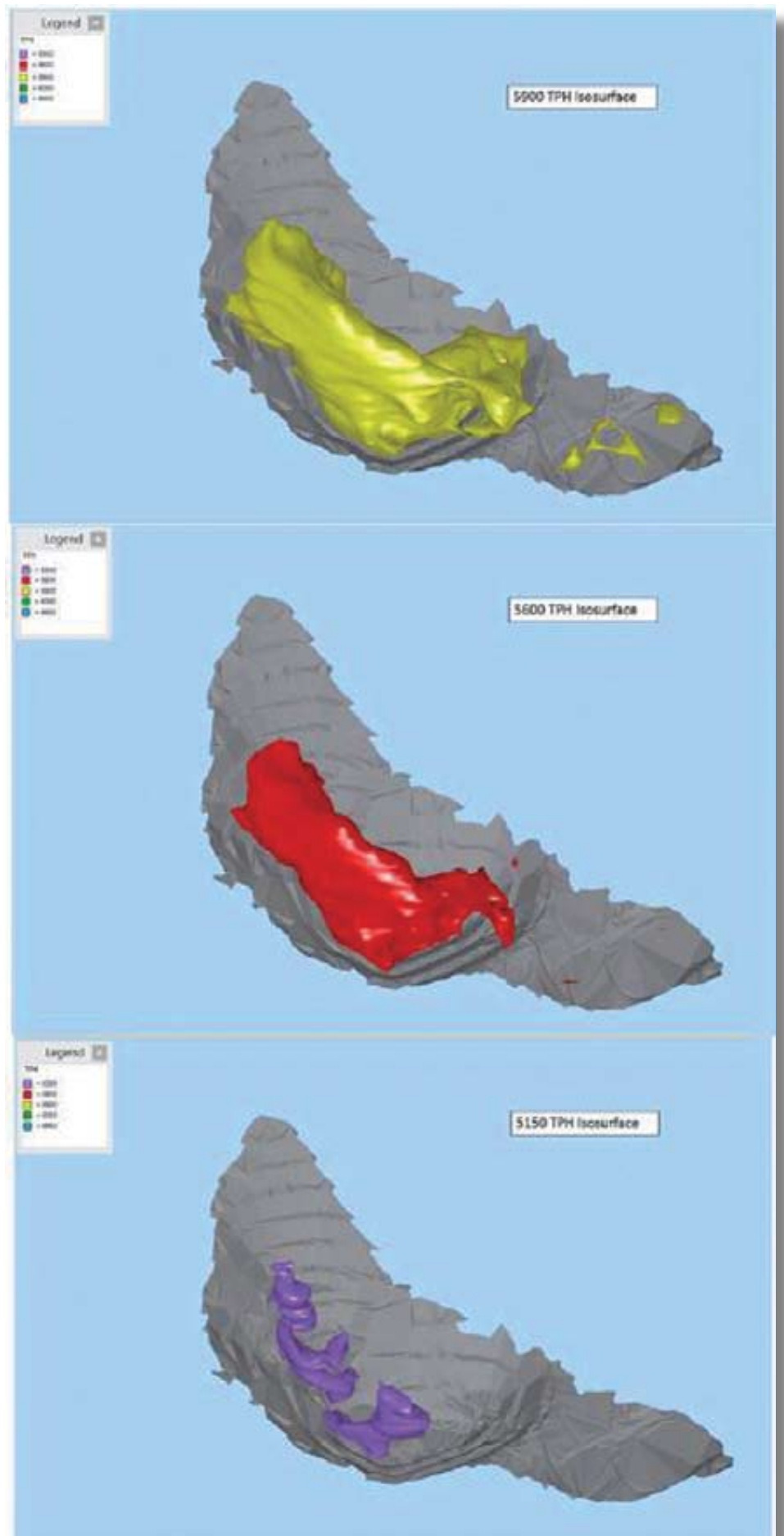
#### Paul Linton

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Figure 4.  
Leapfrog modelling  
of mineralogy to aid  
exploration



*Figure 5.*  
*3-D shells of throughput modelled from combining spectral data with measured comminution parameters. The shells represent 5900 tonnes per hour (top), 5600 tonnes per hour (centre) and 5150 tonnes per hour (bottom)*

# obituary

## Peter Winkler 1954 - 2013

### PETER WINKLER

14 October 1954 to 29 November 2013

Peter was born at Lage-an-der-Lippe in Germany, and went to St Paul's school in Windhoek. He spent his formative years in the light and space of Namibia. These early experiences left him with a love of the veld and wild Africa.

Peter was educated at Stellenbosch University, where he met his geologist wife Susan. Peter completed his BSc degrees in 1979 and began his career working for Anglo American Corporation (AAC) Base Metals Division in Namibia, guided by Henk Gewald, a fine mentor for any young geologist. After many adventures in base metal field exploration Peter went back to university in 1985, completing BSc Honours at UCT. In 1986, Peter resumed his career with AAC and he and Sue transferred to the Gold Division of AAC. Susan worked for Pat McMagh at the exploration office in Orkney while Peter worked for Gordon Wylie at 9 Shaft, Vaal Reefs. After the underground experience, Peter moved back to the sunlight of exploration and subsequently to Welkom, later to Potchefstroom and in 2000 to Johannesburg.

Along the way, sons Max and Alex and daughter Sonja were added to the family. Peter and Susan spared no effort in developing their children's' interests and abilities and were rewarded by the sporting and academic achievements of the children which were a source of pride and joy for Peter until the end of his days.

After the turn of the century, Peter spent time in Russia and Brazil for extended periods working for AngloGold Ashanti (AGA), the successor company of the old AAC Gold Division. Between 2007 and 2010, the couple were based together at Siguiri in Guinea where Peter was the formidable Manager: Geology/ Géologue en Chef. On all his assignments Peter built a large circle of friends and was regarded as a practical, pragmatic geologist who never forgot the basics. In



2011, in recognition of his hard work and experience, Peter was promoted to Vice President: Exploration for Greenfields Africa for AGA. He travelled widely in Africa, bringing the benefits of his decades of experience and motivation to the AGA exploration teams on the ground.

To quote John Irving, 'life can get you at any time'. So it was for Peter when he was recently diagnosed with cancer. Despite all medical efforts, Peter succumbed at the end of November 2013. Peter will be remembered by his colleagues as a strong character, a man of honour and mentor who encouraged those around him to give their best. To his many friends he was immensely generous, particularly in times of need. He truly has left us better off for having known him. His early passing has greatly saddened his many friends - from Argentina to Alaska, Australia to Siberia. He has gone beyond the ranges, exploring where we cannot follow. We join Susan, Max, Alex and Sonja in celebrating his rich and full life whilst we mourn his passing.

**Andreas Rompel**

# media monitor

## MINING AND EXPLORATION NEWS

### Copper

Blackthorn Resources and Intrepid Mines have agreed to an all-share merger. Blackthorn said that the combined company will be fully funded to complete the definitive feasibility study on the Kitumba copper project in Zambia, and to explore the wider Mumbwa project licence areas. The optimized pre-feasibility study for Kitumba, released in April 2014, is based on 58 kt/a of copper production for an initial 11 year mine life. A definitive feasibility study is currently under way with a view to starting construction in early 2016.

### Gold

Armada Capital has increased the overall resources at its Mpokoto project in the DRC's Katanga Province to 678 100 ounces (14.58 Mt at 1.45 g/t Au), with 75% in the JORC Indicated category. An expanded scoping study demonstrates a project with a 9 year mine life, producing over 230 000 ounces of gold at a low operating cost of less than US\$650 per ounce, with a relatively low start-up cost of US\$20.4 million. The company plans to complete a definitive feasibility study by the first quarter of 2015.

An updated scoping study for Orbis Gold's Natougou project in Burkina Faso shows exceptional financial returns, including a 'triple digit' after-tax IRR of 100% at a gold price of US\$1300 per ounce. The study, based on a resource of 18 Mt at 3.4 g/t (more than double the average grade of gold deposits typical of the region), assumes a 2.0 Mt/a mill throughput capacity, with a total production of 1.5 million ounces over a 6.7 year mine life. The pre-production capital cost estimate is US\$233.9 million, and the life of mine total cash costs US\$586 per ounce. Early accessing of shallow, high-grade mineralisation would enable production of 702 000 ounces in the first two years of operation,

and result in a payback period of only 8 months. A definitive feasibility study is scheduled for completion in mid-2015.

### Industrial minerals

Triton Minerals has outlined the world's largest known graphite-vanadium deposit at Nicanda Hill in north-eastern Mozambique, only 6 months after drilling began. The combined JORC resources are 1457 Mt at 10.7% total graphitic carbon (TGC) and 0.27% V<sub>2</sub>O<sub>5</sub>, containing 155.9 Mt of graphite and 3.93 Mt of V<sub>2</sub>O<sub>5</sub>, with 328 Mt in the Indicated category. The resource, which is hosted by a sequence of graphitic schists with minor intercalated gneissic intrusive units, is continuous over 5.6 km and extends to depths of up to 350 m. The mineralisation remains open at depth and along strike. Triton aims to complete a scoping study on Nicanda Hill shortly, and is focusing on further definition of the high-grade zones (>15% TGC), which would constitute an early mining target.

In Tanzania, Kibaran Resources has started a feasibility study on its Epanko graphite project. The study will be based on a 15 year mine life with an initial annual production rate of 40 kt of high-quality large-flake (>75 µm) graphite. Epanko currently has an Indicated plus Inferred mineral resource estimate of 22.7 Mt grading 9.8% TGC, which covers only 20% of the project area. The scoping study completed in August estimated the cost of development at US\$56 million.

### Iron ore

Timis Corporation has purchased London Mining's Marampa mine in Sierra Leone from the company's administrators for an undisclosed sum. The purchase was part-funded by Cape Lambert Resources, which will receive US\$2 per ton royalty for four years for concentrate exported from Marampa. In addition, Timis will have exclusive rights to mine and purchase



100 Mt of oxide ore from Cape Lambert's Sierra Leone projects, which adjoin the mine. African Minerals, in which Timis Corporation is the controlling shareholder, has approved access to its rail and port infrastructure for the export of 6 Mt/a of Marampa's product on commercial terms. African Minerals' Tonkolili project has a current capacity of 20 Mt/a of direct shipping ore.

### Nickel

Norilsk Nickel is selling its operations in Africa, comprising a 50% participating interest in the Nkomati nickel mine in South Africa and an 85% stake in Tati Nickel in Botswana, to BCL for US\$337 million in cash. Norilsk's Nkomati concentrate offtake agreement will be assigned to BCL, allowing both Tati Nickel and Nkomati concentrates to be treated at BCL's smelter in Selebi Phikwe. In addition, Norilsk will enter into a matte offtake agreement with BCL, and process the matte at its Harjavalta refinery in Finland.

### PLATINUM GROUP ELEMENTS

Hebei Zhongbo Platinum Co. Limited has agreed to buy Eastern Platinum's South African platinum group metals business for US\$225 million in cash. The assets include the Crocodile River Mine, which was placed on care and maintenance in mid-2013, and the Spitzkop, Kennedy's Vale, and Mareesburg projects on the eastern limb of the Bushveld Complex. Meanwhile, Aquarius Platinum terminated the proposed sale of its interests in the Blue Ridge and Sheba's Ridge projects to a consortium led by the China National Arts & Crafts Group. The deal, which was announced in January, was subject to a number of conditions, including certain South African regulatory approvals that as of mid-October had not been granted.

### Rare earths

Mkango Resources' Songwe Hill project in southeastern Malawi could produce an annual 2.8 kt of rare earth oxides in concentrate over a mine life of 18 years, according to the recently completed pre-feasibility study. The study is based on a conventional open pit

operation and a Probable mineral reserve estimate of 8.5 Mt grading 1.6% total rare earth oxides. The initial capital cost is estimated at US\$217 million – amongst the lowest in the rare earth sector – with cash operating costs of US\$17 per kilogram over the life of mine. Mkango is one of only three rare earth projects in Africa with a pre-feasibility or feasibility study announced, the other two being Great Western Minerals' Steenkampskraal project in South Africa and Peak Resources' Ngualla project in Tanzania.

The International Finance Corporation (IFC), part of the World Bank Group, has proposed to partner with Jersey-based Appian Natural Resources Fund to invest US\$25 million in Peak Resources' Ngualla rare earth project in Tanzania. The transactions, which will result in Appian and the IFC holding an interest of 30% and 7.5% respectively in Peak African Minerals, will fully fund the project through the bankable feasibility study. The preliminary feasibility study, completed in March, evaluated a project with a life of more than 50 years producing 10 kt/a of >99% purity separated rare earth oxide products from a high-grade bastnaesite reserve of 20.7 Mt at 4.54% rare earth oxides (REO), 87% of which is in the Measured category. This comprises only 22% of the total resource in terms of contained REO. Ngualla is not only an extremely large rare earth deposit, but is also high quality as a result of high grades, the morphology and outcropping nature of the mineralisation, favourable mineralogy for processing, low levels of uranium and thorium, and an elevated content of high-value neodymium, praseodymium, and europium. The total estimated capital cost is US\$367 million, placing Peak as the only potential producer of separated rare earth products with a capital requirement of under US\$800 million.

### Vanadium

A scoping study has indicated that Bushveld Minerals' vanadium project, on the northern limb of the Bushveld Complex, could be one of the world's largest and lowest cost vanadium producers, producing 10 370 t of V<sub>2</sub>O<sub>5</sub> per annum via the proven salt roast route, with operating costs of US\$2.72 per pound, for a capital expenditure of US\$261.5 million. The project



contains an Indicated resource of 52 Mt at a grade of 1.48% V<sub>2</sub>O<sub>5</sub>, and there would be further scope for processing the high-grade layers in the hangingwall of the Main Magnetite Layer. These, which are currently treated as waste for determining the stripping ratio, contain additional Inferred resources of 68.7 Mt at 0.8% V<sub>2</sub>O<sub>5</sub>.

### EXPLORATION TRENDS

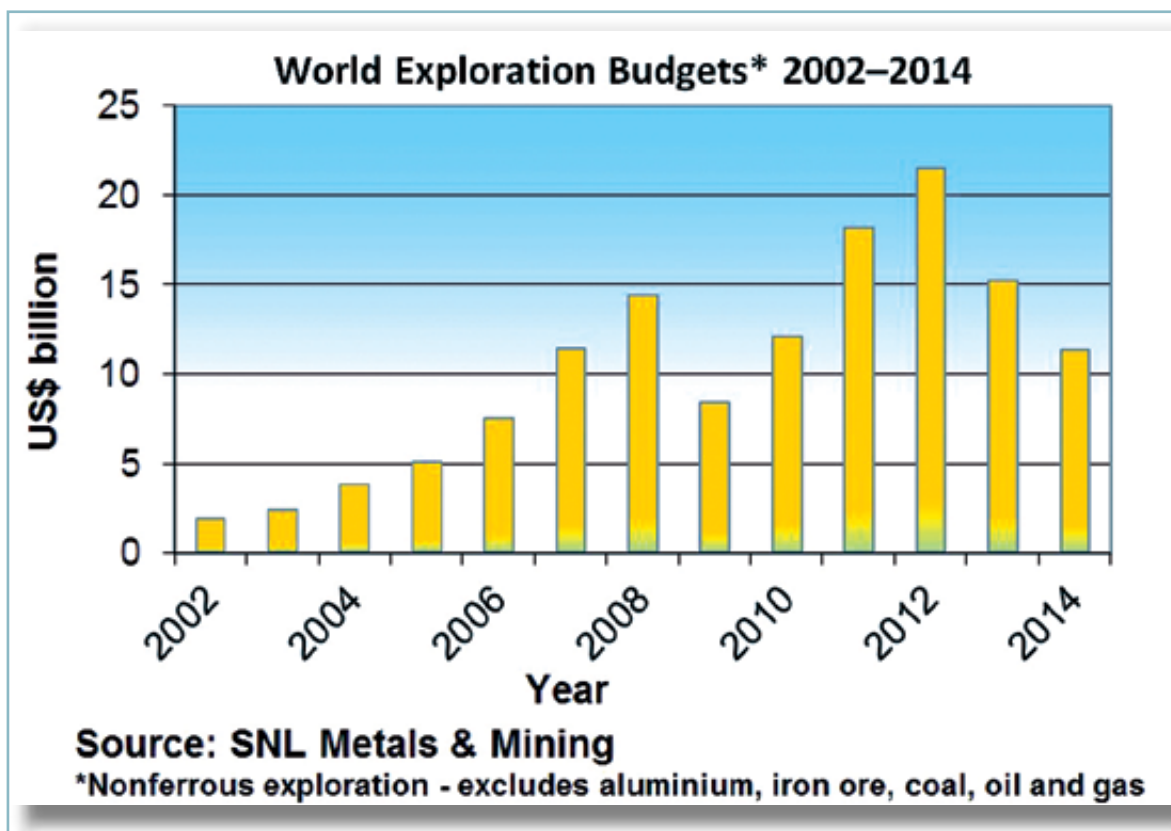
Global expenditure on nonferrous metals exploration dropped to US\$11.36 billion in 2014, a 25% decrease from US\$15.19 billion in 2013, and 53% down on the record high of US\$21.5 billion in 2012, according to SNL Metals & Mining. Exploration budgets fell across all sectors, except for the platinum group metals. Gold exploration spending decreased by 31% to US\$2.57 billion, or 43% of the total – the lowest share of the total since 2009. Base metals budgets declined by US\$1 billion, but the sector’s share of the total increased by 2% to reach the highest level since 2008. Exploration spending in Africa decreased by 28%, slightly above the overall decrease, but this was weighted by the 38% decline in West Africa – due primarily to the weak gold price and regional insecurity.

### Other Geoscience News

For more than 60 years, the ‘sailing stones’ of Racetrack Playa in Death Valley National Park, California have excited speculation. Rocks ranging from pebble- to boulder-sized pieces of dolomite and granite move across the nearly flat playa surface, ploughing trails in the mud that can stretch for more than 100 m. Groups of rocks leave parallel tracks, including synchronous high-angle turns and occasional reversals in direction. Various researchers have attributed the movement of the rocks to high winds, slick algal films, or thick ice floating rocks off the playa surface, but until recently the process had never been seen in action.

At the beginning of 2014 a team led by paleobiologist Richard Norris from the Scripps Institution of Oceanography at the University of California San Diego, recorded the first direct scientific observation of rock movements. The experiment, which was set up in 2011, used 15 rocks fitted with custom-built motion-activated GPS units together with a high-resolution weather station and time-lapse cameras, as well as observations in the field. The results, which were published in the online journal PLOS One (doi:10.1371/

World exploration budgets 2002-2014



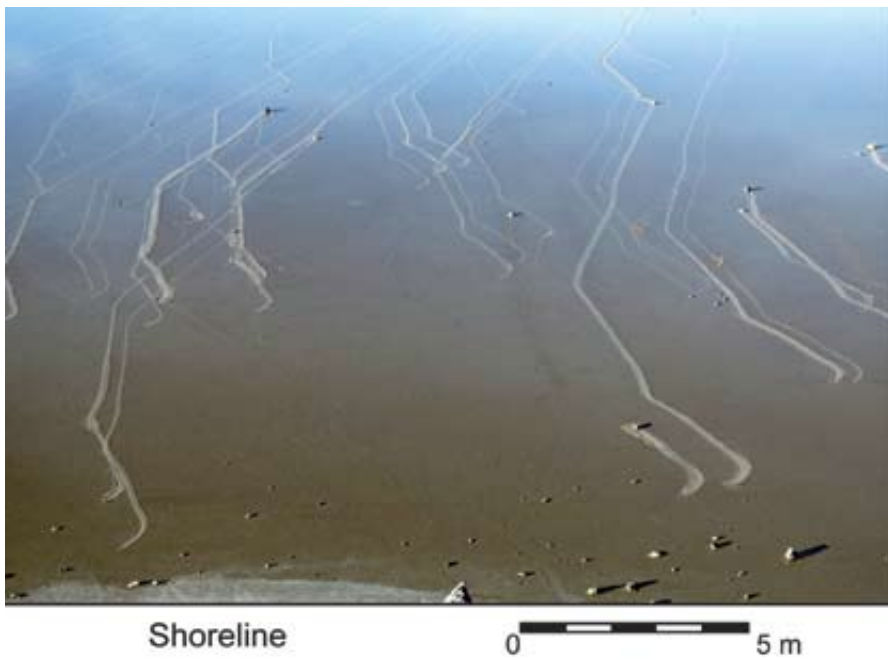


*A 'sailing stone' on the dry surface of Racetrack Playa in Death Valley. (Photo: Ian Parker, Evanescent Light Photography)*

journal.pone.0105948.g008), showed that the movement results from a rare combination of events. After infrequent rains, parts of the playa floor become a broad, shallow pool a few centimetres deep, which freezes when night-time temperatures in winter drop below zero to form thin sheets of 'windowpane' ice between 3–6 mm in thickness. When the ice begins to thaw in the late morning it breaks up into large floating panels, which steady light winds (about 4–5 m/s) drive across the playa, pushing the rocks in front of them and leaving trails in the soft mud below the surface. The rocks move only a few metres per minute, a speed that is almost imperceptible to the casual observer. Furthermore, the trails become visible only after the ice has melted and the muddy water clears. A surprising finding is the power of

even thin sheets of ice to move large stones, without buoyant uplift. The longest trail recorded was left by an instrumented rock with a mass of a 16 kg that travelled 65.6 m in 16 minutes.

**Antony Cowey**



*Congruent trails generated by the largest observed rock movement, involving more than 60 rocks, on 20 December 2013. Some instrumented rocks moved up to 224 m between December 2013 and January 2014 in multiple events. (Photo: R. Norris, Scripps Institution of Oceanography)*



*The Jurassic Coast,  
Southern England*

# THE GEOTRAVELLER

**By Roger Scoon**

## THE JURASSIC COAST, SOUTHERN ENGLAND:

*Classic coastal scenery and fossil beds*

My PERIOD	STRATA	LOCATION
CRETACEOUS	CHALK	Beer - Axmouth Lulworth, Old Harry Rocks
	UPPER GREENSAND	
	GAULT	Beer - Axmouth Lulworth
	LOWER GREENSAND	
	WEALDEN GROUP	Lulworth, Swanage
JURASSIC	PURBECK GROUP	
	PORTLAND GROUP	Portland, Lulworth
	KIMMERIDGE CLAY FORMATION	Kimmeridge Bay, Portland
	CORALLIAN GROUP	The Fleet, Portland
	OXFORD CLAY	East of Weymouth
	MIDDLE JURASSIC	West Bay to The Fleet
	LIAS GROUP	Lyme Regis, Charmouth
TRIASSIC	PENARTH GROUP	East of Axmouth
	MERCIA MUDSTONE GROUP	Sidmouth to Branscombe
	OTTER SANDSTONE FORMATION	Budleigh Salterton to Sidmouth
	BUDLEIGH SALTERTON PEBBLE BEDS	Budleigh Salterton
	AYLESBEARE MUDSTONE GROUP	Exmouth to Budleigh Salterton

Simplified stratigraphic column of the Mesozoic in Dorset and East Devon.

The Jurassic Coast in southern England reveals superb coastal scenery and spectacular fossils. A renewed interest in palaeontology, in part inspired by the film *Jurassic Park*, resulted in the area being proclaimed a World Heritage Site in 2001. This was the first area in England to receive this status for entirely natural reasons. The Site includes 155 km of the English Channel coastline of Dorset and east Devon. The geomorphological features and landforms are renowned and this area has yielded a major contribution to the earth sciences.

The World Heritage Site includes rocks that reflect 185 million years of Earth History as it includes not only the Jurassic but the entire Mesozoic. In southern and central England, these strata crop out in a north-easterly trending belt with the rocks becoming progressively younger toward the south-east. The combination of relatively flat-lying strata (in most, but not all sections), abundance of fossils, and exposed cliff faces make this area ideal for a geological park.

The Heritage Site is visited by huge numbers of tourists and even on rainy days in the summer, as experienced on the writers visit, is extraordinarily popular. The area supports a number of educational centres and museums. Brochures with maps and details of the main fossil-types are readily available. Guided walks are popular and collecting fossils in an ethical manner is emphasized (restricted to wave-cut platforms, boulders). Many of the cliff faces are eroding rapidly and are quite hazardous. The area supports professional collectors and new finds, including entire skeletons excavated over many weeks, are continuously being unearthed.

The westerly point of the Heritage Site reveals Triassic-

age cliffs near Exmouth, east Devon. The easterly limit is the Cretaceous-age rocks of Old Harry Rocks near Swanage in Dorset. The preserved area is restricted to cliffs and foreshore. Many sections can be reached by road with short walks; others are accessed from a coastal path. The main towns in the area are mostly holiday resorts; they include Weymouth and Lyme Regis.

The area is associated with some famous geologists. William Smith mapped the Mesozoic throughout southern England, including the Dorset hills. Together with Henry de la Beche, and others, he was involved with selecting building stones from the area for the then new Houses of Parliament. De la Beche was a geologist who moved to Lyme Regis as a young man where he met Mary Anning, the celebrated fossil collector. His first paper, "Remarks on the geology of the south coast of England, from Bridport Harbour, Dorset, to Babbacombe Bay, Devon", was read to the Society in 1819, at the age of 23. His 1822 article on the geology of the coasts of

Dorset and Devon included details of the marine fossils.

Mary Anning has been described as one of the great fossil collectors. Many of her finds are presented in the museum at Lyme Regis. Her discoveries in the Jurassic strata of the area were significant as they provided crucial evidence in support of the long time periods involved in geological science. She found the first ichthyosaur (in 1810), and subsequently found near-complete skeletons of *Plesiosaurus* ("sea-dragon") and *Pterodactylus* (flying-dragon"). Despite not being formerly educated, in later life she received an annuity from the Geological Society, but was never made a member.

A walk between Seaton and Beer in the westerly part of the area reveals the oldest and youngest rocks in the section. Cliffs at Seaton are comprised of Triassic red beds, whereas those at Beer are of the Cretaceous-age chalk. The latter reveals near-horizontal beds with bands and nodules of flint, together with minor faults.



Map of part of the western section of the Heritage Site.



Triassic rocks exposed in the cliffs at Seaton looking east toward Axmouth and the River Ax. Blocks of limestone at the base of the cliff are to prevent erosion.



*Syncline in the Cretaceous Chalk at Beer.*



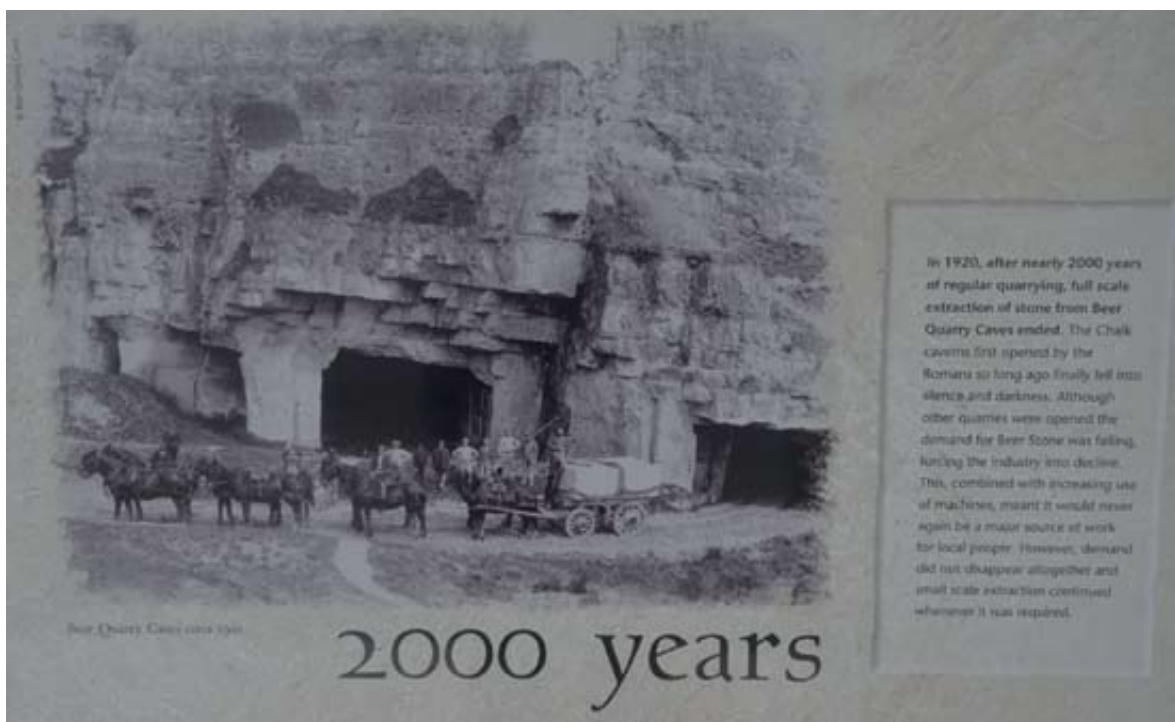
*The unconformity between the Triassic and Cretaceous is well exposed; the absence of Jurassic strata is due to a syncline as seen on the beach at Beer and faulting. In 1790, a major slump occurred at Hooken, between Beer and Branscombe (this is where the container ship MV Napoli was beached in 2007). This created a secondary cliff that has eroded to leave pinnacles of chalk.*

*Fosse Way, one of the main Roman roads in England, and this may have been influenced by the quarry. The quality chalk occurs in a bed some 2 metres in width, with the juxtaposed strata inferior. The masonry stone (it has no fabric) is ascribed to a localized facies of chalk comprised of densely-packed coccoliths cemented by calcite derived from sea urchins.*

*The chalk at Beer has been exploited as a building stone. Beer Quarry is open to tourists as a historical site. Both the Romans (rounded workings) and Saxons (square cuts) mined here. Axmouth is the southern end of the*

*Major landslides have occurred in an area between Axmouth and Lyme Regis known as the "Undercliff", a series of benches. Some of the slips that occurred in the 18th and 19th centuries have been described in some*

*Information board at Beer Quarry.*



In 1920, after nearly 2000 years of regular quarrying, full scale extraction of stone from Beer Quarry Caves ended. The Chalk caverns first opened by the Romans so long ago finally fell into silence and darkness. Although other quarries were opened the demand for Beer Stone was falling, forcing the industry into decline. This, combined with increasing use of machines, meant it would never again be a major source of work for local people. However, demand did not disappear altogether and small scale extraction continued whenever it was required.



detail. The “Great Slip” of 1839 – in which a large tract of land slipped toward the sea, creating Goat Island and the Chasm - was investigated by Oxford-based geologists William Buckland and William Conybeare. This became a popular spot with visitors and the fascination with this area is illustrated by the setting of several novels. Access is now difficult as the terrain has unstable cliffs, deep gullies and dense undergrowth. It provides a rare and unusual habitat for plants and birds and is now a protected area.

Lyme Regis and Charmouth provide some of the best areas for collecting fossils. Large ammonites are found closely-packed in a wave-cut platform in Pinhay Bay. This consists of a hard, resistant bed of limestone (the Blue or Lower Lias). This sequence includes the “paper shales with beef”, the latter being thin bands of impure, but more resistant limestone. The marls and clay at the Black Ven cliffs, Charmouth, are notably soft. They contain abundant belemnites in specific sections.



Small landslide in the Black Ven cliffs at Charmouth. The prominent beds of limestone in the marl are known as “beef”.

The BGS Landslides Team reported on a slip in 2008 near Charmouth. They used terrestrial and aerial LiDAR to record the details. The main failure surface was identified as at, or just above, the top of the Blue Lias Formation. The marls in the upper part of the cliff appeared to remain intact with the so-called Beef Member material actively sliding over the vertical cliff onto the foreshore. The Black Ven cliffs are particularly unstable. Slips are common

and included major slides in 1958/9. The boulder arcs on the beach from these slips are being reworked. In 1995 failure of a large bench was photographed.

The Middle Lias and Upper Lias reveal sequences of sandstones and marls in which fossils are considerably less abundant. The Middle Jurassic is well exposed in the East Cliff at West Bay, and includes the Bridport Formation which forms near-vertical cliffs up to 190 m in height at Golden Gap. The cliffs have a distinctive ribbed pattern due to intercalation of lenticular bands of harder, blue calcareous sandstone in yellow micaceous sandstone.



The striated cliffs at West Bay are comprised of Middle Jurassic-age sandstone.

The Pleistocene glaciations that reshaped much of the land surface of the British Isles, and created flooded estuaries in the southwest left little imprint on the coastline of Dorset and east Devon. The exception to this is Chesil, one of the best preserved barrier beaches known. This is a 28 km-long arc that protects the Fleet Lagoon, and joins the headland of Portland Bill. The pebbles move eastward along the beach. They reach a height of 15 m. The origin is much debated but it may have formed in part due to sea-level changes, with material derived from ancient landslides, far more violent than seen today, with pebbles being replenished from an offshore lagoon.

The Upper Jurassic includes the resistant Portland Limestone, an important building stone from which a number of landmarks in London are constructed. This formation forms Portland Bill, a prominent headland, from where it is still quarried. At Osmington there is some seepage of natural oil from the Oxford Clay. These



Part of the 28 km-long Chesil Beach with the interior Fleet lagoon and the headland of Portland Bill just visible.



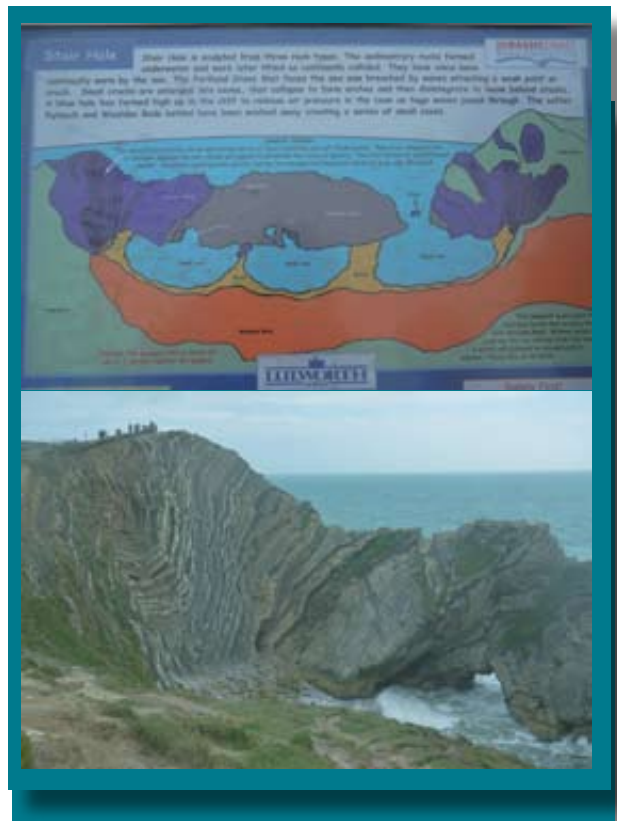
rocks include trace fossils, observed as burrows and other markings. To the east of here is the "Burning Cliff", a name based on natural fires from organic-rich clays.

with poorly compacted, near-horizontal strata to the west is remarkable and is ascribed to the strain of the Alpine orogeny having been restricted to a localized block.

The Upper Jurassic strata are well exposed to the east of Weymouth, with the most important sites being at Kimmeridge, Lulworth, and in the Purbeck Hills. Kimmeridge Clay is a marine bed that contains most of the North Sea oil. It is rich in fossils and has yielded finds of plesiosaurs, pliosaurus, sauropods, turtles, ichthyosaurs, and invertebrates. The Purbeck Group straddles the boundary between the Jurassic and Cretaceous. It includes limestone that has been quarried for building stone and is well known for both dinosaur and mammal fossils, as well as dinosaur tracks.

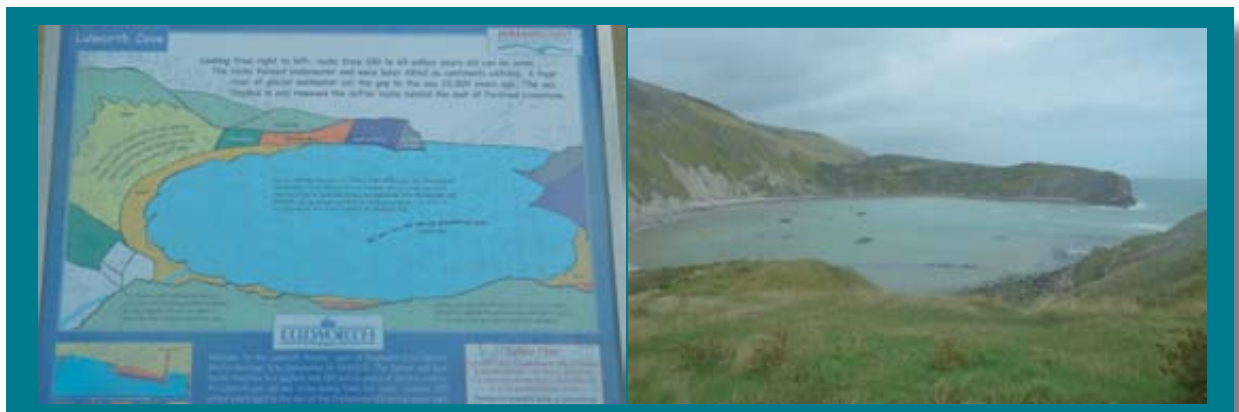
The most famous part of the Heritage Site is probably the area around Lulworth. Lulworth Cove is a horseshoe-shaped bay with headlands of very resistant Purbeck Limestone. The softer, Wealden and Greenstone beds have been removed from the centre of the bay with the somewhat more resistant Chalk forming the interior cliff. The Cove includes a section of fossilized trees.

Stair Hole is a small cove with steep cliffs, sea stacks, and caves comprised of subvertical beds of the Purbeck Group. They have been severely deformed. The contrast



Information board and view of the crumpled beds at Stair Hole (looking east).

Information board and view of Lulworth Cove (looking east).





## Durdle Door

There are five types of rock exposed in these cliffs. Each was formed underwater and later tilted as continents collided. The tough Portland Stone was breached by the sea, creating Durdle Door and the stacks which describe the coastline of 10,000 years ago. Softer rocks behind have been washed away leaving an eroding line of Chalk cliffs.

In the rock above the arch look for several holes which are the fossilised remains of where Great Trees once grew 147 million years ago.



The rose vertical Purbeck Beds bear the flowing ripple marks of an ancient sea floor.

The name 'Durdle' comes from the 'Durd' meaning a pointed hole, as in 'Durdle'.



Information board and view of the Durdle Door sea-arch looking west with cliffs of Chalk in the background.

This has also resulted in preservation of the famous sea arch, Durdle Door, in which the subvertical bedding of the Purbeck Limestone is noted.

Due to the high rate of erosion and mass movement in the area, the boundaries are periodically monitored to ensure that changes to the shoreline are reported. The Fleet Lagoon is an important site as sediments provide evidence of late Holocene changes in sea level. The Isle

of Purbeck is particularly notable for its well-developed coastal landforms, including textbook examples of bays, stacks, and sea-arches.

Photographs by the author.



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The Official Guide to the Jurassic Coast: A walk through Time. Coastal Publishing Limited (2001), 64 p.



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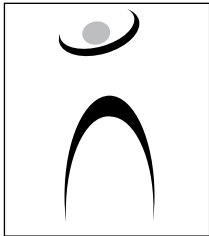
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## 3. PRINTING MATERIAL

Material to be supplied on CD as a FH MX/InDesign CS2 or PDF file. Accompanying images should be high resolution in CMYK format (NO RGB or Pantone colours, or). Any full page material to be trimmed to 297 x 210 mm and must include a bleed of 5 mm all round. A COLOUR HARDCOPY MUST ACCOMPANY MATERIAL. Any modifications to incorrectly-supplied material will be charged to the advertiser at R250.00 per hour.

## 4. LOOSE INSERTS

R5 660.00. Printed material to be supplied. Please ensure that the inserts do not exceed the trim size of 297 x 210 mm. All inserts must be delivered to the Editor GB (see below).

## 5. DEADLINES FOR COPY AND ADVERTISING MATERIAL

March issue:	16 February 2015
June issue:	15 May 2015
September issue:	14 August 2015
December issue:	16 November 2015

## 6. CANCELLATIONS

Four weeks prior to deadline

## 7. ADVERTISING AGENCY COMMISSION

Excluded

## 8. CIRCULATION

Geobulletin is issued and dispatched at no additional charge to all of the various members of the Society and its local and overseas exchange partners. The circulation list exceeds 1800 and reaches all of the decision-makers in the geoscience and mining community; the geological consultants and leaders in the Mining Groups, the Mining Industry and Government Institutions, universities, private, public and state libraries. Electronic versions of the GB are freely distributed through the society's web page.

## 9. ADVERTISING BOOKINGS AND SUBMISSION

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**The design and layout of the adverts is the responsibility of the advertiser. If you wish to utilise the services of the GB graphics and layout supplier, please contact Belinda directly, well in advance of the advert submission deadline to make arrangements.**

**SAFETY  
QUALITY  
SPEED**



**Safety. Quality. Speed.** Three key elements at the core of Rosond, one of South Africa's leading providers of drilling, grouting and geotechnical services to the mining industry.

Without doubt, safety is the most important consideration for Rosond's business of supplying drilling and grouting services to the mining and exploration industry. Rosond's rigorous attention to every detail of safety has earned it an enviable reputation in this critical aspect of the mining industry. On every site – be it surface or underground – Rosond's dedicated safety officers and site representatives cooperate to apply safety processes at all levels, and regular reports are analysed to identify and address safety challenges. This dedicated attention to detail is a hallmark of Rosond's safety operations.

In an industry in which safety is such a high priority, quality of product and service is of paramount importance. More than half a century of experience in drilling and grouting for the mining and exploration industry results in a high quality service and ability to solve even the most challenging of problems. Rosond's state-of-the-art manufacturing facilities supply products that are designed and engineered to the highest standards of quality.

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