GSSA
Geological Society of South Africa

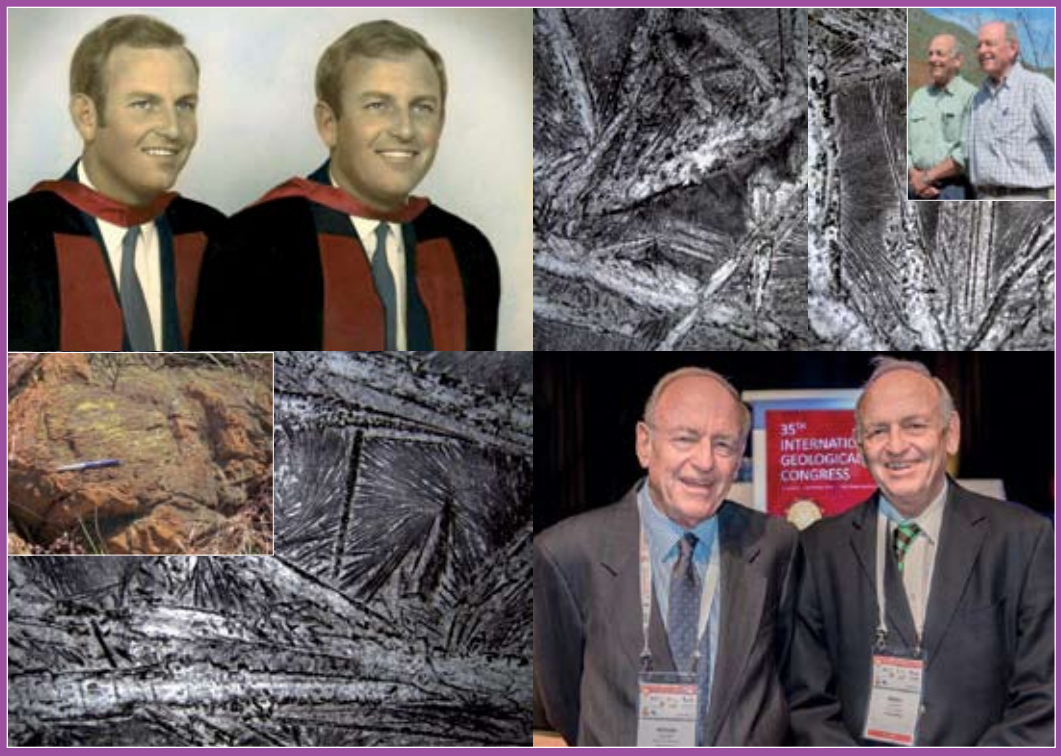
geobulletin

QUARTERLY NEWS BULLETIN ~ DECEMBER 2019

VOLUME 62 NO. 4

news

Komatiite 50th Anniversary
ICDP approves funding for drilling project
Geoplaque at Chapmans Peak Drive



CENTREFOLD:

Viljoens, a lifetime with komatiite.

3 Photos: David Reid, Komatiite in Barberton and Nondweni

GSSA
Geological Society of South Africa

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Front Cover:
'The mantle has gone dark….' Kinked twin planes in a deformed olivine crystal included within garnet. Crossed polars. FOV = 3mm. Mantle Peridotite nodule collected from the Boshof Road dumps, Kimberley. Photo by D.L. Reid.

GSSA
Geological Society of South Africa

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Contributions for the next issue should be submitted by:
15th FEBRUARY, 2020.

Geobulletin is provided free to members of the GSSA. Non-member subscriptions per four issue volume are R350.00 for South Africa. Overseas and rest of Africa, R350 plus postage. Surface mail, R200.00. Airmail, R300.00. The views expressed in this magazine are not necessarily those of the GSSA, its editor or the publishers.

ADVERTISING RATES (Excl. VAT & Agency Commission): Geobulletin is published by the Geological Society of South Africa (GSSA) and appears quarterly during March, June, September and December each year.

2019 RATES: Jann Otto 082 568 0432 (inside back cover)

For detailed prices, mechanical and digital submission requirements, please contact the GB advertising co-ordinator, editor (see Contents Page for contact information) to obtain an up-to-date Rates Card or other information.

DEADLINES FOR COPY AND ADVERTISING MATERIAL are 15th February (March 2020 issue), 15th May (June 2020 issue), 15th August (September 2020 issue) and 15th November (December 2020 issue).

Please note that the design and layout of adverts and inserts is entirely the responsibility of the advertiser. If you wish to contract the services of the GB graphics and layout supplier for this service, please contact Belinda Boyes-Varley directly, well in advance of the advert submission deadline to make arrangements.

(ISSN 0256-3029) publisher-id: gb.62.4

from the editor's desk

Chris Hatton

'You've never had it so good' is one way of looking at our current climate of blistering heat and drought alternating with incessant rain and flooding. The basis for this questionable perspective is the emerging picture of the world as it was relatively recently. 12 800 years ago a remarkably abrupt cold snap ushered in the Younger Dryas glaciation, rudely interrupting the warming trend which followed the end of the Older Dryas glaciation. One explanation for this sudden cooling, initially regarded as quite far-fetched, is that a meteorite struck the Earth, producing wild fires on a global scale, darkening the sky and demolishing human populations. The evidence for this apparently outrageous explanation is actually quite considerable, including a sample of an iron meteorite in Greenland, the nearby Hiawatha impact site with an appropriately juvenile morphology, soot deposits across the globe, and to cap it all, platinum spikes within these soot deposits. Francis Thackeray of the University of the Witwatersrand presents the most recent description of a platinum spike, found within the Wonderkrater peat deposit. The timing of the Wonderkrater spike appears to correspond remarkably closely with the demise of the spear-wielding Robberg culture and the colonisation of their erstwhile hunting grounds by humans who are effectively indistinguishable from the San, using the bow and poisoned arrow to bring down their prey. In the Cape the transition is as abrupt as the Younger Dryas impact hypothesis would predict. Only in KZN does the transition appear more gradual but the use of the bow and arrow in this part of the world dates back to more than sixty thousand years, showing that the use of this weapon was no new thing for this culture. DNA evidence suggests that the hunter-gatherer culture originated here so this culture might have spread from KZN when the rest of Africa was reeling from the impact at the beginning of the Younger Dryas. At the end of the Younger Dryas to the north, the domestication of the auroch in the Middle East saw the beginning of the farming culture. The southward spread of nomadic farmers would ultimately overwhelm the hunter-gatherer culture.

The proliferation of the farming culture is in large measure due to the stable temperature regime of the last six thousand years. During this time, the average annual temperature has varied by less than 5 degrees. By comparison the beginning of the Younger Dryas saw much large temperature variations within a matter of years. Although one might take comfort in a belief that meteorite impacts are infrequent, wild temperature swings, with or without a meteorite impact, are not unusual. The warming at the end of the Younger Dryas was almost as abrupt as the cooling at the beginning, and it was the feedback loops that are associated with relatively mundane events such as glacier melting and shifts in storm patterns that drove this heating. The take away message from the Younger Dryas is that wild swings in temperature are the rule rather than the exception. The stable climate that currently prevails cannot last. The relatively miniscule temperature increase associated with current global warming, whether anthropogenic or not, may be just the beginning of a feedback loop which will escalate to the frightening fluctuation at the end of the Younger Dryas. The question is, what should we do during these good times? How do we make hay while the sun shines?

Whilst an individual geologist can certainly make a difference to the world, the greatest impact arises when the geologist and society act in concert. For a South African geologist the interaction between geology and the wider society begins with our microcosm, the Geological Society of South Africa. Strengthening of the local branches of the Society is one of the aims of our new President, Sifiso Sexwale. Pp. 20-24 of this issue illustrate the activities of a local branch that is already flourishing. The Western Cape branch has updated plaques on Chapman's Peak and Sea Point. The association of the Sea Point site with the geological activities of Charles Darwin provides a bridge between geology, biology and evolution, inviting exploration of the links between these interrelated aspects of science. Another vehicle for communication among geologists is the conference. The revival of Geocongress, begun last year at the University of Johannesburg continues next year at Stellenbosch University (p.25). Another conference, with a narrower focus than Geocongress but nonetheless with wide appeal began when a collaboration between the late Barry Hawthorne († previous issue) and the late

John Gurney (†pp.78-81) led to the staging of the First International Kimberlite Conference at the University of Cape Town in 1973. John Gurney's scrapbook of this event is on pp. 47-64. This was the beginning of a career which inspired many to join in a lifelong intellectual adventure grappling with the many facetted mysteries of diamonds, their inclusions, the peridote and eclogite xenoliths that contain diamonds and the kimberlites that brought xenoliths and diamonds to surface. Although rare the diamond content of intact diamondiferous xenoliths is sufficient to induce most diamond miners to crush them during routine mining operations. The practice of separating xenoliths before crushing of the softer kimberlite is rapidly vanishing so the collection of xenoliths that John Gurney and collaborators amassed in the John Gurney Mantle Room at UCT will become increasingly valuable. Only time will tell which of the twin pillars of John Gurney's legacy, the International Kimberlite Conference or the Mantle Room will prove the more imporant.

Mercifully the Viloen twins are still among us. Pp 36-46 reports on a field trip during the commemoration of the 50th anniversary of their discovery of komatiite, which together with kimberlite, is one of the only two rock types to be named after a South African locality. The quench needles of orthopyroxene and olivine in komatiite (spinifex texture, see centrefold and p. 38) attest to the much higher temperature of the earth as it was three and a half billion years ago. From their beginnings in komatiites the Viljoens' careers diversified into multitudinous areas of geology and business, including major roles in the successful organisation of the 32nd International Geological Congress held in Cape Town in 2016 (see centrefold). In business their latest venture includes a bold attempt to build an integrated mine to manufacture vanadium redox flow battery. The ultimate fate of vanadium is to strengthen the iron that reinforces the concrete that holds skyscrapers together, but along the way, vanadium could feasibly spend a few decades lending its considerable redox potential to a tank that would store the intermittent flux of renewable energy to earth from the sun, that great nuclear reactor in the sky. Conceivably the South African vanadium cycle could be entirely indigenous. With the days of the Zuma kleptocracy behind us, such dreams might yet be realised.

Chris Hatton

executive managers corner

Craig Smith

The Membership Portfolio of the GSSA Management Committee (Manco) recently circulated a survey for the purpose of better profiling our diverse membership. The 500 responses received represents a 15-16% return rate, which is considered to be very good in marketing circles. Thank you to all who participated. The full results need to be considered by Council before release, but a report will be made available in due course. There were a few surprises, and expected outcomes were generally verified and quantified. Because the membership is diverse, some groups may be under- or over-represented in the responses and this needs to be considered when drawing conclusions. In line with expectations, 65% of you are employed in mining, 16% in other industry roles, and 12% in academia. 70% have not changed employment sector in the last five years, indicating either or both some career path 'stickiness' or role stability. Few of you belong to a GSSA Branch or Division (22%) while many of you are a member of at least one other professional society. Somewhat troubling is that 32% of you are

not registered with SACNASP or other regulatory authority, and even making allowances for student participation and retirees, of the order of 10% to 20% are not registered – and therefor working illegally. Please get registered!

Geocongress 2020 at Stellenbosch University, June 29 – July 31 is on track. The call for sessions closed

December 1, but new proposals can still be considered. Sessions will be finalized and announced on January 31. Abstract submission and registration will open on February 1. April 15 is the final deadline for abstract submission. Announcement of accepted abstracts will be circulated May 15. Students in particular are invited to present their research results in either oral or poster format. The intention is to make the meeting as affordable as possible and to attract student participation, and it should be a good opportunity for employers to meet potential future employees. But to do this, we need sponsorship. Please contact craig.smith@gssa.org.za if you wish to be a sponsor of the event.

In addition to Geocongress, a number of meetings and conferences are scheduled for 2020, starting with Drilling Methods on 19-21 February. The meetings schedule is posted on the website, and we will continue to circulate upcoming events on the Friday mail drop and the monthly newsletter. Thanks are due to Noleen Pauls and the Meetings Committee for organizing the events program.

The GSSA is very pleased that the Western Cape Branch of the GSSA is being re-launched, with a committee in place and a number of events planned for next year. More detail on the event appears elsewhere in this issue.

A new branch in the Northern Cape is also being established, the first meeting held in conjunction with 'Deposits of the Northern Cape' conference at the Red Sands Country Lodge outside Kuruman. The conference was very well attended, as was the branch launch. There is a lot happening in the Northern Cape right now, with a large number of geologists employed in the region. The time is right for a new branch.

This is the last issue of Geobulletin for 2019, and I thank Chris Hatton (editor) and Belinda Boyes-Varley (layout) for putting it all together during the year. The Council for Geoscience is thanked for allowing Chris the necessary time to lead the process. As we move to the year-end holiday period, please travel safely and enjoy your break. The GSSA office will close on the afternoon of December 13, and re-open January 2. All the best for Christmas and the new year!

Craig Smith

Geological Society of South Africa

president's column

Sifiso Siwela

During the past quarter, we have made numerous attempts to address outreach and relevance and continuing to bring geoscientists together.

With regards to Branches and Divisions, we have had a lot of activities in the last half of 2019. Firstly, we have managed to launch the long overdue Northern Cape branch, during the Deposits of the Northern Cape workshop held in Kathu. The EXCO has been selected and these members are geographically spread across this huge province. The Deposits of the Northern Cape event itself included an excellent workshop on the first day covering most commodities found in the province, which was attended by 150 geologists, as well as an excellent visit to Khumani Mine on the second day. Secondly, we have involved remote branches such as the very active University of Venda Branch, which is being run by the students. I visited the branch in September to address concerns and advise on consistency with other branches as well as involvement on future events. Thirdly, the Egoli Branch and the Barberton Branch held the Komatiite trip led by renowned members and past presidents of the society. The event commemorated the 50th anniversary. Fourthly, the Western Cape

Branch was revived after some years of inactivity and an interim committee was elected. Two events were held within one month at the Athenaeum venue. Chris Hartnardy presented an excellent talk on the Western Cape Seismotectonism October, while Robyn Pickering presented on Advances in the geochronology and decolonisation of Human Evolution in Sothern Africa in November. An AGM will be held in April 2020 and a full programme of lectures is planned for the coming year including excursions to notable sites of geological interest. Lastly and importantly, we managed to fill the VP role for the portfolio with Mike Lain, who has been a MANCO member, being the suitable person for this difficult role taking cognisance of the growth of the branches.

The KZN Branch continued to hold events during the year including a talk by Rebekah Singh of the CGS presenting on Monitoring Soil Erosion using Airborne Remote Sensing Data.

MINSA celebrated their 40th birthday in addition to their normal events held throughout the year including the SEM Day, celebrating the 150th anniversary of the period table of chemical elements. The Night at the Museum is planned for early December.

We are also looking at events for Geoheritage Division which incorporates non-members and public interest groups and a lot of emphasis will be placed on this in 2020.

In the new year, the Meetings Committee is planning to stage Geoskills "pop-up" events at University of Venda and University of Johannesburg. The one-day workshop will be at no cost to the students and will involve a select number of industry speakers dedicating their time and going to the respective varsities to assist those who would not be able to attend the usual three-day Geoskills workshop normally held in Johannesburg. After my above visit to University of Venda, I am truly happy to deliver on my promise to them.

In the New Year, which is our 125th year, we are looking forward to another Geocongress that is planned for University of Stellenbosch in June 2020. This is yet another exciting opportunity to bring geosciences together and also making sure we reach all provinces.
The Meetings Committee is also planning a PGE Day, which will likely be held in the Northern Limb of the Bushveld Complex. Similar to the Northern Cape event above, this will hopefully form the launch of the Northern Bushveld Branch. There is interest for a branch and have been identified to champion this. This will be a great addition to the ever-active Bushveld Branch centred in Rustenburg as well as the Eastern Bushveld Branch.

There is also interest and appetite for a possible Highveld Branch and Free State Branch from members based there.

We are also looking at strengthening rapport with other affiliate societies in order to address the outreach within South Africa and we are looking at synergies with other geological societies in Africa and beyond.

In order to address outreach and make sure members from all quarters are catered for, we are having contemplations, at GSSA Management Committee level, about taking some of the formal GSSA events out of Johannesburg.

We also continue to educate on continuing professional development (CPD) when opportunities arise during events held across the country and outside.

We will be focussing on mentoring, which was one of the areas of importance based on our recent survey to the membership.

Council, Management Committee, Portfolio Committees and Editors have set the path for a very fine 2020 with lots of great offerings. Thank you to every one of the staff and volunteers for all their efforts and I would also like to appeal to all members to participate and remain relevant.

We hope that the recent successes in other codes in South Africa, such as sport, manifest themselves in the minerals industry and we achieve bringing geoscientists together and strengthening geosciences in the ever changing world. We as the GSSA hope to make even more strides in the new year for the benefit of the membership. The GSSA is a growing tree which requires branches and renewed life.

I wish all happy holidays and I look forward to the new year.

Sifiso Siwela

codes of practice

THE PROFESSIONAL (AFFAIRS) CORNER

KEN LOMBERG - 2020/21 CHAIR OF CRIRSCO

CRIRSCO (Committee for Mineral Reserves International Reporting Standards) has as its aim to promote high standards of reporting of mineral deposit estimates (Mineral Resources and Mineral Reserves) and of exploration progress (Exploration Results).

CRIRSCO was formed in 1994 and for much of its life was an informal alliance of National Reporting Organisations (NROs) in participating countries. With the rapid increase in international activity associated with the mining industry in recent years, CRIRSCO has evolved to become a more rigorously constituted committee which is governed by its Terms of Reference and Organisational Statutes.

Current members (as of November 2019) represent Australasia (JORC), Brazil (CBRR), Canada (CIM), Chile (National Committee), Colombia (CCRR), Europe (PERC), India (NACRI), Indonesia (KOMBERS_KCMI), Kazakhstan (KAZRC), Mongolia (MPIGM), Russia (NAEN), South Africa (SAMREC), Turkey (UMREK) and the USA (SME), with the prospect of other regions and countries joining in future. CRIRSCO encourages other countries or regions to become members and has a Membership Application Policy and Process for intending members.

CRIRSCO (www.crirsco.com) is currently involved in several initiatives which will impact on the future of the mining industry.

The International Reporting Template

The CRIRSCO Template is intended to be a guideline for countries developing their own reporting standards, and a benchmark for comparison with other international reporting systems, including the UNFC and the Society of Petroleum Engineers (SPE) Guidelines. The current (2019) template has been completed and will be available on the CRIRSCO website soon.

Alignment with the United Nations Framework Classification

Although agreement was reached with the UN-ECE in 1999 to incorporate CRIRSCO definitions into the UNFC for those categories of resources and reserves used for market-related reporting, an updated UNFC produced in 2009 with input from the hydrocarbon industry failed to recognise the differences between the hydrocarbon and solid mineral industries in the way they report resources and reserves. As a result, the updated UNFC does not serve the minerals industry well. In response, CRIRSCO has re-engaged with the UNECE, and has committed to lead efforts to produce definitions and guidelines based on the CRIRSCO Template that are compatible with the needs of the users of the UNFC. Work continues on this project with the recent release of a UN Task Force report recommending that the UNFC should adopt generic definitions that would cover oil and gas and solid minerals, and that it should be re-drafted as a simpler, 'umbrella' reporting standard which would encompass other systems including the CRIRSCO Template and the Petroleum Resource Management System (PRMS).

While few individual companies report their resources and reserves using the UNFC, the system is accepted as a basis for reporting by some governments, including those of China, India and some Eastern European countries. The relevance of these countries to future mining developments, including stock exchange listings, is clear and CRIRSCO is working jointly with Russia and China to map existing systems to the Template and

vice versa in order to promote the use of consistent and readily understood definitions and guidelines.

International Financial Reporting Standards for the Extractive Industries

Since 2005, CRIRSCO has been involved in advising the International Accounting Standards Board (IASB), which is considering the development of a new Accounting Standard for the Extractive Industries as part of its International Financial Reporting Standards (IFRS), on the use of mineral reserves and mineral resources for financial reporting purposes. The petroleum industry, through the Society of Petroleum Engineers (SPE), has been similarly involved.

The IASB has recently indicated its preference to use existing widely accepted reporting systems; primarily the CRIRSCO Template and the PRMS, rather than attempt to develop its own resource and reserve definitions and standards. The 'rules' whereby the major assets of an exploration or mining company, its mineral resources and reserves, are used for example in depreciation and impairment are obviously highly relevant to the companies concerned. With the general global acceptance of IFRS, CRIRSCO believes it is increasingly important to engage with regulators such as the IASB and the US Securities and Exchange Commission (SEC) to ensure that the eventual standards do not disadvantage mining companies or render ineffective the various current national reporting standards.

Convergence of Definitions between the Hydrocarbon and Solid Minerals Industries

Arising from discussions with the UNECE and IASB there is a perception outside the extractive industries that the hydrocarbon and solid minerals sectors are essentially the same and that resource and reserve definitions should be compatible.

CRIRSCO is participating in discussions with each organisation to demonstrate the similarities, and considerable differences, between reporting systems in the two industries. Continuous contact has been maintained with the SPE Oil and Gas Reserves Committee since early 2006, and in 2007 this resulted in the publication of a CRIRSCO-SPE Mapping Report. CRIRSCO and the SPE continue to work together to assist the UNECE_UNFC and others to interpret the needs of the two industries and to establish the main points of similarity for potential future convergence.

Standing: Ken Lomberg (Deputy Chairperson/ SAMREC), Roger Dixon (SAMREC), Neil Wells (Chairperson/PERC), Gerlee Bayanjargal (Mongolia), Sanjay Pattnaik (India), Edmundo Tulcanaza (Latin America), Yoseph. Swamidharma (Indonesia), Deborah McCombe (CIM), Ian Douglas(SME), Sergio Vicencio (Chile), Peter Stoker (JORC), Ian Goddard (Past Chairperson/JORC), Thomas Brenner (Brazil), Ricardo Arias (Chile), Harry Parker (Honorary Representative), LI Yuxi (China), Saule Urazayeva (Kazakhstan), Bo Ziphing(China), Wang Hanyu (China), Wilfredo Lopez (Colombia), Front Row: Don Hulse (SME), Lufi Rachmad (Indonesia), Jun Angeles (Philippines), Daniel Jerez (Argentina), Abani Samal (India), Wang Jue (China).

2019 Annual CRIRSCO Meeting

CRIRSCO (Committee for Mineral Reserves Internal Reporting Standards) recently held its 2019 Annual Meeting in Washington DC, USA (9 -11 September 2019). The meeting included the opportunity for the various NROs to report back on their activities during the past year; and representation by various countries seeking to become members of CRIRSCO, including Argentina, China, Peru, and the Philippines.

The meeting held a strategy session in which the path CRIRSCO will be taking in the next few years was discussed. The meeting ended with a workshop with the SME and SEC as well as an opportunity to meet with the SEC to foster relationships going into the future.

Ken Lomberg

At the CRIRSCO Annual Meeting held in Washington DC (USA) in September 2019, South Africa's Ken Lomberg was confirmed as the Chairperson for 2020.

Ken has more than years' experience in the minerals industry (specialising in the platinum and gold sector). He has extensive experience in exploration and mine geology. His skill set provides expertise in the project management, mineral reserve and resource estimation fields.

Ken has undertaken Mineral Resource and Mineral Reserve estimations and reviews for platinum, gold, copper, uranium and fluorite projects. He has assisted with the reviews or estimation of diamond and coal projects. He has assisted or compiled Competent Persons Reports / Qualified Persons Reports (NI 43-101) for various projects that have been listed on the TSX, JSE and AIM stock exchanges.

Ken is also the Chairperson of the SAMREC Committee and is the SAMREC representative on the SAMCODES Standards Committee (SSC). He is heavily involved in the SSC's education and training programmes.

Ken's initial degree is a BSc (Hons) Geology and Geochemistry from UCT. Subsequently Ken has read for a B. Com (Statistics and Economics) (UNISA) and a MEng (WITS). Ken is a Fellow of the GSSA, a member of SAIMM and is registered with SACNASP as Pr.Sci. Nat.

Ken is married to Bonny, and has 2 adult children, is a keen swimmer and works for Pivot Mining Consultants, a company that he established (along with partners Hannes Bornman and Jared Draper) through the acquisition of Coffey Mining South Africa (Pty) Ltd in 2017.

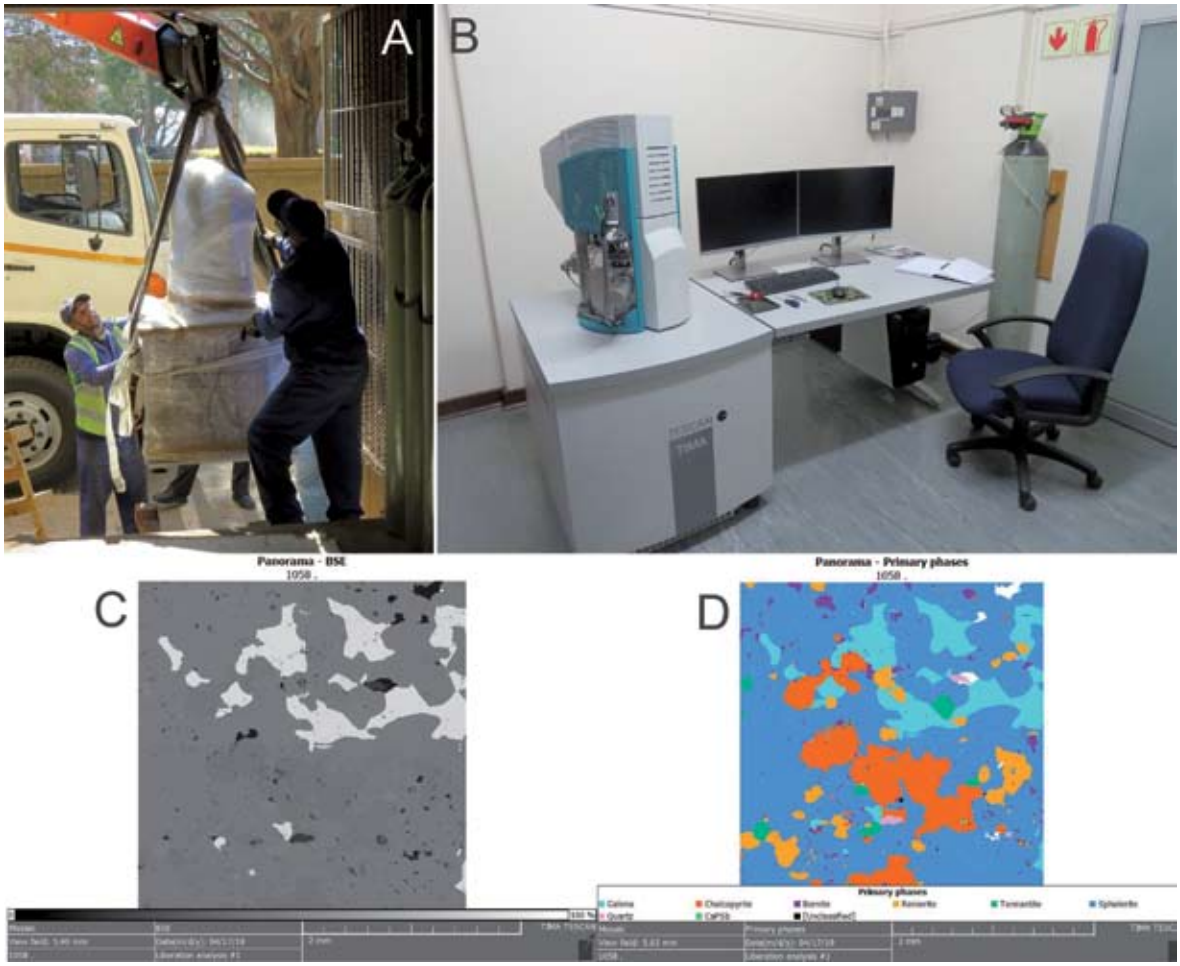
all the news fit to print

UNIVERSITY OF WITWATERSRAND

On the 30th of July, the TESCAN Integrated Mineral Analyser (TIMA) was delivered to its new home in the School of Geosciences Building. The TIMA was bought from Wirsam Scientific and was installed with the help of Jere Claase and Manuel Grobbelaar.

The TIMA is an automated mineralogy instrument designed for high resolution (minimum pixel size of 1 µm) elemental /phase mapping and imaging of various geological and material science samples using a combination of BSE and CL detectors. The instrument is also capable of searching for bright phases such as platinum group elements, gold, silver, zircon, rutile, monazite, apatite and rare earth elements. Ms. Nonkuselo Madlakana, who oversees the instrument, is also the new associate lecturer for metamorphic petrology within the School of Geosciences.

An unclassified meteorite, purchased at a Moroccan market in 2014 by Dr. Ronnie McKenzie, was classified by then honours student Leonidas Vonopartis (now a PhD student) and Prof. Lew Ashwal. Together they classified the meteorite as an achondrite, which is among the more uncommon types of meteorites. Petrographic, geochemical and isotopic work further allowed for the Moroccan meteorite to be classified as a brecciated basaltic Eucrite, part of the Howardite, Eucrite, and Diogenite (HED) clan which are suggested to originate from differentiated asteroidal bodies. These meteorites are unique and invaluable as they provide an opportunity to study the magmatic processes which happen inside these large asteroids.



Tense moments as the TIMA is delivered via the side entrance of the Geosciences Building (A), The TIMA lab (B), Examples of a BSE image (C) and primary phase map (D) taken on the TIMA.

The Moroccan meteorite. Further details on the official classification can be found at: https://www.lpi.usra.edu/meteor/metbull.php?code=70053

However, this classification was not official as it needed to be accepted by the Meteoritical Society and subsequently put into the database of officially classified meteorites. In order for this to happen, a representative piece of the stone needed to be selected as the type specimen and then placed in a registered and curated meteorite repository. At the time Wits was not recognised as a repository. However, through the efforts of Prof. Roger Gibson and Prof. Ashwal, the Fossil and Rock Collection at the Evolutionary Studies Institute was officially recognised as a repository. Thus, the Wits School of Geosciences is now capable of not only studying planetary material, such as fallen and found meteorites, but officially classifying and curating them as well.

The 50th anniversary of the discovery of komatiites by Morris and Richard Viljoen during their research as part of the Upper Mantle Project in 1969 was recently celebrated by a three-day field trip to the famous Barberton Mountainland. The field trip was attended by 30 people from academia, industry as well as by interested members of the public. The event was organized by the Egoli Branch of the GSSA. Field trip leaders and contributors included Prof. Laurence Robb, Prof. Carl Anhaeusser, Dr. Trevor Pearton and Prof. Allan Wilson in addition to the Viljoen brothers, all of whom have affiliations with Wits. Chris Rippon represented Barberton Mines, and support funding came from Bushveld Minerals, the GSSA and the 35th IGC Legacy Trust. Apart from viewing the classic komatiite lava flows, the field trip also included aspects of the granitoid basement and Barberton gold mineralization, in addition to several talks held in the evenings.

Wits staff and students were well represented on the respective Barberton field trips.

The South African Student chapter of the Society of Economic Geologists (SAS-SEG) hosted a field trip which overlapped somewhat with the 50th anniversary proceedings. Prof. Axel Hofmann guided the 13 participants, taking them to various geosites in the Barberton area. The field trip also included a visit to Sheba Gold Mine (one of the world's oldest, continuously productive gold mines) and listening in on the evening talks.

Still on the topic of komatiites, Prof. Allan Wilson was co-author on a Nature paper, published in July, entitled 'Deep hydrous mantle reservoir provides evidence for crustal recycling before 3.3 billion years ago'. The team of international researchers lead by Prof. Alex Sobolev from Grenoble University, isolated and measured the compositions of melt inclusions in olivine from the 3.2 Ga Weltervreden Formation in Barberton. The deep mantle reservoir was shown to contain the signature of seawater-altered lithospheric crust showing that deep subduction had started at least by this time.

Continuing on with other publications and awards, Prof. Grant Cawthorn and Prof. Terence McCarthy were awarded the Jubilee Medal of the GSSA (given each year for the best publication within the South African Journal of Geology), for their contributions to the multi-authored paper: McCarthy, T.S., Corner, B., Lombaard, H., Beukes, N.J., Armstrong, R.A. and Cawthorn, R.G. The pre-Karoo geology of the southern portion of the Kaapvaal Craton, South Africa.

Barberton Field Trip

Prof. Carl Anhaeusser was awarded the Nigerian Mining and Geosciences Society (NMGS) Shell Award in March at the opening ceremony of the 55th Annual International Conference of NMGS held in Enugu, Nigeria. The Shell Award is the highest honour of the NMGS (the umbrella body for all Geoscientists and Mining Engineers in Nigeria), and it is bestowed on those for exceptional accomplishments in Geology or Mining on the African continent.

In July Dr. Sharad Master attended the 82nd Annual Meeting of the Meteoritical Society at Hokkaido University in Sapporo, Japan, where he presented two papers. The first (co-authored by Lunga Bam of NECSA, and Joachim Karfunkel of UFMG, Brazil) was presented at a workshop on micro-imaging. Here he presented what is possibly the very first strain analysis of pre-solar material, based on X-Ray microtomographic measurements of three-dimensional inclusion-free haloes around the largest primary cubic inclusions yet found in carbonados (in a specimen from Bahia, Brazil). At the main meeting he presented a paper (co-authored by Tushar Chakraborty and Tanmoy Mukherjee from Kolkata, India), on the first evidence (in the form of abundant variably-oriented shatter-cones and striated conical surfaces in basalt) for the impact origin of the >45 km-diameter Simlipal ring structure in Odisha, Singhbum Craton, eastern India. The structure is dated at between 3.14 and 3.09 Ga, making it the oldest impact structure on earth.

In early September Dr. Master also attended the Annual Meeting of the International Commission on the History of Geological Sciences (INHIGEO), hosted by the University of Insubria at its two campuses in Varese and Como, Lombardy, northern Italy. Here he presented a paper on the "Geological Exploration of the Ruwenzoris, the legendary Mountains of the Moon". During the meeting Dr. Master was elected as Regional Vice-President for Africa of INHIGEO and has been tasked with increasing membership and interest in the activities of INHIGEO on the African continent.

Prof. Anhaeusser was unfortunately unable to receive the award in person, however, Prof. Okunlola (right) received the Shell Award, on behalf of Prof. Anhaeusser, from the General Manager of Shell Petroleum Nigeria (left).

In Geophysics news, the ICDP - Bushveld Complex Drilling Project has been approved and awarded US$ 1.3 towards drilling costs, while the DSeis project has completed drilling and has moved onto detailed analyses of the core material, which will help answer the question of what controls individual earthquake ruptures and their interactions.

The ICDP-DSeis project came about after the town of Orkney was rocked by a magnitude 5.5 earthquake on the 5th of August 2014. The ensuing aftershocks

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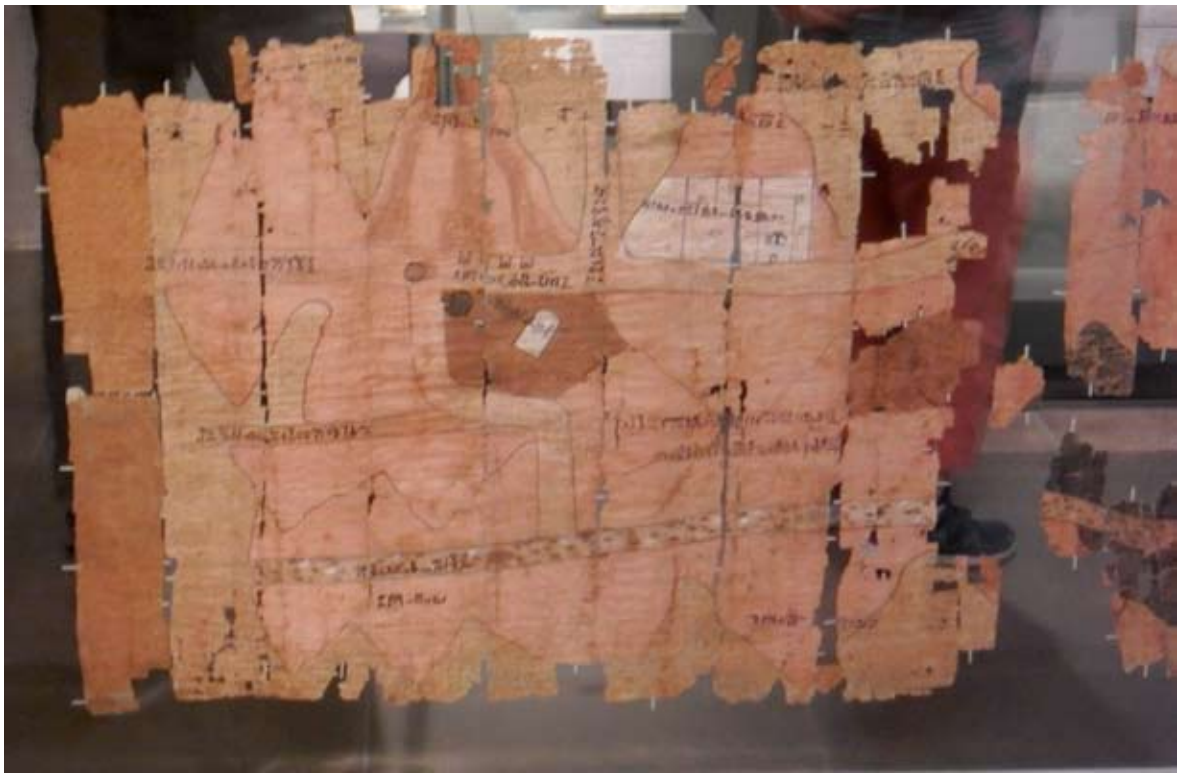

In a guided tour of the Egyptian Museum in Turin, Dr. Master encountered the oldest geological map in the world (1150 BCE). The Turin papyrus scroll (pictured) depicts at its centre a rock referred to as the "Bekhen stone", which is a fine-grained greywacke, much utilized for carvings. Also depicted are mountains, and a dry river course or wadi.

delineated a seismogenic zone at a shallow depth (~ 3.5 km), several hundreds of meters below the mine workings of Harmony's Moab Khutsong Mine (previously owned by AngloGold Ashanti). An ICDP bid was granted back in 2016 to drill into this zone and sample the fault. Drilling began in June 2017, with Hole A unfortunately deflecting and running parallel to the fault zone. A second hole, Hole B, intersected the 3-meter fault zone in February 2018 at 620 m and a deflection hole, off of Hole B, was drilled to better sample the rock.

The project is being led by Hiroshi Ogasawara from Risumeikan University in Japan and Prof. Ray Durrheim at Wits and includes many other researchers from several international and local institutions.

The annual AfricaArray field school took place over June and July and was attended by 9 South African geophysics honours students as well as 16 other students and industry persons from elsewhere in Africa. The first week of the field school consisted of survey planning at Wits. In the second week the participants carried out field work in the Vredefort Dome area in order to answer questions pertaining to archaeology, ground water and dam stability. The third week was spent analysing the data back at Wits, after which the participants presented their integrated results. The methods used include seismics, resistivity, electromagnetics, magnetotellurics, gravity, magnetics and Ground Penetrating Radar.

During the final week of the field school, the AfricaArray Workshop was held, and this year over 80 participants attended. The line-up of events included 39 presentations, 26 posters, and 3 workshops.

The 16th South African Geophysical Association (SAGA) Biennial Conference and Exhibition was held this October in Durban. The Wits geophysics department was well represented at the event and two witsies were winners of best talk as well as best student talk. The latter went to Thiashen Nadan (for a talk on his honours project: using near surface geophysics to investigate the far western limb of the Bushveld Complex); while best talk was awarded to Lebogang Sehoole for her talk from her MSc thesis: using seismic data to investigate potholes in the western Bushveld Complex.

Other SAGA events this year included "a Principles and Application of Machine Learning in Geosciences workshop" at the Mandela Mining Precinct in August, run by former Wits lecturer Dr. Glen Nwaila.

The 2019 AfricaArray Workshop participants

The student led initiatives within the Wits School of Geosciences have been very active this past year. In particular the Wits Geosciences Bridge the Gap mentorship program (which was launched in 2017 by a few enterprising MSc students, and has been running successfully for the past three years), now has 80 mentees, 61 student mentors and 17 industry mentors involved. The program is designed to create a support network for students at various levels of study, by pairing undergraduates with postgraduates, in order to help them transition into the tertiary landscape and develop their passion for geology. This year the Bridge the Gap committee arranged numerous talks and workshops by industry professionals on CV writing, exam stress management, interview skills and professionalism in the workplace just to name a few. Students were also given the opportunity to participate in excursions and give back through outreach projects.

For anyone interested in becoming either a mentor or a sponsor, or to give a talk/workshop please contact Bridge the Gap directly via the following link: https://forms.gle/Sf5tMciuSStAQuFL8

SAS-SEG activities this year included an "introduction to drilling" course offered by Colin Rice (from Colin Rice Exploration and Training), a day trip to Vametco Alloys Vanadium Mine, the multi-day Barberton field

The Wits SAGA participants

SAS-SEG participants visiting Vametco

trip as well as the annual Geoquiz. As always, the SAS-SEG events are aimed at providing the 60-odd student members networking opportunities with professionals in the field of economic geology. The ROC-SOC committee also hosted their annual careers day, which aims to help students with networking opportunities and expose them to various geological careers.

An up-and-coming science communicator Thashen Naidoo, who is a geophysics honours student at Wits, participated in both the FameLab science communication competition as well as Science Slam. Thashen was the regional winner for the FameLab competition at Wits and was given the chance to compete to go onto the Cheltenham Science Festival in the United Kingdom. In the Science Slam competition Thashen placed second, after being judged by high school learners who scored the participants on the creativity, content and clarity of their presentations.

Thashen presenting during the FameLab competition (left), Prof. Ray Durrheim and Prof. Gill Drennan with Thashen after he placed second amongst MSc, PhD and postdoctoral researchers at the Wits Science Slam (Right).

Compiled by **Sarah Glynn** from various departmental contributors.

Thashen Naidoo

Call for Industry Participation

BridgeTheGap
GeosciencesGuidanceProgram
EMPOWER || INSPIRE

Bridge the Gap Geosciences Guidance Program (BTG), is a student run organization at the University of the Witwatersrand, that focuses on mentorship between undergraduate and postgraduate students, as well as students and industry professionals. In addition to the mentorship program, BTG hosts a number of informative talks, workshops and field trips to expose prospective students and graduates to opportunities and expectations in the work environment.

BTG invites all geosciences/mining related companies and industry professionals to "bridge the gap" between students and industry, and to act as positive role models by joining the BTG program as a mentor, sponsor or motivational speaker.

If you are interested in getting involved please complete the Google form by clicking on the following link: https://forms.gle/6PXQwpWtBromVb4T9

For more information, please email bridgethegap.wits@gmail.com

Your influence can go a long way in encouraging and shaping aspiring geologists to become future leaders. We believe that each of us can inspire and empower students by being "the mentor you wish you had".

A selection of the SU Earth Sciences Honours 2019 class and their supervisors proudly showing off their completed theses.

STELLENBOSCH UNIVERSITY

Farewell to 2019 Honours class

The academic year is almost at its close, and the Stellenbosch University Department of Earth Sciences recently bid farewell to the 2019 cohort of Honours students. This student group was particularly enthusiastic about the Earth Sciences and were thus an absolute pleasure to teach. Their theses and thesis presentations were also of an exceptionally high calibre, which led to our external examiner/moderator to comment: *"If this is the end product of the Honours degree at Stellenbosch University, then you are very clearly doing something right"*.

We wish our 2019 Honours students all the best with their future endeavours. Several of them will be entering into the Southern African mineral resources sector where we have no doubt that they will make a positive contribution. Several others will be pursuing post-graduate degrees with the hopes of advancing the scientific understanding of our important discipline. Irrespective of their career choices, we are certain that our students will be successful as they move into the next chapter of their lives.

Students making impact abroad

Asmita Singh travelled to Norway in September 2019 to conduct post-cruise analysis on samples

Asmita carefully conducts scientific analysis in the Norwegian partner laboratory.

collected on-board the Norwegian Polar ice breaker, Kronprins Haakon, during the Dronnning-Maud-Land Autumn 2019 research cruise along the Antarctic ice shelf. Asmita is a PhD student in a joint collaboration between the Southern Ocean Climate and Carbon Observatory (SOCCO) at CSIR under Dr Ryan-Keogh's supervision and the Department of Earth Sciences at Stellenbosch University under Dr Fietz' supervision. Asmita's research focusses on the seasonal cycle of iron limitation in Southern Ocean phytoplankton. On her last night in Norway, she was lucky to witness the Northern lights (Aurora Borealis)!

Tahnee Otto, a PhD student, is the second South African in the SU Earth Science Department to receive a scholarship from the French Embassy for studies abroad. Tahnee is part of a joint degree program between SU and Université Jean Monnet (UJM) in France, which is an established, long-term collaboration in research and training between the two institutions. Her project revolves around the age-old debate surrounding the formation of massive chromitite layers in the Bushveld Complex, and she is taking an experimental approach to the problem. She arrived in Saint Etienne on 25 October and will spend some time at the Laboratoire Magmas et Volcans in the Faculté des Sciences et Techniques to work on the modelling side of her project. Tahnee will return to South Africa on 11 December. For more information about the joint degree program between SU and UJM, please contact Professor Gary Stevens at gs@sun.ac.za.

Johan Viljoen participated in the international Geotraces summer school on-board the Spanish Intermare school vessel in Cadiz. The summer school promotes a good understanding of the biogeochemical cycles of trace metals in the ocean.

PhD candidate Johan Viljoen on board school vessel Intermares.

Below:
Preparing a trace metal clean sampling rosette for deployment, right: in the laboratory on board.

Tahnee Otto, at the Faculty of Science and Technology in Saint Etienne, France, where the Geology Department is located.

Outreach activities

Students and staff from the Department of Earth Sciences hosted school learners, organised by SU's Centre for Student Recruitment and Career Advice. In August, we hosted 120 Grade 6 learners from Sun Valley Primary, Fish Hoek, and in October, we hosted 25 Grade 10 learners from Delft Technical High school. The pupils learnt about climate change and ocean chemistry, but also that science is fun and that it takes you to exciting places.

The Tracex team sent special greetings for the Delft Tech learners all the way from the Antarctic ice.

Staff invited plenary

Dr Susanne Fietz, a Senior Lecturer at the Department of Earth Sciences gave an invited plenary lecture at the 13th International Conference on Paleoceanography (ICP13) in Sydney, Australia in September 2019 (photo) on the development of paleo-climate proxies based on organic molecules (biomarkers). Thereafter, Dr Susanne Fietz also gave an invited talk at the Geotraces Southern Ocean Biogeochemistry workshop in Hobart, Tasmania (12-13 September 2019).

Dr Susanne Fietz giving an invited plenary talk at ICP13 in Sydney, Australia.

Delft Tech learners in the Department of Earth Sciences.

Diamonds – Source to Use — 2020 Conference

Innovation and Technology

9 June 2020 — A technical and economic guide to diamond process engineering workshop and Technical Visits

10 June 2020 — Conference

11 June 2020 — Conference and Site Visit

The Birchwood Hotel & OR Tambo Conference Centre, Johannesburg

BACKGROUND

The *Diamonds – Source to Use* conference series targets the full spectrum of the diamond pipeline, from exploration through to sales and marketing. The 2020 conference, the eighth in the series, will focus on advances in the mining and metallurgical aspects as well as many of the downstream and related industries

KEYNOTE SPEAKER
L. Hockaday, *Mintek – Renewable Energy Technology*

OBJECTIVE

The objective of the conference is to provide a forum for the dissemination of information relating to the latest tools and techniques applicable to all stages of the diamond industry, from exploration through mine design, processing, to cutting, marketing, and sales.

WHO SHOULD ATTEND

- Geologists
- Mineral (diamond) resource managers
- Mining engineers
- Process engineers
- Consultants
- Suppliers
- Sales/marketing
- Diamantaires
- Mine managers
- Mining companies
- Students

2 ECSA CPD points,
24 GSSA CPD points and
3 SACNASP CPD points
will be allocated to
all attending delegates

TOPICS

- Geology and exploration
- Mine expansion projects
- Mining, metallurgy, and processing technology
- Rough diamond sales and marketing
- Cutting, polishing, and retail
- Synthetic diamonds
- Financial services and industry analysis
- Industry governance, beneficiation, and legislation
- Mine-specific case-studies

Site visits

- **Epiroc South Africa**
- **Multotec South Africa**

For further information contact:
Camielah Jardine • Head of Conferencing · SAIMM
Tel: (011) 834-1273/7 • E-mail: camielah@saimm.co.za

SAIMM
THE SOUTHERN AFRICAN INSTITUTE OF MINING AND METALLURGY
125 YEARS

GeoPlaques

Mark Jacobs of Entilini Concessions, who run the tolled Chapman's Peak Drive, points to a potential site for the new GeoPlaque of the Geological Society on 15th April, 2016.

Millard Mhlanga, Jannik Plougmann and Len Gardner (GSSA) after the installation of the Chapman's Peak GeoPlaque on 10th April, 2019.

Doug Cole (GSSA) addressing the invited guests before the unveiling of the Chapman's Peak GeoPlaque on 12th November, 2019. In the background are Reijer van der Vlugt (GSSA), Galvin Klein (TMNP Ranger), Phil Janney (Acting HOD Geological Sciences at UCT) and his wife, Wendy Taylor (GSSA).

UNVEILING OF THE GEOPLAQUE AT CHAPMAN'S PEAK DRIVE

The first Provincial Administrator of the Cape, Sir Frederick de Waal, mooted Chapman's Peak Drive to link Hout Bay to Noordhoek, which convicts built between 1915 and 1922. The Drive was opened on 6th May, 1922 by the third Governor of the Union of South Africa, Prince Arthur of Connaught, a grandson of Queen Victoria.

In 1994, a landslide caused a man to be partly paralysed and in 1999 and 2000, a man and then a woman were killed by rockfalls. This led to the closure of Chapman's Peak Drive in January 2000 and rock-barring, involving Paul Schlotveldt, an athletic geologist from UCT. Paul's thesis was on the engineering geology of the Katse Dam in Lesotho. He supervised the rock-barring from March to May, 2000. The road was re-opened on 20th December, 2003 after a consortium of civil engineers, coordinated by Entilini Concessions, built a half-tunnel and two concrete canopies to deflect

Doug Cole (GSSA) and John Rogers (GSSA) with the unveiled Chapman's Peak GeoPlaque on 12th November, 2019.

falling rocks, as well as many catch-nets. Poor-quality sections were shot-creted for safety: https://www.chapmanspeakdrive.co.za

Engineering geologist, Reijer van der Vlugt, also a veteran of Lesotho, attended the unveiling.

In 2016, the Geoheritage Subcommittee of the Western Cape Branch of the Geological Society of South Africa liaised with Mark Jacobs of Entilini Concessions and with Jannie du Plessis of the Table Mountain National Park to plan a new unilingual (English only) plaque to replace the bilingual (English and Afrikaans) plaque that went missing while being safeguarded by the civil engineers. The Subcommittee updated the text and a new plaque was manufactured by Metalgrapho in Oude Molen, Coenie de Beer liaising for the Subcommittee. Len Gardner of the Subcommittee then engaged Jannik Plougmann and Millard Mhlanga to install the plaque on a gently sloping plinth on 10th April, 2019 at the view-site opposite The Sentinel.

The unveiling took place on 12th November, 2019, after the current Chairperson of the Subcommittee, Doug Cole, gave the background to the Subcommittee's involvement in this project. John Rogers then spoke about the geology of Chapman's Peak. Finer details can be found on the website: https://sites.google.com/site/gssawcb/geo-heritage-initiatives and in the book by John Rogers, published by the Council for Gescience n 2018:
Geological Adventures in the Fairest Cape: Unlocking the Secrets of its Scenery (Chapter 8, pages 215 to 235)

The hard work of another Subcommittee member,

The plaque was funded by the Western Cape Branch, thanks to the current President, Dr Jodie Miller of the University of Stellenbosch.

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Front: Suzan Muroa (Ranger, Table Mountain National Park (TMNP) Central Region), Sue Smith (SANParks Honorary Ranger, Table Mountain Region), Lauren Clayton (TMNP, Western Region Communications Manager). Back: Galvin Klein (Ranger, TMNP Central Region), George Smith (SANParks Honorary Ranger, Vice-Chairperson, Table Mountain Region), John Elford (SANParks Honorary Ranger, Chairperson, Table Mountain Region) and Michael McSweeney, (SANParks, Honorary Ranger, Communications Officer, Table Mountain Region).

George Smith, currently the Vice-Chairperson of the Table Mountain Region of the SANParks Honorary Rangers was highlighted. George and his assistant, Harry Phiri, removed graffiti from the view-site a few days before the unveiling. His wife, Sue, also an Honorary Ranger, took several photographs to record the occasion.

George was accompanied by John Elford, the current Chairperson of the Table Mountain Honorary Rangers and their Communications Director, Michael McSweeney. George facilitated the attendance of Lauren Clayton, the Communications Manager for the Western Region of the Table Mountain National Park (TMNP) and two TMNP Rangers from the Central Region, Galvin Klein (correctly spelt) and Suzan Muroa.

Michael MacHutchon and Wilhelm van Zyl represented the Council for Geoscience's marine geologists, who, earning UCT MSc degrees in the process, have meticulously mapped the marine geology of the seafloor between Hout Bay and Robben Island. Their colleague, Dr Hayley Cawthra used a photograph by John Rogers to create the line-drawing on the GeoPlaque. Our local dolerite expert, Professor Dave Reid was also present, having acted as an examiner of Michael's thesis, a magnetometric survey detecting many dolerite dykes under Hout Bay.

Charles Sprong of the Hout Bay Probus Club, who witnessed the initial installation of the GeoPlaque was present at the unveiling and, a few days earlier was part of a group, led by local geologist, Bob Burrell, who took members of the Probus Club to see the new GeoPlaque, including Dave Cowley of Hout Bay Heritage.

An article on the unveiling, published in the community newspaper The Sentinel can be accessed via the following link:
https://www.sentinelnews.co.za/news/new-plaque-for-chapmans-peak-36867019

John Rogers

Willem Cupido, Hayley Cawthra (PhD), Michael MacHutchon (MSc) and Wilhelm van Zyl (MSc), the Council for Geoscience Marine Geology Team, who mapped the seafloor from Hout Bay to Robben Island. Hayley produced the line-drawing on the Chapman's Peak GeoPlaque from a photograph by John Rogers (GSSA).

sea point contact

On 14th November, 2019, Coenie de Beer of the GeoHeritage Subcommittee of the Western Cape Branch of the GSSA, installed a new, unilingual plaque explaining the geology of the Sea Point Contact. This world-famous GeoSite was visited by Charles Darwin in 1836, the fifth and final year of his circumnavigation of Planet Earth aboard H.M.S. Beagle.

The plaque was funded by the Western Cape Branch, thanks to the current President, Dr Jodie Miller of the University of Stellenbosch. Jodie's colleague, Professor Alex Kisters, supervised the Honours Project of Jacques Horn during 2009 on the Sea Point Contact and the plaque's text incorporates Jacques' fine-tuning of the geological processes that had been at work there.

The 200th anniversary of the birth of Charles Darwin on 12th February, 2009, was celebrated by the installation of plastic plaques, funded by the City Council of Cape Town. The plastic plaques were designed to frustrate metal thieves, who had stolen the bronze plaques of the National Monuments Commission. Sadly, the plastic plaques, 10 years later are badly bleached. The Subcommittee is actively liaising with Ms Sonette Smit of the City Council to install ceramic plaques, which will not be of interest to metal thieves.

Coenie de Beer after installing Unilingual Plaque. PHOTO Marc Goedhart

This site exposes a geological contact zone between metamorphosed sedimentary (metasedimentary) rocks of the Precambrian Malmesbury Group and granite of the Cape Granite Suite. Since the time when Playfair and Hall in 1813 used their observations to argue for the intrusive origin of the granite in support of Plutonism (as opposed to Neptunism, which proposed that all rocks formed by precipitation from the primordial oceans), the rocks at Sea Point have been influential in guiding our understanding of igneous intrusive geological processes. In 1817, Clarke Abel also regarded the granites to be intrusive rocks, but pronounced the sandstones of Table Mountain to have an origin by marine precipitation. An intrusive origin for the granite only became fully accepted after Charles Darwin visited the contact in 1836. Treatises of this history and full references for the above are contained in Master (2010, 2012).

The 150 metre-wide transitional contact zone between granite and metasedimentary rocks has previously been described as a migmatite, but this term is currently reserved for rocks that have experienced such high grades of regional metamorphism that they display partial melting. Studies of the regional metamorphism of the Malmesbury Group, however, indicate that temperatures never exceeded 350° C. It is therefore highly unlikely that the rocks would have started to melt during their metamorphism and intrusion by granite around 540 million years ago. The contact

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should therefore rather be described as a mixed zone of folded metasedimentary beds and sheets or stringers of intrusive, coarse-grained, porphyritic to fine-grained granite. The hot, molten granitic magma, at temperatures of around 750° C, locally changed the metasedimentary wall rocks through the process of contact metamorphism into "baked" rocks called hornfelses, which contain the minerals cordierite and chlorite in places.

Where not in contact with granite, the metasedimentary rocks are a mixture of dark brown, thick-bedded, quarzitic meta-greywacke (a metamorphosed type of impure sandstone), shale and siltstone layers with a few thin gritstone and conglomerate beds. The originally horizontal layers are folded into open, north-westerly trending synclines (troughs) and anticlines (arches). The granite is composed of pale potassium feldspar crystals in a matrix of grey, glassy quartz, feldspar and biotite mica. Phenocrysts of euhedral feldspar in the coarse-grained, porphyritic types of granite are up to 60 mm in length. Pale aplogranite and fine-grained microgranite are also present. In the contact zone, the granite occurs as lenses, stringers and blobs, many of which have been folded, pinched out and variably deformed during and after their intrusion. A common parallel relationship between metasedimentary wallrock and granitic intrusions, a low incidence of crosscutting relationships and the slightly deformed character of granitic intrusions indicate that the magma intruded by stoping into the beds after most of the folding had already occurred. The granite magma was emplaced into fractures which opened and closed in response to local tectonic stresses, with strong control by bedding in the Malmesbury wall-rocks and fold hinges assisting its trapping in places.

References

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New unilingual plaque explaining the geology of the Sea Point Contact. Photo: Marc Goedhart.

The Department of Earth Sciences at Stellenbosch University, the Geological Society of South Africa and the Igneous and Metamorphic Studies Group

are pleased to announce:

GEOCONGRESS 2020
29 JUNE - 01 JULY

SAVE THE DATE!

Stellenbosch - Western Cape

The next 125 years of Earth Sciences

GET EXCITED ABOUT THE EVENT!

The theme of this conference is "***The next 125 years of Earth Sciences***", with the aim of highlighting current geoscience research and industry practice, whilst simultaneously looking forward to where we perceive that this important scientific discipline will develop in the future.

The conference seeks to attract students, researchers, and industry professionals involved in the various sub-disciplines of the Earth Sciences. For more information, visit the event website:

http://allevents.co.za/geocongress/

We look forward to welcoming you to Stellenbosch in 2020!

Call for Sessions is currently live and will close on **15 December 2019**!!!

For Geocongress 2020 to be a success, we need the inputs of the entire southern African Earth Sciences community!

Kindly send your session suggestion to: bvon@sun.ac.za

Your submission should include:

- A brief but descriptive title (~65 characters max.);
- A short contextualizing paragraph (200 – max. 350 words) explaining the importance and rationale of the session;
- Name, affiliation and email address of the session chair(s).

REI fund

REQUEST FOR APPLICATIONS TO THE RESEARCH, EDUCATION AND INVESTMENT (REI) FUND OF THE GSSA

CLOSURE DATE FOR APPLICATIONS: 31 JANUARY 2020

The GSSA Research, Education and Investment Fund (REI Fund) is inviting applications from GSSA paid up-members (including current post-graduate student members) for grants from the Fund, to be received at the GSSA office not later than 31 January 2020. Applications can be made using the online application form available on the GSSA web site (www.gssa.org.za) or see link below for the online form.

https://www.cognitoforms.com/GeologicalSocietyOfSouthAfrica/researcheducationandinvestmentfund

Grants are intended to support a variety of earth science research costs, including analytical and field costs, conference attendance, and publication costs. Projects that promote and support earth science awareness such as geoheritage, geotourism and geo-education may also be supported. Expenses related to (annual) registration and tuition fees, text books, accommodation, etc. required at Higher Education institutions are not covered.

In particular we welcome applications from post graduate student members and would appreciate it if Heads of Departments at Higher Education Institutions and their staff would inform their students of this opportunity. Grants are usually limited to R20 000 per application but well-motivated applications for larger amounts are also welcome. All applications will be judged on merit and/or the importance to the Society in promoting its image. Note that grants are only awarded to members/student members in good standing.

Applications are screened by the REI Fund Committee during February with input and ratification by the GSSA Management Committee and Council, respectively. In evaluating the applications and recommendations, the Committee considers the merit of each application, and depending on the amount of money available for that year, makes a final decision on the allocation of grants for that year. The decision of the Committee is final and no further correspondence on the matter will be entertained. By following this procedure it is anticipated that applicants will be informed by early to mid-March 2020 whether or not their applications are successful. Recommendations made by the Committee require Council approval, which may delay notifications.

The current members of the REI Fund Committee are: Reinie Meyer (Chairman), Frank Gregory, Bertus Smith, Rob Ingram, Derek Kyle, Richard Viljoen, Mike Wilson and two office bearers of the Society who have *ex officio* status, namely the President (Sifiso Siwela) and the Executive Manager (Craig Smith).

Geological Society of South Africa

IUGS and IGCP

The South African National Committee for the International Union of Geological Sciences (IUGS) and International Geoscience Program (IGCP)

Sharad Master[1], Sue Frost-Killian[2]
[1]School of Geosciences, University of the Witwatersrand, Johannesburg, sharad.master@wits.ac.za
[2]The MSA Group (Pty) Ltd, Victory Park, Johannesburg, susanf@msagroupservices.com

The International Union of Geological Sciences is the largest international umbrella body representing the geological sciences globally. The IUGS is in turn part of the International Science Council (ISC), which was formed in 2018 by the merger of the International Union of Scientific Unions (ICSU) and the International Social Science Council (ISSC).

The International Science Council is an international, non-governmental, non-profit-making, scientific organisation. It is composed of autonomous international scientific unions representing various disciplines of the natural sciences as well as national scientific bodies (academies or other scientific organisations) and has as its purpose the development of international cooperation in scientific activities. The ISC is the largest global science organization of its type, bringing together both the natural and social sciences. As a global forum, the International Science Council has the prestige and clout equivalent to the United Nations, and it is often called upon to provide expert scientific advice on matters of global concern. The ISC convenes the multidisciplinary scientific expertise and resources needed to lead on "catalysing, incubating and coordinating impactful international action on issues of major scientific and public importance."

The ICS currently has 135 Member Organizations, 40 Member Unions and Associations, and 30 Affiliated Members. Among the 40 Member Unions are such bodies as the International Astronomical Union, International Geographical Union, International Mathematical Union, International Union of Biological Sciences, International Union of Geodesy and Geophysics, International Union of Geological Sciences, International Union of Quaternary Research, International Union of Pure and Applied Physics, International Union of Pure and Applied Chemistry, and the International Union of History and Philosophy of Science and Technology. Among the Member Organizations are the National Academies of Science of most countries in the world that have one. In South Africa, it includes the National Research Foundation. The ICS has its world headquarters in Paris, France. It also has three regional offices in Latin America and the Caribbean (San Salvador), Africa (Pretoria) and Asia and the Pacific (Kuala Lumpur).

The vision of the ISC is:

> *"to advance science as a global public good. Scientific knowledge, data and expertise must be universally accessible and its benefits universally shared. The practice of science must be inclusive and equitable, also in opportunities for scientific education and capacity development".*

More information about the ISC can be found at their website https://council.science/about-us

The International Union of Geological Sciences (IUGS) (www.iugs.org) is one of the largest and most active scientific associations in the world, with a membership representing 115 countries and regions, 8 commissions, 4 working groups and 38 affiliated organizations.

The IUGS was created in 1961 in response to a need to coordinate geoscientific international research programmes on a continuing basis in between the International Geological Congresses (Harrison, 1978). The IUGS-IGC Council (hereinafter the Council) is the governing body of the International Union of Geological Sciences and the International Geological Congress. The IUGS is governed by an Executive Committee consisting of a President, two Vice-Presidents, a Secretary General, the immediate Past President, a Treasurer, and four Councillors. All

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positions are elected by secret ballot. The number of votes that adhering member countries of the IUGS have is determined by their annual contributions, in multiples of a basic contribution of $440 per unit per year from 2003 (with inflation pegged to US CPI). The largest countries, like USA, Russia, UK, China, make the largest financial contributions, and they get allocated 8 votes at the Council meetings during the IGCs. South Africa has four votes. The largest countries contribute about 10 times more than South Africa for twice the number of votes. Smaller countries make smaller contributions, and the smallest contributors are allocated one vote.

Among the aims of the IUGS is to unite the global geological community in promoting development of the Earth sciences through the support of broad-based scientific studies relevant to the entire Earth system, and applying the results of these and other studies to preserving the Earth's natural environment, using all natural resources wisely, and improving the prosperity of nations and the quality of human life.

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The International Geological Correlation Programme (IGCP) has been co-sponsored by UNESCO and IUGS since 1972. Currently, IGCP involves 140 nations and thousands of geoscientists. Sixty per cent of nations involved in IGCP have been classified as developing. The programme has been widely regarded as a highly effective vehicle for the transfer of geoscience information and training from the developed to the developing world. This serves to fulfil the Union's objective of capacity building.

IUGS and its sister organization under ICSU, IUGG, continue their sponsorship of ICSU's Scientific Committee on the Lithosphere (SCL) which focuses on the dynamics, origin and evolution of the Earth's deep crust and upper mantle (lithosphere) and pays special attention to the continents and their margins. Special scientific interests and disciplines are represented in the Union through its Affiliated Organizations, that is, large autonomous international associations which share with IUGS an interest in planning and undertaking certain scientific activities and meetings of mutual benefit.

The International Geological Congress (IGC) is a non-profit geoscientific and educational organization whose meetings are held in collaboration with and under the sponsorship of, the IUGS. The origins of the IGC lie in an initiative of geoscientists in America in the 1876, who saw the need to have international meetings of geologists. They persuaded the French Government to sponsor the First International Geological Congress in Paris, to coincide with other activities of the great Exposition Universelle, in 1878 (Vai, 2002). Since then, the IGC has been held at intervals of between three and five years (excepting during the two World Wars), with the most recent being the 35th IGC which was held in Cape Town in 2016. The next IGC is due to be held in Delhi, India, in March 2020 (www.36igc.org).

The South African National Committee for IUGS/IGCP is the national body affiliated to the IUGS, and it participates in the International Geological Congresses. South Africa has voting rights at the IUGS-IGCP Council Meetings (formerly, General Assembly). Obviously, the more a country contributes to the IUGS, the more votes it has, and the more it is able to control the activities and priorities of the Union. From 2000 to 2004, South Africa had a Councillor on the board of IUGS, in the person Dr N. Frick, former Director of the Council for Geoscience. In 2012, Prof. Hassina Mouri of the University of Johannesburg was elected as a Councillor and served a four-year term on the Executive, leading up to the hosting of the 35th IGC by South Africa in Cape Town in 2016.

Prof. Hassina Mouri is the current Head of the South African National Committee for IUGS-IGCP. Other members of the current committee are: Ms Sue Frost-Killian, Dr Sharad Master, Prof. Geoff Grantham, Dr Trishya Owen-Smith, Ms Vusani Mathada, and representatives from the Geological Society of South Africa (Dr Craig Smith), The Council for Geoscience (Dr Greg Botha), and the South African Geophysical Association (Prof. Ray Durrheim).

The National Committee has number of tasks, to further the aims of IUGS, and to facilitate participation in its activities. One of the most important tasks that the SANC-IUGS/ICGP performed in recent years was to lobby for, and obtain, the right to host the 2016 35th International Geological Congress in Cape Town, which was done jointly with the Geological Society of South Africa and the Council for Geoscience. The National Committee is mandated to attend the Council Meeting of IUGS-ICGP, which is held every four years to coincide with the IGCs. At least four voting delegates, as well as a capacity-building delegate, have attended recent meetings. The Head of the National Committee may attend extraordinary meetings in the intervening years. South African participation in the IUGS-IGCP Council, and its hosting of the 35th IGC, has meant that we are in the forefront of setting the global agenda in the activities of IUGS, and for a more assertive role of South Africa and of other African countries in global geoscience-related issues. These issues include climate change, sustainable development of natural resources, natural disaster reduction, hazard mitigation, medical geology, and gender issues. At the next IGC in Delhi in March, we are hoping that Prof. Mouri will be elected as one of the Vice-Presidents of IUGS- she is the only African and only female candidate for that position!

Among the previous activities of the National Committee has been its involvement with the International Year of Planet Earth (which was actually a three-year project, from 2009-2012). For IYPE, the following was achieved:-

- Special publication of Quest magazine with papers covering a variety of topics on Earth and Society, Groundwater, Hazards, Earth and Health, Climate, Resources issues, Mega cities, Deep Earth – crust to core, Oceans, Soil, Earth and Life, and Earth and Art.
- Provision of fact sheets for five IYPE science themes as topics for debate in the final rounds of the National Schools Debating Project run by the South African Schools Debating Board (SASDB) in partnership with the South African Agency for Science and Technology Advancement (SAASTA). The committee participated in this debating project and attended the final debates.
- Promotion of the Africa Alive Game - Participation in the Africa Launch of IYPE in Arusha, Tanzania (8-9 May 2008) which was attended by some 300 delegates including Earth scientists, politicians, educators, and scholars from across Africa and the world. Delegates included the Director General of UNESCO Mr Koïchiro Matsuura, both the Chairman and the CEO of the international IYPE Corporation, and the President of Tanzania, H.E. Jakaya Mrisho Kikwete, with his Minister of Education and Vocational Training and Minister of the Environment. Perhaps the most exciting focus of our South African delegation, under the auspices of the National IYPE Committee, was the prominent participation of 10 top secondary school scholars selected from around the country through a competition organized by SANBI. They joined 10 top scholars from Tanzania in a living demonstration involving a hot-off-the-press card game - 'Earth Alive Strategies' along 'Africa Alive Corridors'. The aim: seeking ways that the youth of the world can actively participate in holistically, sustainably, managing our earthly heritage (geological, biological, cultural) for all - today and tomorrow. It proved a "hit" with many of the delegates, including the Tanzanian President and the International Year Secretariat, amongst others.
- The organization of a student competition to select delegates to attend the Global launch Event of IYPE in Paris 12-13 February 2008. Three members of the SA national Committee also attended. Pamphlets advertising the Special Issue of Quest were distributed at the Global Launch. Laura Byrne (University of the Witwatersrand), one of the South African student representatives, was chosen to read her winning essay during the launch. The main themes included "Population growth and climate change – challenges for planet Earth", "Earth resources – threat or treat?", and "Geohazards: minimizing risk, maximizing awareness".
- Participation in SciFest Africa, or the National Festival of Science, Engineering and Technology in Grahamstown in April, 2008. Educational aids were presented to school teachers for use in the classroom. Other activities and draw cards included a rock display; mini lecture(s) and pop quizzes; a presentation on IYPE to the Minister of the Department of Science and Technology (DST), Mr Mosibudi Mangena; a theatre presentation for the minister from the Leap school organised by ACCESS (African Climate Change and Earth System Science; and a radio interview on 702 "green tip of the day"; amongst others.

- Competition for students to attend the third International IYPE event in Lisbon, Portugal
- KZN based lecture series from May to October 2008, with lectures linked to selected IYPE themes
- A Lecture series on IYPE held at the School of Geosciences, University of the Witwatersrand, in Johannesburg in October 2008.
- Co-editing of a Special Issue on the International Year of Planet Earth of the "Journal of African Earth Sciences" in 2010 (Toteu et al., 2010).

Other activities of the National Committee include:-

- Involvement with the ICS Regional Office for Africa in Pretoria
- Involvement with Young Earth Scientists (YES), and getting them to piggyback on the IGC.
- Vetting of proposals for International Geoscience Programme (IGCP) Projects emanating from South African academics and institutions. The National Committee seeks to ensure that the applications have complied with all the requirements, and are of a sufficient standard. Some members of the Committee have led previous IGCP Projects, and have a good idea of what is needed to merit successful funding.
- Involvement in Subcommittees and Commissions of the IUGS- e.g., CCMW/CCGM (Committee for the Geological Map of the World), involvement with the Tectonic Map of Africa; IUGS Commission on Stratigraphy, and the International Commission on the History of Geological Sciences (INHIGEO). At the recent Annual Meeting of INHIGEO at Como and Varese, Italy (September, 2019), Dr Sharad Master was elected as Regional Vice-President for Africa of INHIGEO.

For the 35th International Geological Congress in Cape Town (2016), the National Committee was one of the hosts of the Congress, and was heavily involved in a number of activities:-

- Attending all the meetings and related activities of the IUGS Council
- Involvement with writing, editing, refereeing, and production of the magnificently illustrated volume "Africa's Top Geological Sites" (Anheusser et al., 2016).
- Involvement with writing, editing, and refereeing of a special volume of Episodes, "The Great Mineral Fields of Africa" (Viljoen and Wilson, 2016).
- All members of the Committee also presented several papers and posters at the Congress.

The achievements of the 35th International Geological Congress included:

- Exposing the spectacular geology of Southern Africa to the scrutiny of the world's geoscience community, through many well-organized field excursions, and seminars devoted to Southern African geology
- getting young scientist involvement in the organisation of the IGC
- Getting many young geoscientists to present papers and posters showcasing research at South African and related universities
- Getting South African geologists exposure to the international geoscientific community, and to the latest ideas and techniques in geosciences.

The South African National Committee for IUGS/IGCP performs an important task in connecting South Africa to the global network of geologists and geoscience organizations. We also wish to extend our active membership to under-represented parts of the country. If you are interested in participating in its activites, please contact Prof. Hassina Mouri at UJ.
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Sharad Master and **Sue Frost-Killian**

ICDP approves funding

ICDP approves funding for drilling project on the Bushveld Complex

The International Continental Scientific Drilling Programme (ICDP), headquartered in Potsdam, Germany, recently provided funding to the value of $1.5-million to a group of international researchers based on a funding proposal submitted in January 2019. The project will aim, among other things, to establish the first semi-continuous vertical reference section through the 9 km thick layered sequence of mafic/ultramafic rocks of the Bushveld Complex and the felsic rocks above them. The ICDP project will coordinate international multi-disciplinary research on this reference section in search of answers to fundamental questions including the nature of magma sources and melting processes that gave rise to such enormous magma volumes about 2000 million years ago, and how these magmas were emplaced and evolved in magma chambers to produce the extensive mineral layering and stratiform mineralization we see today.

The ICDP project will coordinate international multi-disciplinary research on this reference section in search of answers to fundamental questions which include the nature of the melting processes that gave rise to such enormous magma volumes about 2000 million years ago , how these magmas were emplaced and evolved in magma chambers to produce the extensive mineral layering and stratiform mineralization which we see today.

Geophysicists will focus on the thermal, isostatic and stress responses of the crust to the BIC emplacement and will track changes in Earth's ancient magnetic field that are preserved in the drillcores. Hydrologists and geomicrobiologists will use the boreholes to study deep groundwater systems, assess their age and geothermal energy potential, and to characterize the microbial communities.

The journey that culminated in the successful funding of the project started with a workshop proposal submitted to the ICDP in January 2012. The workshop took place at the University of the Witwatersrand in September 2014 and was attended by 55 delegates from across the globe.

A total of 6852 m of donated drill core has already been transferred for use by the project to the National Core Library of the Council for Geoscience in Donkerhoek and to the University of the Free State in Bloemfontein. These donations and sections of existing core that are already housed at the National Core Library led to a significant reduction in the meters that will have to be drilled to provide complete reference sections for the Northern and Eastern limbs of the Bushveld Complex. In the Northern Limb, a hole of only ~650 m will have to be drilled, whereas in the Eastern Limb, a hole of ~3000 m will be drilled. The Northern Limb hole will target the central reaches of the Main Zone and the Eastern Limb hole the Lower Critical Zone, Lower Zone, Marginal Zone and Basal Ultramafic Sequence (BUS).

The total project budget stands at ~$3-million and the immediate focus of the project team is the securing of the balance of the funds needed to successfully complete the project. We are also happy to report that South Africa has rejoined the ICDP as a member due to the collective efforts of many, including researchers working on another successfully funded South African ICDP project, the "Barberton Archean Surface Environments" project, with Nic Beukes as the main South African proponent.

The coordinators of the project would like to invite all parties interested to contribute to this project, either scientifically or financially, to not hesitate to make contact.

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The official website for the project is:
http://bushveld.icdp-online.org

new dinosaur

New dinosaur species fossil discovered in South Africa

Massospondylus
Photo Nobu Tamara
Wikimedia Commons

A new genus of dinosaur was identified after gathering dust for over 30 years. The near-complete fossil was collected from a farm in the Fouriesburg area in Free State, South Africa, in 1978 and has been in the collection at the Evolutionary Studies Institute (ESI), part of the University of the Witwatersrand in Johannesburg. Paul Barrett and PhD student Kimberley Chapelle at the Natural History Museum in London identified the new species after comparing the bones with a number of other museum specimens. Their findings were published in the August 2019 volume of the journal *PeerJ*.

Initially the fossil remains were classified as *Massospondylus* at it was common in South Africa. After comparing the remains to other *Massospondylus* and ruling out the possibility that the differences were age related or due to deformation during fossilisation (Eye witness news, 2019), it was concluded that it in fact represented a previously undescribed species.

Grey Skull
Photo Jonah Choinere, NHMdinolab and ESI

The fossil remains consist of an almost complete skeleton and skull. It was named *Ngwevu intloko*, which is Xhosa for "grey skull". It is suggested that the fossil belongs to a dinosaur that measured about 4m from the tip of its snout to the end of its tail and may have weighed as much as 300 kg. The dinosaur is inferred to have been a herbivore but scavenge on smaller animals if the opportunity presented itself, walked on its hind legs and had a barrel-shaped body, a long, slender neck and a small, boxy skull. The individual is suggested to have been a fully-grown adult at about 10 years old when it died.

Chapelle, Barrett and their colleagues compared the specimen with those from definitive *Massospondylus* fossils that ranged from tiny animals with skulls measuring 10 centimetres to fully grown adults with skulls about 30 centimetres long. Chapelle applied CT scanning to each specimen to get as much detail as possible. Usually this would be considered a near impossible task, but South Africa has *Massospondylus* specimens ranging from embryo to adult (Eye witness news, 2019). Firstly, none of the changes in growth patterns in these Massospondylus specimens reflected the differences observed in N. intloko. Secondly, the skull is clearly not deformed. It's not obviously been twisted in any particular way and no fractures in the skull to suggest it had been broken, ruling out that possibility. The team also considered whether sexual dimorphism might explain the differences in size and proportions. But while the size and structure of horns and antlers may vary between males and females in mammals, the general proportions of their skulls do not (Eye witness news, 2019).

According to Barret, it used to be commonly believed that there was only one type of long-necked herbivorous dinosaurs, known as sauropodomorph dinosaurs, in South Africa after a mass extinction between the

Triassic and Jurassic periods, around 200 million years ago (de Villiers, 2019). He went on to say that the high degree of diversity and varied appearance of these dinosaurs not only questions whether *Massospondylus* is indeed an organism which developed after an extinction, but also how groups of animals responded to large extinction events in the past? (de Villiers, 2019). *Massospondylus* was a disaster taxon, a species that rapidly became common after mass extinction events and took advantage of the empty landscape (Eye witness news, 2019). It is now suggested that there were actually six or seven of these dinosaur species in what is now southern Africa during that period, as well as a variety of other dinosaurs from less common groups. It also suggest that their ecology was much more complex that previously thought.

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natal colony gold rush

Natal Colony Gold Rush of 1853

During June of 2018 there was a small gold rush in the Harding area in KwaZulu-Natal after quarry workers found a yellow metallic mineral they suspected to be gold. This led to thousands of local residents getting involved in illegal diggings before the site was closed. The reader is referred to original article in the Geobulletin in the June 2018 issue for background. The Council for GeoScience (CGS) was approached to test the material to determine whether or not there is any gold mineralisation. Almost a year later, the CGS announced their finding, there is no gold mineralisation detected in the assayed samples.

This was however not the first gold rush in KwaZulu-Natal that started off with a folly of excitement only to end in disappointment. In early 1853, a minor rush occurred on the outskirts of Pietermaritzburg. In the 10 January 1853 edition of The Natal Mercury, a notice stated that a consortium of 20 Durban merchants and businessmen had pledged themselves to equally contribute towards a reward of £1 000 "to any person first finding gold in any locality in the district of Natal, such reward to be payable as soon as Five Thousand Pounds value shall have been produced from such locality by the discoverer or other parties" (Davenport, 2016). Other sources report that the Natal Government, fearful of the increased drainage of manpower and as a counterbalance of manpower supported by several private firms, offered rewards of £1000 for the discovery of gold in Natal. In addition, 20 Durban merchants, who had decided to make Natal their permanent home, had offered a reward to the value of £5000 to anyone who could discover gold in Natal. This offer was valid for a limited period of four months (Lembethe-Xulu). Immediately it resulted in a rush to prospect the vast tracks of unmapped countryside.

In March 1853, a British Settler by the name of Henry Dineley claimed to have discovered traces of gold on the 6 000 acre farm Doorn Hoek, at the foot of the Natal's very own Table Mountain, located some 12 km east of Pietermaritzburg and was owned by

Jan Thomas Martens (Davenport, 2016). By the end of the month, The Natal Witness reported that 17 men were at work on the 'gold diggings' on Martens' farm and a pit of 18 feet deep had been dug on a quartz vein occurrence. By mid-April it was reported by the Independent that the gold miners had formed a consortium and had offered to buy Martens' farm for £7 000, which was worth approximately £600 at the time. The purchase never happened, and the farm remained in the Martens family until 1947 (Davenport, 2016). However, by the end of May 1853, with the pit dug to a depth of 65 feet on the quartz vein, no payable gold was recovered, and the diggings were abandoned.

At the same time traces of gold were found in Pine Town and in and around Bellair and Sarnia in the vicinity of Paradise Valley, Durban, but the amounts discovered were not nearly enough to sustain prospecting (Boucher, 2015). The riverbeds in Durban were also worked up, but no alluvial gold was found. An unnamed prospector was however able to claim the £1 000 after a discovery in Umfolozi, but the mining there died down soon too (Boucher, 2015). After the discovery of gold in Barberton and on the Witwatersrand, most gold prospectors left the Natal Colony.

The influence of the mini gold rush was however enough to motivate the Natal colonial administration to make the appointment of the country's first government geologist and commission the first geological survey in 1854 (Davenport, 2016).

Fifty years later in 1905 the Natal prospector, Nathan Young, going on a rumour that gold was in the Queensburgh area, prospected in the valley between Pinedale and Chester Roads, without success (Lembethe-Xulu, 2017). A prospect near Jubilee Hill in Escombe also yielded uneconomical trace amounts of gold. Anyone with knowledge of the location of the Queensburgh mining efforts, is requested to contact Donald Davies who is doing research on the subject at: dsdavies@iafrica.com.

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Table Mountain between Durban and Pietermaritsburg

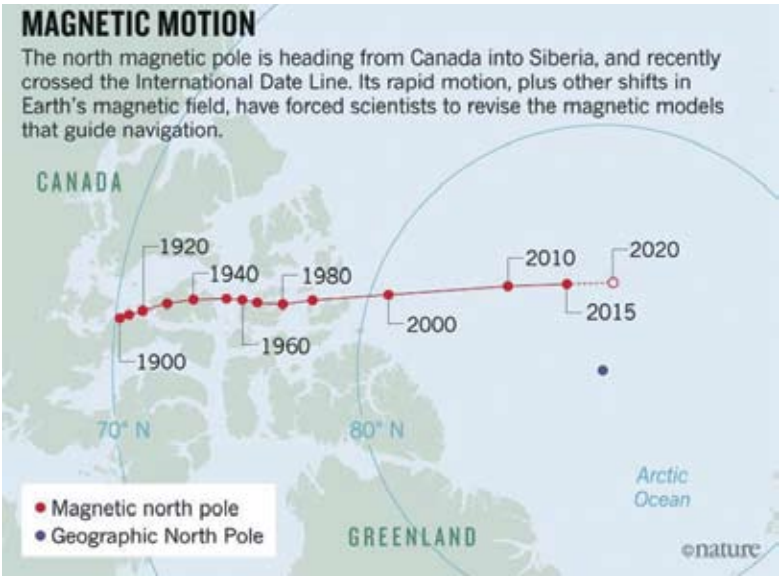
geo-curiosity

Rapidly shifting magnetic north pole

The magnetic north pole has been erratically moving over the last couple of years, forcing the model that guides global electronic navigation to be updated earlier than planned.

In the January 2019 issue of Nature, it was reported that as a result of the erratic movement of the magnetic north position, the model that guides all electronic navigation systems, from smartphones to civilian GPS devices, had to be updated earlier than expected. the World Magnetic Modelis updated every five years, between each update, the model's accuracy is checked against data from ground magnetic observatories and the European Space Agency's Swarm mission, a trio of magnetic-field mapping satellites that orbits Earth 15 to 16 times a day (Wei-Haas, 2019). The previous version of the model came out in 2015 and was supposed to last until 2020. However, by 2018, the World Magnetic Model was in trouble. The National Oceanic and Atmospheric Administration's (NOAA's) National Centers for Environmental Information and the British Geological Survey in Edinburgh had been doing their annual check and found that the inaccuracy was about to exceed the acceptable limit for navigational errors (Witze, 2019). For most civilian purposes, and the changes are mainly limited to latitudes above 55 degrees (Wei-Haas, 2019).

Earth in effect has three northern poles: True north located at the northern end of the rotational axis of Earth. The second is the geomagnetic north, Earth's core creates a magnetic field that is slightly tilted from the planet's rotational axis and is located off the northwest coast of Greenland that's changed position little over the last century. Finally, there is magnetic north, which is defined as the point at which magnetic field lines point vertically down. This position is more susceptible to the surges and flows in the swirl of liquid iron in the core.



The problem lies partly with the moving pole and partly with other shifts deep within the planet. Two phenomena may be responsible for this. The first is a geomagnetic pulse beneath South America in 2016 that resulted in the magnetic field lurching more than anticipated (Witze, 2019). The second is the unpredictable motion of the magnetic north pole. The motion of the movement of the magnetic north has been tracked since James Clark Ross first measured it in 1831 in the Canadian Arctic. By the mid-1990s the magnetic north polar movement picked up speed, from an average of 15 kilometres per year to around 55 kilometres per year and in 2001, it had entered the Arctic Ocean. In 2018, the magnetic north pole crossed the International Date Line into the Eastern Hemisphere and moved towards Siberia (Witze, 2019).

It is suggested that events such as the geomagnetic pulses, like the one that happened in 2016, might be traced back to 'hydromagnetic' waves arising from deep in the core. In turn the fast movement of the magnetic north pole could be linked to a high-speed jet of liquid iron (Witze, 2019). The location of the north magnetic pole appears to be governed by two large-scale patches of magnetic field, one beneath Canada and one beneath Siberia, but the one beneath

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Canada appears to be smearing out and weakening the magnetic field, resulting in the increased shift of the magnetic north pole toward the Siberian patch (Witze, 2019). How long this rapid shift will last, and the effect is still unknown.

In the last 20 million years, magnetic north and south have flipped places multiple times, as revealed by paleo-magnetic studies. Inversion of the poles have been found to happen roughly every 200,000 to 300,000 years (Wei-Haas), but at this point it appears unlikely that this increase in the shift of the magnetic north pole is a precursor to such an event.

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komatiite 50th

Komatiite 50th Anniversary Geoheritage Field Excursion

This half-centennial anniversary marks one of the greatest breakthroughs in the 20th century in Earth science. It celebrates the discovery of a new rock type that has provided important insights into our understanding of the formation of the earliest crust on our planet, the origin of life and the source of gold deposits. Much of the Barberton area, where the komatiite story unfolded in the late 1960s, has now been proclaimed a World Heritage Site by UNESCO.

The field excursion was planned to revisit some of the more accessible sites which led to the discovery of komatiite and associated rocks in the Barberton area by the twin brothers, Professors Morris and Richard Viljoen, whose research was released to the scientific world in 1969.

A team of about thirty participants convened in the car-park of the Gordon Institute of Business Science (GIBS) in Illovo on an unseasonably cold Johannesburg morning (26th October 2019), to set off towards the Barberton Greenstone Belt.

The participants included many familiar stalwarts from the South African geological fraternity with, of course, Profs Morris and Richard Viljoen, Prof. Carl Anhaeusser, Prof. Laurence Robb and Dr Trevor Pearton as leaders

View over the Schapenburg Greenstone Belt (Dr Trevor Pearton in the foreground) with granite pluton in the background

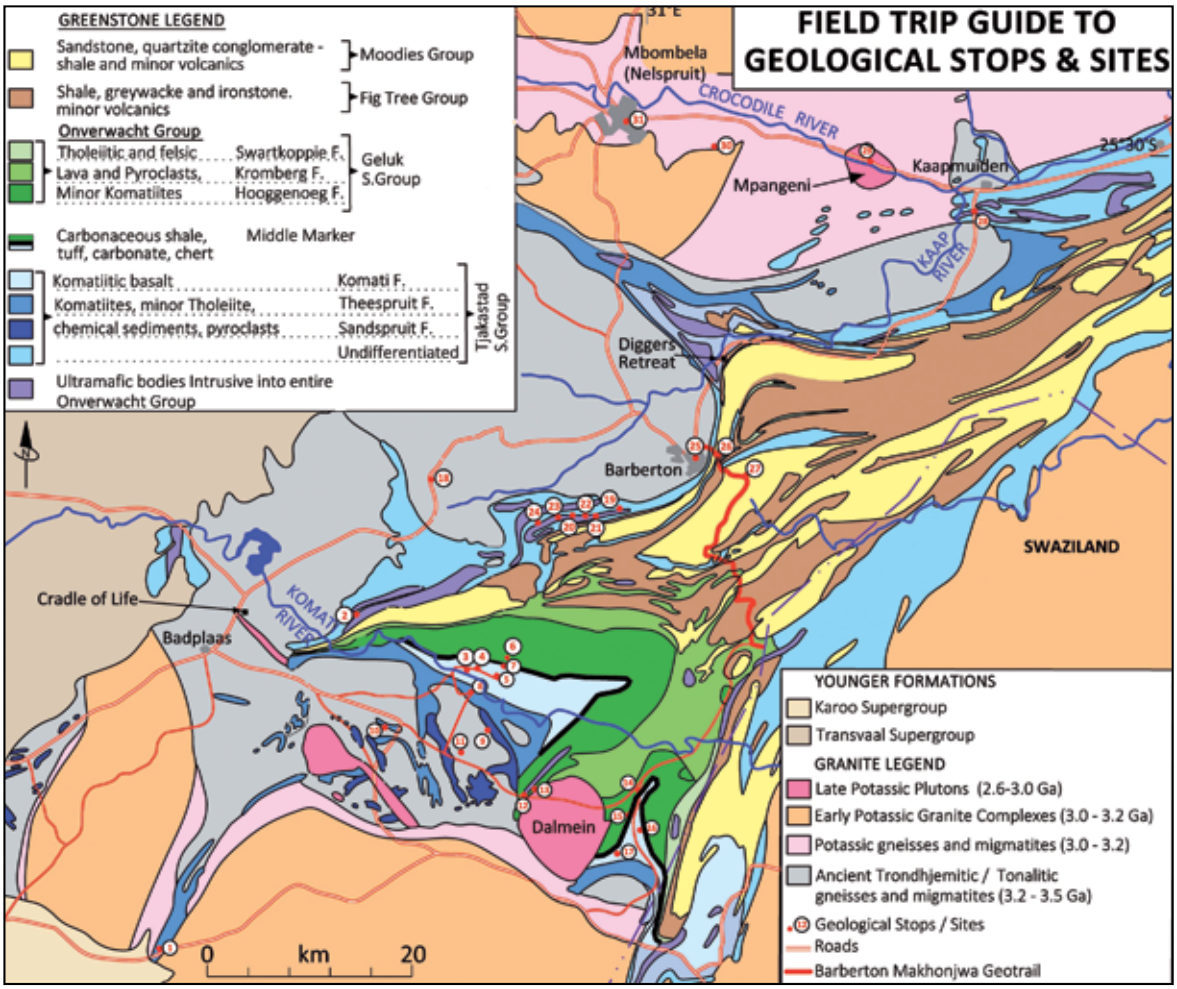


Figure 1
Geological map of Barberton Mountain Land showing many of the important and more accessible geological sites/stops (those visited on this trip are indicated in square brackets in text)

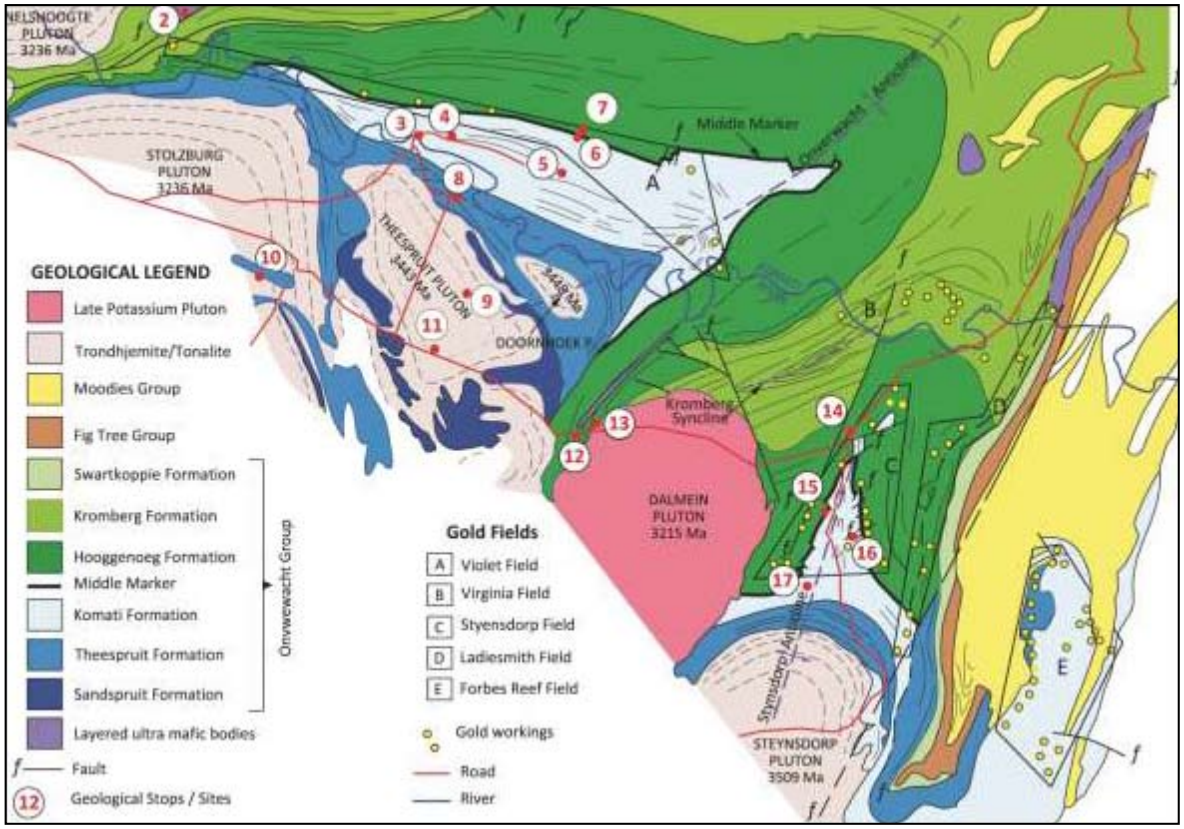


Figure 2
The regional geological map of the Southern Barberton greenstone belt showing the distribution of the six formations of the Onverwacht group established over a period of four field seasons during the Upper Mantle Project 1965-1969

and field-guides. There was also the refreshing presence of a few postgraduate Wits and UJ students and it was heartening to welcome several members from non-geological disciplines; the Archaeological Society of South Africa and members of HASA, a heritage/tourism organisation. A superb field guide had been compiled by the field trip leaders, with image-drafting, preparation and typing respectively by Lynn Whitfield, Jade Greve, Patricia Fivas and Sammy Mnkandla.

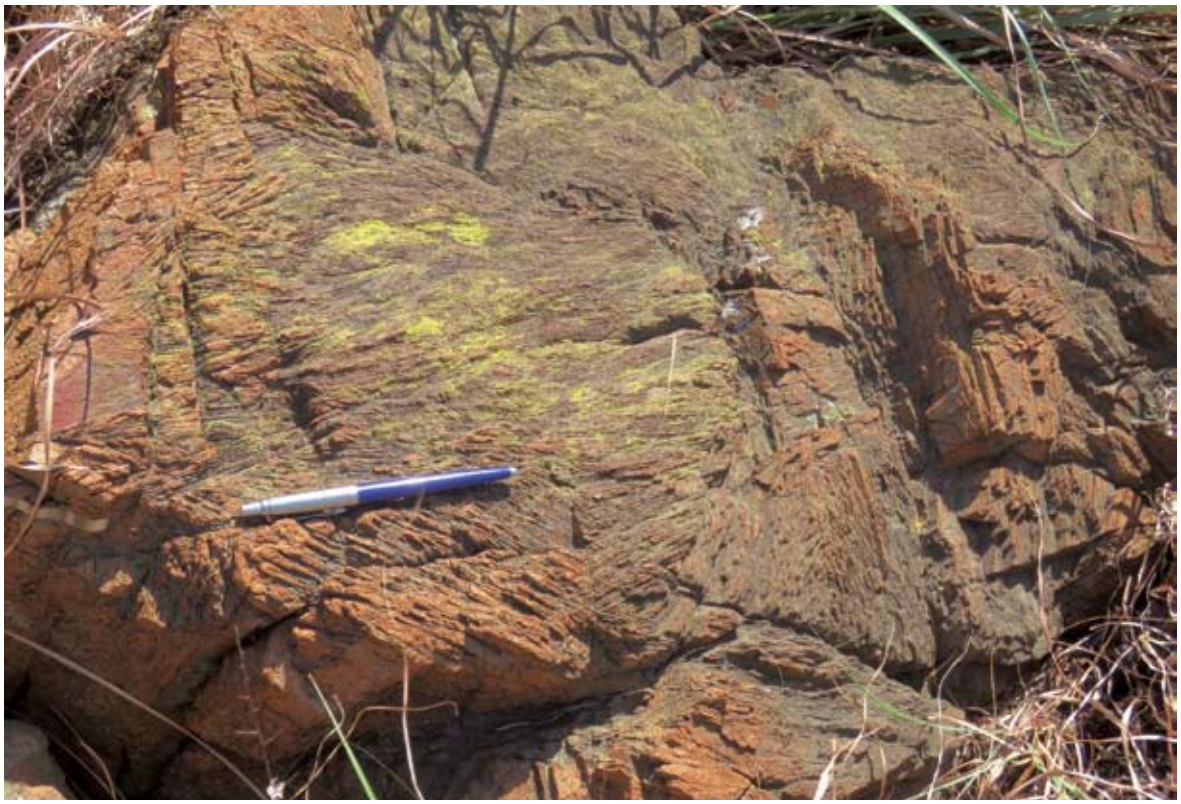
Highly effective organisation and time-management was to be maintained by Taryn Scharf, Andries Botha and Grant Bybee from the GSSA Egoli-branch committee with further input in the field by the Barberton team including Tony Farrar, Chris Rippon, Rolland Jones and Phumulele Mashele, (involved with an MSc on Geotourism in the Barberton Belt). Figures 1 and 2 present the geology of the broad area as well as the planned stops on trip, some of which were not visited due to time constraints.

The day's first stop was in the Schapenburg Belt, a south-western remnant of the main Barberton Belt and scene of a study by Prof. Carl Anhaeusser in the 1980s, which corroborated the extrusive origin of komatiite, and outlined the role of the ancient granite plutons intrusive into the earliest komatiite crust and forming the major component of the early-continental nucleus. The narrow Schapenburg Belt [1] and its ca. 3105 Ma flanking batholiths were pointed out by Prof. Anhaeusser from this point.

The komatiite flows are exceptionally well preserved in this belt and exhibit spectacular examples of the diagnostic spinifex texture.

Continuing to Badplaas with spectacular views of the retreating scarp face of the great eastern escarpment formed by the resistant, Neoarchaean Black Reef formation unconformably-overlying granitic rocks of the Barberton Greenstone Belt; a 500 million-year time gap. Earlier, a c. 3 Ga time-gap in the stratigraphy had been seen from the travelling vehicles, where the Ecca-Group sediments rest nonconformably on basement granite.

Morris Viljoen kicked off evening proceedings at the Cradle of Life Resort by providing the background to the work by him and his brother, Richard, during the Upper



Spinifex textures in komatiite lava flow in the Schapenburg Belt

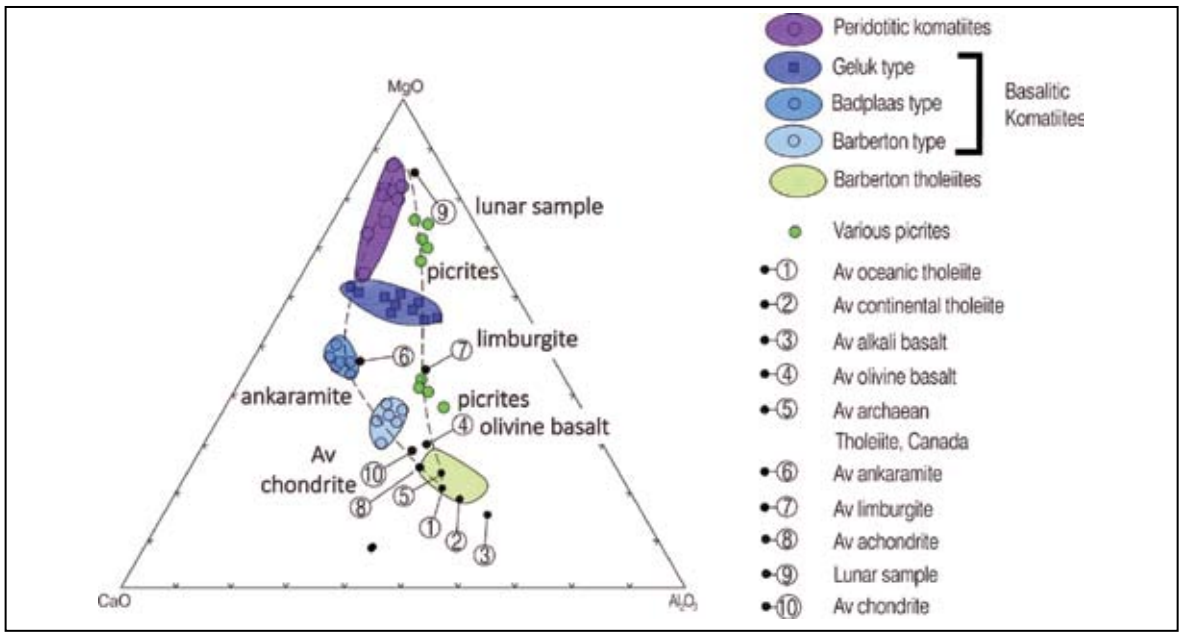
Mantle Project. This involved four years of mapping, sampling and interpreting the geology in the Barberton area from 1965, culminating at the international upper mantle conference in Pretoria in 1969. It was this work that led Morris and Richard to the realisation that they were dealing with a profusion of high-Mg, ultramafic lavas and near surface sills. Prior to this discovery, many foremost geologist and experimental petrologist had considered it physically impossible for an ultramafic magma to reach the surface of the earth's crust. Prof. Harry Hess from Princeton, USA had agreed with the Viljoen brothers' interpretation that this komatiite, as they had named it, was an as-yet unrecognised rock type and was the ultramafic "missing link" in the standard igneous/volcanic classification.

Richard Viljoen followed up with an account of the chert and pyroclast dominated, 3.47 Ga, Middle Marker and its significance with regard to evidence of the earliest life on Earth manifested by carbonaceous layers representing prokaryotic, microbial mats. Carl Anhaeusser provided an excellent explanation of the Stolzberg Complex as a layered, ultramafic, intrusive suite of dunite and pyroxenite. He pointed out the difference between this and komatiite flows, which with the interlayering of sediments, proves that they are not layered intrusions or parallel dykes. Carl then rounded up the evening's talks with an explanation of the ca. 3.7 Ga to 2.7 Ga granitoids in the Barberton Belt as evidence for the early accumulation of a granitic crust. A fine buffet roast dinner followed.

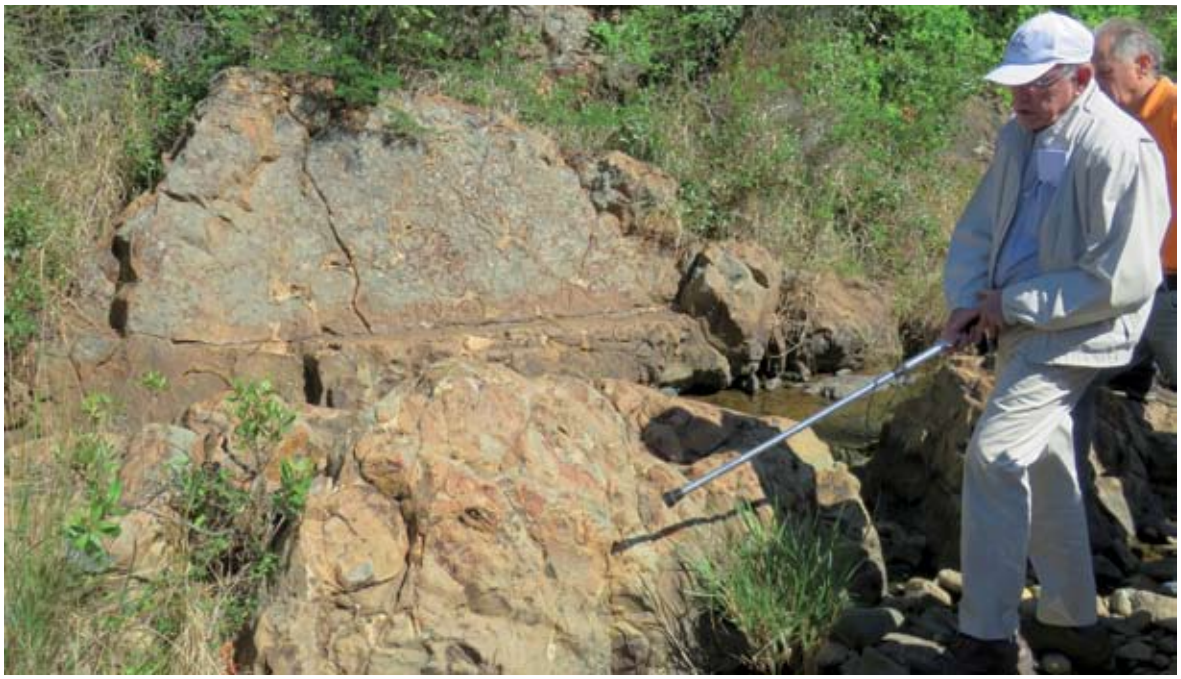
Day Two saw the convoy make its way through the huge, thriving, urban settlement of Tjakastad, which was not at all in existence in 1969. Stop [3] highlighted a complete komatiite flow, about 60 cm thick and showing the olivine cumulate base upwards into platy or bladed spinifex then up into random spinifex with a chilled flow top. These textures were initially thought to be metamorphic until it was realised in this area that they represented high-Mg, ultramafic lava flows. Prof. Allan Wilson explained how these flows were extremely hot (> 1500° C) and consequently had a very low viscosity and moved quickly. Good examples of Barberton-type, komatiitic basalt pillows with concentric zones of spherulites within them are exposed along the stream.

Back up along the road [4], examples of string-beef spinifex (Badplaas type) and dog-tooth weathering (Geluk type), talc schist were pointed out; Allan Wilson explained that single spinifex needles can reach spectacular lengths in string-beef spinifex.

At this point, envoys arrived from the Traditional Authority led by Indvuna Phillip Maseko. After description of the komatiite story by the Viljoen's, the Indvuna gave an eloquent response; welcoming geotourism in the



Mg/Ca/Al ternary plot showing the position of the 1969 Neil Armstrong lunar sample as well as other classes of terrestrial mafic and ultramafic rocks in relation to the Barberton komatiite geochemistry



Prof Richard Viljoen pointing out pillows in komatiitic basalt.

area. The dialogue was expertly translated between English and siSwati by Phumelele Mashele who had been instrumental in community engagement during the World Heritage Site process.

On the watershed of Spinifex Creek [5] the group, enjoyed packed lunches in a shady boma whilst Morris and Richard explained that the best exposures of komatiite flows were in Spinifex stream but were difficult to access in the time available. The Viljoens had however brought along a sample of an almost complete komatiite flow kindly made available for the trip by Dr Theunis Cloete. After lunch the significance of the Middle Marker was explained and an outcrop close to the clinic [7] was examined with conspicuous carbonaceous biomats being clearly seen. This horizon represents what must have been a major hiatus and a long-lived period of quiescence in vulcanicity, also evident in the geological record elsewhere on Earth. During this long period of comparative silence the earliest life-forms had a chance to develop.

At Theeboom [10] a contact between komatiite and intrusive, 3.4-3.2 Ga tonalite-trondjemite granite (TTG) was examined, with Prof Laurence Robb leading the group. This is an impressive lit par lit migmatitic contact

Profs Richard (l) and Morris Viljoen (3rd l) with Indvuna Phillip (2nd l) Maseko and Phumelele Mashele (r) (photo by Taryn Scharf)

Middle Marker chert with rip-up clasts near Mbhejeka Clinic

(ribbon migmatites) with a zebra-striped appearance . At the Ebutsini Tourism Centre [14] the group was welcomed by the manager, Douglas Nkosi and the traditional authority representative for that area, Indvuna William Gcina Motha. Morris and Richard re-told the komatiite story for their benefit.

At the final locality of the day, the relationship between gold and the Middle Marker in the Steynsdorp Anticline at Fullerton Creek, was explained. In Fullerton Creek, the Middle Marker [15] was seen exposed as a thin horizon of banded black and cream coloured chert (Fig. 10) with a footwall of sheared komatiitic basalts, now schists, with carbonate alteration in part, and a hanging wall of pillowed tholeiitic lavas.

The Londozi valley was the scene of intensive gold mining in the early to mid 1880s with over fifteen small

Lit-par-lit contact of intrusive tonalite-trondjemite granite into komatiitic basalt with flattened pillows

The Middle Marker in Fullerton Creek

mines exploiting auriferous quartz/carbonate veins, mostly above the Middle Marker and controlled by carbonate alteration and hydrothermal remobilisation from the carbonaceous layers in the footwall of the Middle Marker. The gold exploited from Fullerton Creek was alluvial however; having been eroded from quartz veins. One of the mined veins, at the Gypsy Queen mine, was pointed out high up on the side of the valley [16].

In the evening, Morris Viljoen went deeper into the link between komatiites, the Middle Marker and gold whilst Trevor Pearton discussed the significance of alteration and the leaching of gold from komatiites. Laurence Robb gave a superb explanation of the origin of early granitic crust, partial melting and the evolution from vertical tectonics ("sagduction") to plate tectonics, subduction and I- and S-type granites. Finally, Allan Wilson reported on the advances in the understanding of komatiites since their discovery fifty years ago.

The convoy set off the next morning, stopping near the top of the steep pass down into Barberton to view the Devil's Knuckles [18], a distinct ridge formed by a spheroidally weathered diabase dyke. The objective for the day was a visit to the Oorschot-Welteverden schist belt incorporating the Agnes mine to the southwest of Barberton. The group was shown part of the differentiated assemblage of the lower part of the Pioneer Complex where a basal dunite is overlain by pyroxenite representing an intrusive component of a komatiitic sill [19]. In the talc-chlorite schistose zones, transecting and sub-parallel joints and cleavages result in interlocking, lentil-shaped phacoids, remarked upon as being a mining nightmare.

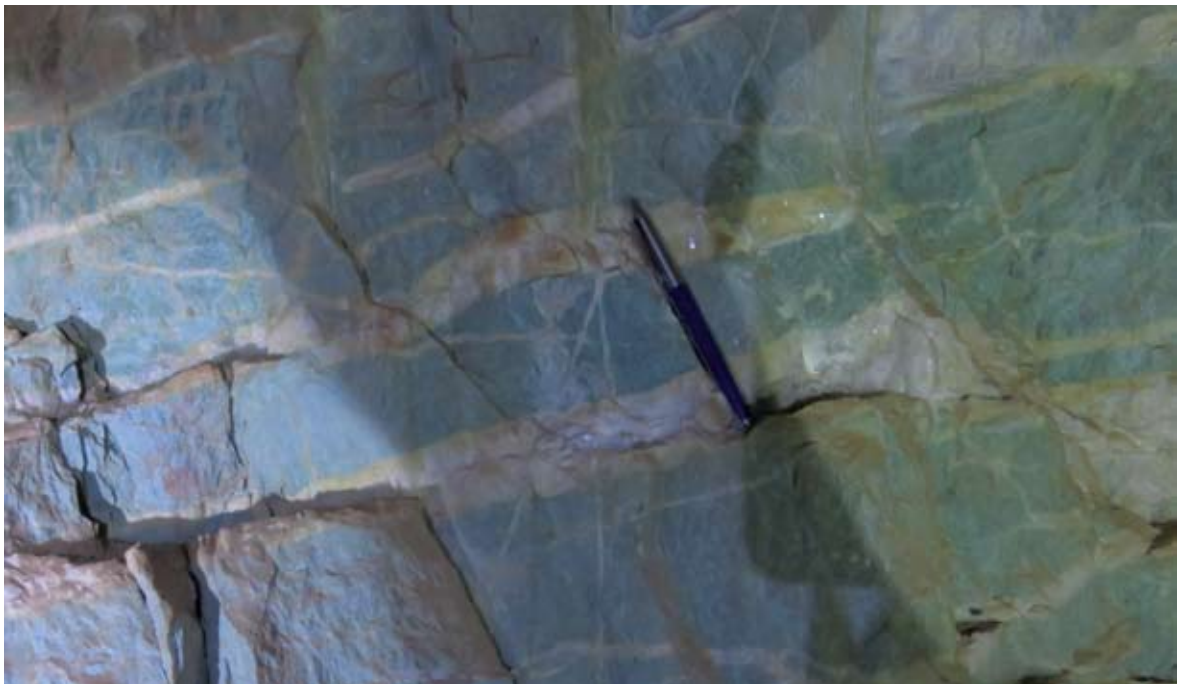
Shearing along the margins of the competent Pioneer Complex acted as fluid conduits for H_2O-CO_2 fluids resulting in extensive carbonate alteration accompanied by metasomatism of the chrome-rich ultramaphics giving rise to the characteristic green, fuchsitic quartz-carbonate, host to the gold leached from the komatiitic assemblages. It was one of these gold deposits; the currently non-operating Tiger Trap mine [21] into which a visit had been arranged through Norman Hartman and Andrea Els of Barberton Mines and Barberton Adventures, respectively. The strong presence of armed security at the mine entrance was a stark reminder of the on-going threat posed by illegal mining throughout the country.

Phacoidal talc-chlorite schist of the Oorschot-Weltevreden schist belt in places representing an altered Geluk Type Komatiitic basalt and in other instances an ultramafic pyroclast.

The fuchsitic, carbonatic ore zone with ptygmatic, and anastomosing quartz veins is spectacularly green underground when fresh. Small drill-core souvenirs of this material, brought from Sheba Mine, were kindly provided by Chris Rippon. On surface the ore zone is not as obvious; this being also demonstrated at

The Komatiite 50th Anniversay Geoheritage field group with mine personnel at Tiger Trap gold mine (photo by Andrea Els).

Into the adit of Tiger Trap gold mine (photo by R. Mohala)



Green Fuchsitic, quartz-stockworked ore zone in Tiger Trap gold mine

Golden Hill showing distinctive orange limonitic weathering of the carbonate alteration zone

the next stop, Golden Hill [22], where weathering of an extensive zone of carbonate alteration causes an orange limonitic colouration when viewed from a distance. The ore zone is a sinisitral shear cutting through the alteration zone with en-echelon and stockwork quartz veining.

A drive up to the valley head [23] accessed the upper units of the Pioneer Layered Complex to view pillow structures and excellent examples of string-beef spinifex in the Badplaas-type and Geluk-type komatiitic basalts [24] at the top of the succession.

Morris Viljoen pointed out various heritage sites in Barberton [25] including the Stopforth house museum, enroute to our overnight accommodation at Digger's Retreat.

Dr Trevor Pearton points out the stockwork veining of the gold-bearing shear zone of Golden Hill (photo by Frank Schie)

Prof. Morris Viljoen during a "hands-on" examination of spinifex with Trevor Pearton behind him, pointing out a textural boundary (photo by Frank Schie)

In the evening, Richard Viljoen provided an overview of the trip for the benefit of the Barberton guests. Norman Hartman, Barberton Mines head of local economic development, spoke on the support for the UNESCO World Heritage project from Barberton Mines and welcomed input by the GSSA in several areas. Tony Farrar then discussed the history, current status and way forward with the World Heritage site.

An open discussion was then held, opened by a senior representative from Mpumalanga Tourism and Parks. Mark Ngwenyama from the Barberton Tourism and Biodiversity Corridor (BATOBIC) addressed the audience and provided assurance that the Government was progressing with the World Heritage status to protect the UNESCO site. An excellent braai and conversations over drinks in Mark Seady's cosy bar at Digger's Retreat, with its collection of antique mining artefacts, wrapped up the evening.

At the first layby and viewpoint of the day [26] on the Barberton-Makhonjwa-trail, led by Tony Ferrar, the group could appreciate the breath-taking view to the north over the vast bowl of the negatively-weathered Kaap Valley pluton; a mind-blowing example of the longevity of erosion on the Gondwanan surface. The

Looking across the upper units of the Oorshcot-Weltevreden schist belt to hills of Moodies-Group Quartzite. Trenches, dug by early gold prospectors, are just discernible on the steep quartzitic hillside in the centre of the photo.

sheared, intrusive contact of this pluton was seen on the right-hand side of the road.

The final stop in the Barberton area [27] was at the boulder of meta-arenite with its carbonaceous layers, placed on the trail with a description, to display the evidence of earliest life. It is a remarkable example and shows distinct microbial features such as domes, tufts and fluid-escape structures.

It was then time for the tour to return to Johannesburg. Back past Fairview gold mine and onwards to pass the old mining activity where leaching of Mg from serpentinised dunite (birbiritisation) and alteration by carbonitic fluids produced magnesite veins [28].

☞

Tony Farrar's hand points out a fluid-escape structure in meta-arenite with crinkly biomats (photo by Frank Schie).

The tour was not quite finished; from Kaapmuiden the N4 follows the Crocodile River valley which transects the intrusive 2.6 Ga Mpangeni Granite Pluton [29]. Spectacular erosional features of pinnacles and perched, spheroidally weathered boulders were seen from the windows of the bus. On busy freeways, rough roads and at awkward stopping places, Jurgens Wilson, owner of Jabulisa Safaris, had driven us excellently throughout the trip.

Finally, the 3.1 Ga Nelspruit Granite Suite was crossed [30, 31] and the tour moved out of the Archaean and up into the younger Karoo cover on the long road back to Johannesburg. This was time for discussion and contemplation with a lot to ponder upon and undoubtedly find inspiration for further research.

As an undergraduate in 1979, the writer of this article remembers the 1969 discovery of komatiite by the Viljoen brothers being taught with reverence at the University of Newcastle upon Tyne in England.

Stuart Clague
Independent Consultant swclague@gmail.com

(From l to r) Andries Botha, Taryn Scharf, and Profs Morris and Richard Viljoen stand in front of the boulder containing biomats on the Makonjwa trail.

1st kimberlite 1973

The First International Kimberlite Conference (1973)

Topics:		
	Diamonds	Conference Organising Committee
	Diamond Inclusions	Prof. Louis Ahrens, University of Cape Town
	Eclogites	Prof. Barry Dawson, University of Edinburgh
	Kimberlites	Dr. John Gurney, University of Cape Town
	Megacrysts	Hon. Prof. Barry Hawthorne, De Beers Consolidated Mines
	Metasomatism	Dr. Peter Nixon, United Nations Mission, Lesotho
	Peridotites	Ms. Marianne Reichardt, University of Cape Town
	Tectonic Geophysics	

Dates:

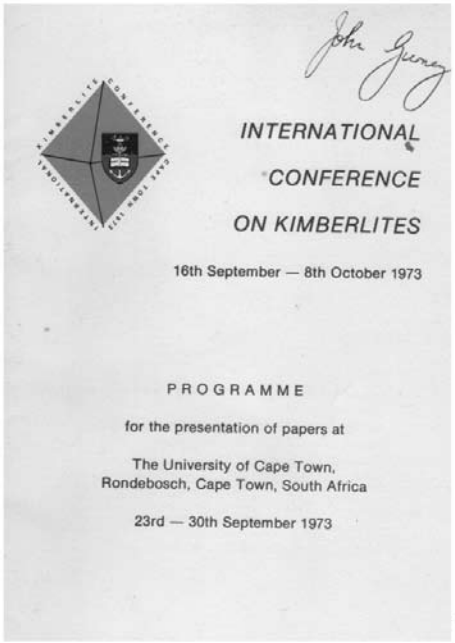
- Field Excursion Northern Cape (16th - 22nd September 1973) led by Barry Hawthorne, De Beers
- Main Conference: Cape Town (23rd – 30th September 1973) led by Louis Ahrens, U.C.T.
- Field Trip Lesotho (1st – 8th October 1973) led by Dr. Peter Nixon, U.N. Assisted by De Beers

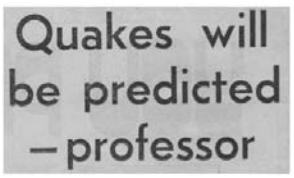
Conference Proceedings Volume

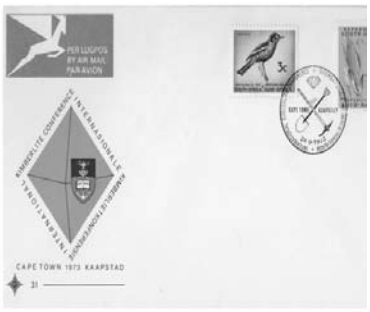
Physics and Chemistry of the Earth,
Volume 9,
Pergamon Press,
Oxford, 1975

Editors: L.H. Ahrens
J.B. Dawson
A.R. Duncan
A.J. Erlank

Conference opened by Minister of Mines, Dr. Piet Koornhof







Delegates Attending the First International Kimberlite Conference at UCT (1973)

Front Row: G.J. Geringer; A. Nicolas; M.J.O'Hara; G.W.Berg; Mrs D. Barrett; J.R.McIver; W.J. van Biljon; K.H.Wedepohl; P.H.Nixon; A.R.Duncan; J.B.Hawthorne; C.v.d.M.Brink; L.H.Ahrens; P.Koornhof; J.B.Dawson; D.L.Anderson; F.R. Boyd; A.J.Erlank; J.J. Gurney; R.P.E.Morgan; A.N.Dempster; P.K.Hall; P.J.Wyllie; M.G.Bardet; I.D.MacGregor; S.E.Rasmussen; J.C.Serre; J.C.Siebert; W. Kramer.

Second Row: A.E.Schoch; B.A.Wyatt; J.Krynauw; H.S.Yoder; G.S.James; A.A.L.Linholm; O.von Knorring; F.Hoffman; A.Cornelissen; A.F.Daily; M.Prinz; D.H.Eggler; D.V.Manson; D.P.Gold; K.D.Collerson; A.C.Moore; J.Ferguson; W.J.Verwoerd; E.Gübelin; R.T.Liddicoat; H.S.Pienaar; G.J.Greeff; G.Levin; A.E.Moore.

Third Row: D.D. van Reenen; M.S.Bravo; G.J.Keogh; C.L.Fieremans; F.C.Conquere; J.B.Jeppe; P.Seel; C.C.Begley; W.A.Nel; F.A.Raal; Miss B.Scott; V.Lorenz; K.J.Stracke; Miss P.C.Perkins; J.J.Ravier; I.M.Mason; R.M.McIntyre; S.B.Lumbers; A.G.Bloomer; P.Kresten; K.G.Cox; D.A.Carswell; Mrs G.Bain;

Fourth Row: H.G.Wilshire; A.A.Bisschoff; W.L.Anderson; M.R.Marx;J.Kanis; M.E.McCallum; G.G.Whitfield; R.J.Caveney; P.L.McFadden; P.J.Lawless; S.M.F.Sheppard; W.L.Griffin; K.Aoki; S.Akimoto; K.Suwa; K.D.Watson; W.G.Wahl; E.Gerryts; F.Bertsche; R.V.Danchin; S.E.Haggerty; G.W.Bain.

Fifth Row: P.Moura; C.D.Hallam; W.M.McKeown; B.Harte; Mrs J.Hawthorne; P.B.Saxby; C.R.Clement; M.Skinner; M.A.Lappin; C.H.Emeleus; J.S.Dickey; R.B.Hargraves; C.S.Erasmus; W.P.V.Loo; D.M.Bibby; E.J.D.Kable; H.Fesq; H.O.A.Meyer; A.A.van Zyl; D.G.Fullerton; J.Kramers; C.W.Glatthaar.

Sixth Row: P.G.Harris; J.V.Smith; T.K.Whitelock; J.W.Harris; D.du Toit; A.E.Short; A.B.Simpson; R.F.Figueiredo; N.Shimizu; R.F.Fudali; J.S.Marsh; S.Yui; P.J.Smit; D.J.Schutte; H.Helmstaedt; G.Blumel; Miss J.L.Johnston; A.L. Boettcher; C.Frick; R.H.Mitchell; D.B.Clarke.

Back Row: A.M. Reid; A.J.R.White; E.M.Luttrell; P.S.Bagnall; L.M.Bear; Mrs J.Gittins; J. Gittins; F.Schreuder; A.J.A.Janse; J.A.Muller; H.L.Allsopp; G.M.Koen; B.C.Hearn; D.N.Robinson; P.Lerotholi; R.I.Gait.

International Geophysics

International Geophysics

International Kimberlite Conference

An international conference on kimberlites and their origin will be held in Cape Town, Republic of South Africa, on September 23–29, 1973. The aim of this conference is to bring together a widely dispersed and diverse group of scientists who have a common interest in kimberlites in order to enhance communication and to focus attention on especially significant research problems. Most scientists engaged in kimberlite research are specialists in some aspect of geochemistry, geophysics, or field studies, and there have been few opportunities for discussion or for coordinated work. This conference will provide opportunities for formal and informal discussion and will permit scientists to initiate coordinated programs if they wish.

The conference will embrace a wide range of scientific disciplines to best develop our understanding of kimberlites and of the xenoliths of upper mantle rocks that they contain. Papers that relate to kimberlite genesis are invited in the following areas:

1. Geochemistry: including age, isotopic and trace element studies.
2. Geophysics: physical properties of upper mantle rocks and seismic and theoretical work.
3. Petrology and mineralogy of kimberlites and of mafic and ultramafic xenoliths.
4. Field studies: structure of kimberlite intrusives and eruptive models.

Participants will be able to visit a large number of kimberlite pipes and dykes in southern Africa and to collect from the abundant suites of nodules they contain. Prior to the conference there will be a week-long field trip to mines and other kimberlite exposures in the Kimberley area. There will be a second field trip after the conference to kimberlite localities in the Maluti mountains in Lesotho. These field trips will provide a unique opportunity to collect rocks that have crystallized in the upper mantle. Participation in the Lesotho field trip must necessarily be limited to 80 persons, but a somewhat larger group can be accommodated on the Kimberley trip.

Fig. 1. Ultramafic nodules, rounded by abrasion during eruption of the kimberlite, at the Sekameng pipe, Lesotho. This locality will be visited during the second field trip scheduled during the International Kimberlite Conference next September.

The provisional stops on the first field trip are listed below.

Premier Mine: The largest kimberlite pipe in South Africa. It is Precambrian, unlike those to the south.

The De Beers, Wesselton and Dutoitspan Mines: Three of the five large pipes in Kimberley.

The Bellsbank 'Finsch' kimberlite mines and neighboring localities, where dyke kimberlite is mined to depths greater than 1000 feet.

Frank Smith Mine: A locality from which large xenocrysts, eclogites, ilmenite/pyroxene nodules, and peridotites have frequently been recovered.

Roberts Victor Mine: The best known xenolith locality in the country, if not the world. Mining has been recommenced and the mine should be known as the 'Jewel Box' at the time of the conference. Old records suggest that xenoliths of eclogite are especially common in this section and present development seems to confirm this.

Newlands Mine: No longer an active mine, this kimberlite is reported to have an even more outstanding xenolith suite than the Roberts Victor.

Leeuwndal Mine: The intrusion of this kimberlite was controlled by a delicate sill, and present development has exposed this feature very clearly.

Koffiefontein Mine: A large open-pit mining operation, presenting excellent sampling opportunities.

Benfontein Sill: An important locality because of the very strong field evidence presented in favor of its intrusion as a magma.

The Bultfontein Floors: This area in Kimberley, where kimberlite was laid out to decompose in the days before the ore was all crushed, contains abundant ultramafic xenoliths.

The Kamfersdam, Klipfontein, and Ebenezer kimberlite occurrences: Each of these kimberlites has features that are not found at the other localities listed above.

Listed below are visits planned for the Lesotho field trip.

Liqhobong Dyke: A narrow dyke crowded with xenoliths of rocks of deep crustal and mantle origin.

Sekameng Pipe: A kimberlite pipe with good exposures and a xenolith suite (Fig. 1), which is notable for the high chromium content of the garnets and diopsides.

Letseng La Terae: A large pipe that has been extensively prospected above and below surface for diamonds. It is relatively unstudied but is known to contain mantle derived xenoliths. This pipe is currently under option to a mining house.

Kao Pipe: The largest pipe in Lesotho, which is now also under option to a mining company. The mining camp here will provide a base for the delegates for four nights.

Thaba Putsoa Pipe: A small pipe with good exposures. The xenolith suite is quite varied, and it includes intensely sheared garnet lherzolites that appear to have equilibrated at unusually high temperatures.

Matsoku Pipe: Another small pipe that contains an unusual and variety of xenoliths greater than any other reported occurrence in southern Africa. The xenoliths include abundant garnet pyroxenites.

Monastery Mine: A kimberlite occurrence well known for the variety of its ultramafic nodules. Very rich in phlogopite and large monomineralic xenoliths and xenocrysts of garnet and pyroxene, the pipe also contains abundant lamellar intergrowths of pyroxene and ilmenite to which some petrologists have attributed a particularly deep-seated origin.

Lodging during the first field trip will be in hotels, and transportation will be by bus and by air. The second field trip to the Maluti mountains in Lesotho will necessarily be more primitive. Accommodations for most nights will be at mining camps, and transportation will be by Land Rover and, on one day, by horse or on foot.

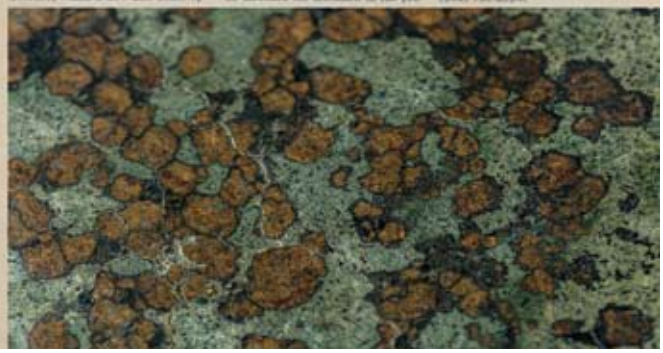
Persons wishing to present papers should submit three-page abstracts by June 1, 1973. These abstracts will be screened for inclusion in the program by an international committee. Accepted abstracts will be collected in a volume and distributed to participants on arrival. The Proceedings of the Conference, which will include the complete manuscripts of the papers presented, will be published by Pergamon Press as a volume in the series *Physics and Chemistry of the Earth*.

The conference is sponsored by the International Association of Geochemistry and Cosmochemistry, which is affiliated with the International Union of Geological Sciences, the Inter-Union Commission on Geodynamics, the Geological Society of South Africa, the Council for Scientific and Industrial Research (Pretoria), and the University of Cape Town. Additional sponsorship, including that of the American Geophysical Union, will be sought.

The convenors of the conference are: L.H. Ahrens (University of Cape Town, R.S.A.), F.R. Boyd (Carnegie Institution, U.S.A.), and J.B. Dawson (St. Andrew's University, U.K.).

Persons wishing to participate in this conference should write immediately to: John J. Gurney, International Kimberlite Conference, Department of Geochemistry, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa.

Persons wishing further information by phone may call F.R. Boyd at (202) 966-0334.



The Argus, 21/09/1973

Kimberlite holds earth's secrets

The Argus Correspondent: Johannesburg, Friday.

A THREE-WEEK conference at which most available knowledge of the earth's interior will be pooled has brought to South Africa a large number of the world's leading scientists, representing 20 countries.

The Argus, 16/08/1973

Scientists from 20 lands to meet at UCT

THE University of Cape Town will become something of a United Nations next month when about 90 top scientists from 20 foreign countries converge for an international conference on kimberlites.

About 40 South Africans will attend and the conference chairman is Professor L. H. Ahrens, well known for his UCT lunar research work and president of the International Association of Geochemistry and Cosmochemistry.

Professor Ahrens said today that while the conference would be of great importance for research into the interior of the earth it would be weakened by the fact that perhaps as many as 15 scientists from four countries would not be allowed by their governments to come to South Africa.

There seemed little hope that 10 Russians, a Czechoslovakian and a Yugoslavian who had said they were interested in coming would be allowed to do so. There was also doubt whether six Indian scientists would be allowed to come.

He said: "Siberia and Southern Africa have the most kimberlites so the research work of the Iron Curtain scientists is obviously very important.

"The scientists who will not be able to come will be missing a tremendous chance of seeing our kimberlites because the conference will include two field excursions to the kimberlite mines of Pretoria, Kimberley and Lesotho.

"In addition perhaps half a dozen papers will not be presented at the conference. One of the Iron Curtain scientists has indicated that he will not even be allowed to send the paper he has prepared to the conference.

"Nevertheless, 85 or 90 papers will probably be presented.

The Minister of Mines, Dr P. G. Koornhof, will open the conference officially at UCT on September 24. The field excursion to Kimberley and Premier will take place from September 18 to 22. Papers will be presented at UCT from September 24 to 28 and the Lesotho excursion will take place from September 28 to October 5.

Diamond Field Advertiser, 21/09/1973

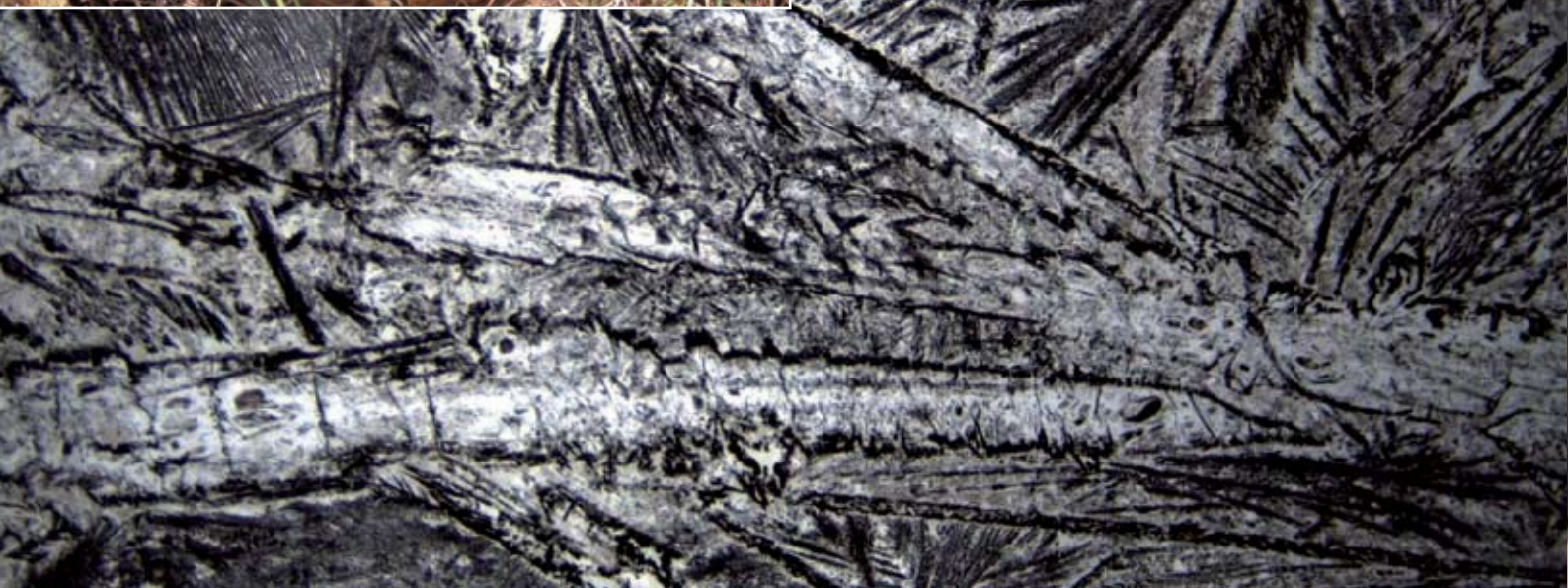
Geologists in city to study kimberlites

A THREE week conference at which most available knowledge of the earth's interior will be pooled has brought to South Africa a large number of the world's leading scientists representing 20 countries, who are meeting in Kimberley this week, before going to Cape Town and Lesotho.

PROF. LOUIS H. AHRENS

Delegates from 20 countries (marked in red) attended the first International Kimberlite Conference.

Continued pp 52




35TH
INTERNATIC
GEOLOGICAL
CONGRESS

Kimberley Field Trip

De Beers Chief geologist Barry Hawthorne and resident director Mr Alex Hall were photographed with three of the leading geologists who attended a dinner given by the company for delegates to the International Kimberlite Conference.

From Left: Dr J.J. Gurney of Cape Town University who was conference secretary; Mr Hall; Dr F.R. Boyd of the geophysical laboratory, Carnegie Institute, Washington; Mr Hawthorne and Dr J.B. Dawson of the department of geology at the University of St Andrew's, Scotland.

DE BEERS NEWS

October 1973 — Registered at the G.P.O. as a new

First international kimberlite conference

Samples of kimberlite were taken out of Kimberley for study purposes by delegates to the first International Kimberlite Conference held in South Africa.

They came, 107 of them, from all over the world to undertake field trips in this area.

Only in Kimberley can samples of kimberlite be obtained from extreme depth. Thus the delegates could not speak too highly of the opportunities which came their way through the courtesy of De Beers company and other mining concerns in this area.

Paying tribute to the excellent programme planned by Chief De Beers geologist Mr Barry Hawthorne, conference secretary Dr J. J. Gurney of Cape Town University said that delegates had visited "many mine point to coming to Kimberley where arrangements had been of an equally high standard.

From Kimberley the visitors travelled to Bultfontein, Roberts Victor, the New Elands, Koffyfontein and the Ebenhaezer and Klipfontein mines.

Locally there were underground visits at De Beers, Dutoitspan and Wesselton in addition to studies of the Bultfontein kimberlite sill and the Kamfersdam pipe till complex.

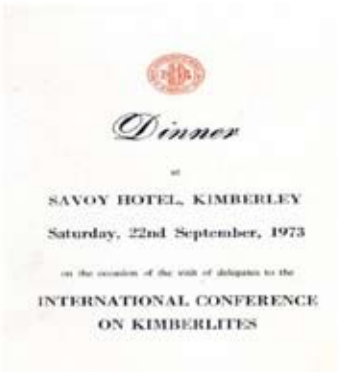
Delegates were shown coastal sorting offices a Kimberley Mine and Museum.

It was possibly the gathering of overseas logists South Africa h been host to—certain biggest since the war.

The opportunity changing ideas and taking field trips del the numerous visitors who are planning to their findings in a few time.

De Beers chief geologist Barry Hawthorne and re director Mr Alex Hall were photographed with three leading geologists who attended a dinner given by the pany for delegates to the International Kimberlites ference. From left: Dr J. J. Gurney of Cape Town Univ who was conference secretary; Mr Hall; Dr F. R. Bo the geophysical laboratory, Carnegie Institute, Washin Mr Hawthorne and Dr J. B. Dawson of the departm geology at the University of St Andrew's, Scotland.

Dinner at the Savoy Hotel, Kimberley



Dinner

at

SAVOY HOTEL, KIMBERLEY

Saturday, 22nd September, 1973

on the occasion of the visit of delegates to the

INTERNATIONAL CONFERENCE ON KIMBERLITES

The Directors request the pleasure of the company of

MRS. M. RICHARDS

at Dinner on Saturday 22nd September 1973, at the Savoy Hotel

7.30 p.m. for 8.00 p.m.
Dress: Lounge Suits

Welcome by
MR. A. S. HALL
Resident Director, De Beers Consolidated Mines Ltd.

Address by
DR. W. P. DE KOCK,
Chairman, Diamond Producers Association

Response by
DR. J. B. DAWSON,
Department of Geology, University of St. Andrews, Scotland

Menu

Fatima Buns with Pineapple

Fillets de Sole Rosina Fermoy

Roast Rump of Venison with Red Currant Jelly and Hunters Sauce

Roast Potatoes *Green Peas* *Stuffed Tomatoes*

Sherry Trifle

Cheese *Biscuits* *Coffee*

Young scientist brings kudos to South Africa

ST GEORGE'S STREET, Wednesday.

THAT South Africa is to have the honour later this month of being host to 85 of the world's most distinguished scientists is a direct result of the diligence of a post-graduate student in Professor Louis Ahrens's Department of Geochemistry at the University of Cape Town.

TALK at The Cavern of the Seas by the Wanderers

Mineral opportunities

Success

Williams Collection

U.K.-kongres wek wyd belangstelling

'MOON MINERAL' FOUND IN SA

"MOONROCK" of a type unknown on earth until now has been discovered near Kimberley and scientists are revising their theories on the evolution of the earth.

IDENTIFICATION

Scientists to study SA kimberlites

LEADING scientists from many parts of the world were being drawn to South Africa for the forthcoming conference on kimberlites at the University of Cape Town, Dr J. B. Dawson of the University of St. Andrews said yesterday.

Dr. Dawson, who holds a D.Sc. degree from the University of St. Andrews and a Ph.D. from the University of Leeds, is a world authority on kimberlites.

He is the first of the overseas delegates to arrive for the conference which starts on September 16 and will continue to October 8.

He is also one of the first scientists to visit South Africa under a new scheme inaugurated and sponsored by the Council for Scientific and Industrial Research (CSIR).

VISITING FELLOW

He will spend nine months in South Africa as a visiting fellow in the University of Cape Town's Department of Geochemistry, the only department of its kind in South Africa and one of few in the world.

The head of this department, Professor Louis Ahrens, is President of the International Association of Geochemistry and Cosmochemistry, and chairman of the conference on kimberlites.

Kimberlites are especially important to the study of the composition of the earth. They are the primary source of diamonds and carry with them in their rapid passage to the earth's surface, while still fluid, fragments of a variety of rocks from deep in the earth's interior.

The first week will be spent on a field visit to Kimberley. The discussions on the University of Cape Town campus will take place between the two field visits.

So far more than 150 delegates from 19 countries have registered for the conference.

Apart from being a scientist of international repu John Gurney, here seen at the 'console' of an fluorescence spectroscope at the University of Town, is an all-round sportsman, having represente university at soccer and now being the captain Pinelands Cricket Club.

Poster sessions contributed to the scientific reports

Cape Times

27th July 1973

Fortuitously the Kimberley Holiday Inn was opened on the first day of the conference and delegates were treated to top class facilities.

De Beers went to great lengths to make everybody welcome. An outstanding example, was that 2 wooden crates for samples were provided and their export facilitated to any place required by the collectors.

There was also a comprehensive entertainment of delegates both at the Holiday Inn, at the Kimberley Club and at De Beers offices.

Mr. T. Stratten (left) of the De Beers geology department seen with Dr. P. C. Perkins of the University of California, Miss J. L. Johnston of the University of California and Dr. P.H. Nixon of the Department of Mines, Lesotho.

De Beers assistant chief geologist Mr. R. Clement (second left) with (from left) Dr. A. Nicolas of France, Mr M. Marx of Angola and Dr. Jean Ravier, also of France.

Dr. H. S. Yoder of Washington (left) with Miss B Scott of the Department of Chemistry, University College of London, Dr E. J. Kable of the Nuclear Physics Research Unit at the University of Witwatersrand and Professor P. J. Wyllie of the University of Chicago.

De Beers geologist Mr. L. Kroll and Mrs. L. Kroll (left) with Dr. D. B. Dawson (centre) of the Department of geology at the University of St Andrews's, Scotland, Mrs Barry Hawthorne and Dr. F. R. Boyd of the geophysical laboratory, Carnegie Institute, Washington.

Dr. M. Prinz of the Department of geology and Institute of Meteorites, University of New Mexico, with Mr P. Lerotholi of the Department of Mines, Lesotho.

Dr. K. Suwa (right) of the Department of Earth Sciences, Nagoya University, Japan, shared a joke with Dr. W. G. Wahl of Canada

Barry Dawson (left) and Hat Yoder (right)

John Dickey (left) and Marty Prinz (right)

John Gurney (left) and the Mayor and Mayoress of Kimberley, Mr. and Mrs. L.H.G. Shuttleworth (right). Barry and Margie Hawthorne (centre)

Louis Ahrens (left) and Barry Hawthorne (right)

Ben Harte (centre) and Dick Rickard (right)

Haro Fesq (left) Joe Smith (centre) and Jeff Harris (right)

Barry Dawson (right)(U.K)

Vincent Manston (left) and Miss J.L Johnston (right)(U.S.A.)

Orson Anderson(U.S.A.)

Braam Janse (left), Yolande Ahrens (centre)(C.T.) and Mrs. Bain (right)(Australia)

Joe Boyd (left)(U.S.A.), Mrs. Bains (centre) and Braam Janse (right)(R.S.A.)

Keith Whitelock, Roving Role. Mine manager Letseng, Mothae, and Namdeb, in conversation with J. Johnston

Bob Fudali (left) and Vincent Manston(U.S.A.)

John Gittins (left), Joe Smith (centre) and Hat Yoder (right)(U.S.A.)

Louis Ahrens (left)(U.C.T) and Mike O' Hara (centre)(U.K.)

Steve Haggerty (left), Barry Hawthorne (centre) and Pete Wyllie (right)

Bob and Louis Fudali (U.S.A.)

Kimberley Holiday Inn atrium, Fortuitously the opening of the hotel coincided with IKC, the hotel design was ideal for socialising.

Barry Dawson (photographed) inspects a pile of mainly peridotite xenoliths from the Bultfontein Kimberlite waste dumps.

A pile of nodules from The Bultfontein Kimberlite set aside by the miners at the crusher in the background for the geologists. The nodules include eclogite, garnet herzolite, wehrlite, harburgite, and peridotite.

Barry Hawthorne engages in a technical discussion

Tony Erlank stands proudly alongside the fruits of his labour, at the Mitai kimberlite in northern Lesotho, Mitai provided some the largest mantle xenoliths recovered from any of the kimberlites visited.

Outcropping at nearly 3000 metres above sea level, it took considerable effort particularly where the xenoliths were exposed within a kimberlite unit.

One particular xenolith ("the Mothae Monster") was selected to be an international standard for laboratory quality control.

Laid out at the Mitai kimberlite for the benefit of delegates to the 1973 conference.

A line-up of Land Rovers provided by various sponsors of the 1973 conference including in particular De Beers, The United Nations and UCT.

The expedition to Matsoku was accompanied by several locals on their horses. This photograph shows one of these guys in full regalia.

At some of the localities, delegates went about concentrate hunting so that they might obtain mineral samples such that might be used in a prospecting program. In this figure these concentrates can be seen laid out to dry in the sun.

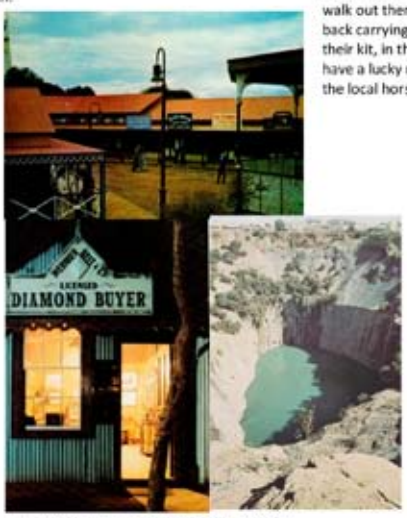
The trip to Matsoku was one of the highlights of the conference field trips and most people had to walk out there and walk their way back carrying their samples and their kit, in this photo though, we have a lucky man riding one of the local horses.

Ian Macgregor, one of the pioneers studying xenoliths from kimberlite. / one of the senior members of the fi trip, he was allocated a mule to ride

Four-legged transportation was at a minimum, and only a lucky few were to catch a ride.

The alternative for the 10 kilometer 10 kilometers in trip was walking, completed in one exciting day for th trek to the Matsoku pipe, which is notable for the high proportion of m xenoliths of these included in the diatreme.

Underground visits to the Kimberley Mines were undertaken in batches of 12 visitors in 12 batchs (144 in total). Thanks to the efforts of De Beers staff and the meticulous planning of Barry Hawthorne.



Diamond buyers in the town of Kimberley

Main Conference: Cape Town

Significance of the kimberlite conference

By Dr J. B. DAWSON

Reader in Petrology and Mineralogy, Department of Geology, St Andrews, Fife, Scotland, who was one of the conveners of the recent international conference on kimberlites.

WHEN viewed on a world-wide scale, kimberlite is a very rare and volumetrically insignificant rock-type, occurring at the present day in the vents of old, eroded volcanoes in some parts of southern Africa, in Siberia and at scattered localities in the U.S.A. and Canada.

Despite its rarity, kimberlite is of interest to earth scientists for two main reasons. First, the kimberlite contains diamond (it is named after Kimberley), second, it contains fragments of a wide variety of rock-types that have been brought up from deep within the earth; kimberlite is, in effect, a type of natural borehole extending from the surface of the earth to depths of 200-300km beneath the surface.

Despite these unique properties, it is only within the past decade that earth scientists have begun to investigate kimberlite really intensively but it was only a matter of time before kimberlites became the focal point of a major international conference. This took place under the chairmanship of Professor L. H. Ahrens at the University of Cape Town from September 23-29, when scientists from 21 countries gathered to present their findings on the various aspects of kimberlite geology.

There were sessions of the geology of kimberlite and on its geo-chemistry, and a large amount of time was devoted to studies on xenoliths — the blocks of material brought up from the earth's upper mantle. There were also sessions on diamonds themselves, and also on experimental petrology — the aspect of geology where rocks can be placed in steel cylinders and melted at very high pressures and temperatures in attempts to simulate natural reactions.

What did we learn from the conference? The papers on the regional distribution of kimberlite confirmed that diamondiferous kimberlites are confined to very ancient parts of the earth's crust that have not been deformed for the past 1 000 million years. This is obviously very important to the economic geologist who can now eliminate large parts of the earth's surface from areas to be prospected for diamond.

In addition, speakers reported the presence of kimberlites in West Africa that lack pyrope and ilmenite — two highly distinctive minerals that are used as tracers when prospecting for diamond. This also gives food for thought for the economic geologist — how many kimberlites have we missed by using the present-day prospecting techniques?

★

Other papers described the detailed mineralogy of the kimberlite itself, these studies revealing a large number of complex chemical reactions that had previously been suspected but not confirmed. Again this is important when considering the growth of diamond within its kimberlite parent.

And what of the sessions on xenoliths? The studies on the rocks from the upper mantle revealed a series of events that we had not suspected. We learnt that there had been melting events with consolidation of the new liquids and growth of completely new minerals, including granulites, first discovered on the moon. In addition, we learnt that many of the rocks had been deformed by slow but large-scale movements (probably similar to the slow, plastic movement of a glacier) that have their effects on the earth's surface in the form of breakage and drifting apart of the continents. All these additional complexities will probably prove to be something of a handicap to the experimental petrologists who, by the very nature of their apparatus, must confine their attention to relatively simple systems. Nonetheless, by adding the gas carbon dioxide to a common upper-mantle rock-type (garnet-peridotite) and melting them at very high pressures and temperatures they already have produced a high temperature liquid that closely resembles kimberlite itself.

As a result of the conference we know much more about kimberlite than we knew six months ago, and it will take some while to digest the mass of information that was presented. It also underlined the major and fundamental gaps in our knowledge. Why, for example, are there these enormous movements in the upper mantle? And where does the necessary energy come from?

THE ARGUS, THURSDAY SEPTEMBER 27 1973

Kimberlites conference

GEOLOGIST Dr Priscilla Perkins, one of the delegates at the Kimberlite Conference.

DEMAND FOR GEMS LIKELY TO GROW

THE Minister of Mines, Dr P. G. J. Koornhof, predicted today that the demand for gem diamonds would increase in future.

Speaking at the first international conference on kimberlites at the University of Cape Town, he said: "It is more than likely that as long as women are women "diamonds are forever".

Even if an eventual breakthrough should come and large gem-quality artificial diamonds could be manufactured economically, it was unlikely that natural diamonds would lose any of their attraction.

RISING STANDARD

The expected rise in the demand for gem-diamonds would be caused by the rising standard of living, the limited supply, and the security which diamonds offered in times of political or monetary instability, Dr Koornhof said.

Diamonds of industrial quality were mined in large quantities in many countries, including South Africa, and diamonds were now also produced artificially for certain industrial uses.

However, with the advancement of technology, exciting new applications of the industrial diamonds, were reported with regularity, Dr Koornhof said.

It would seem that if the synthesis of large industrial diamond stones at a reasonable price is not achieved well before the year 2000, extensive applied research towards the discovery of diamondiferous deposits would become imperative.

WOMAN'S PAGE

WHO would have thought that diamonds are one of the best sources of information scientists have on the structure of the interior of the earth? This interesting fact was told to SUE GARBETT by Dr Priscilla Perkins, one of the 189 delegates at the International Conference on Kimberlites, presently being held at the University of Cape Town.

From Australia

PROF A E RINGWOOD of the Research School of Earth Sciences of the Australian National University visited the CSIR last Monday. He was accompanied by a fellow-Australian, Dr Susan Kovach, and they are on a one-week visit to South Africa as guests of the De Beers Mining Company.

Prof Ringwood delivered a lecture at NPRL dealing with high pressure studies at the Research School of Earth Sciences. Apart from visiting the NPRL, Prof Ringwood and Dr Kovach also visited Wates Research and Feed Research.

DIE BURGER, DINSDAG, 25 SEPTEMBER 1973

KIMBERLIET-KONGRES

Prof. Ahrens kla Russe aan

PROF. L. H. AHRENS, voorsitter van die Internasionale Konferensie oor Kimberliet wat vandeesweek in Kaapstad gehou word, het die Russiese regering by die Internasionale Raad van Wetenskapunies aangekla omdat hy geweier het dat tien Russiese natuurwetenskaplikes die konferensie bywoon.

„Die afwesigheid van die Russiese geleerdes het ons konferensie verswak," het prof. Ahrens gister gesê, maar bygevoeg dat die Russiese natuurwetenskaplikes baie meer deur hul regering se optrede verloor as die res van die afgevaardigdes wat sonder hul teenwoordigheid moet klaarkom.

Die konferensie, die eerste in sy soort en een van die belangrikste oor 'n vakwetenskap wat nog in Suid-Afrika gehou is, is gisteroggend amptelik deur dr. P. G. J. Koornhof, Minister van Mynwese, geopen. Altesame 177 natuurwetenskaplikes — van wie 93 uit die buiteland — neem aan die konferensie deel.

In 'n onderhoud het prof. Ahrens, hoogleraar in geochemie aan die Universiteit van Kaapstad, gister gesê sewe vooraanstaande Russiese wetenskaplikes is verlede jaar na die konferensie genooi. Al sewe het in korrespondensie aangedui dat hulle baie graag die konferensie wil bywoon. „Hulle het hulle geesdriftig geklink."

Voordat hulle gevra is om die konferensie by te woon, het prof. Ahrens die versekering van die Suid-Afrikaanse regering verkry dat visums om Suid-Afrika te besoek aan hulle uitgereik sou word.

„In Rukkie nadat die sewe die uitnodiging na die konferensie aanvaar het, het een van hulle gevra of drie ander natuurwetenskaplikes ook kan kom. Die drie natuurwetenskaplikes is genooi om hul referate aan die organiseerders van die konferensie voor te lê. Dit is aanvaar en die uitnodiging aan die Russe is verander om die drietal in te sluit.

Die eerste aanduiding dat die Russiese regering dalk nie die tien geleerdes sou toelaat om Suid-Afrika te besoek nie, het teen die einde van verlede jaar by die kongres van die Internasionale Unie vir Geologiese Wetenskappe in Montreal gekom.

Prof. Ahrens is by die kongres tot voorsitter van die Internasionale Vereniging van Geochemie en Kosmochemie (I.V.G.K.) verkies. Toe die internasionale konferensies bespreek is, het die Russiese afgevaardigde gesê sy regering sal dalk nie toelaat dat Russiese natuurwetenskaplikes uit die land gaan as die konferensies in Israel of Suid-Afrika gehou word nie.

Prof. Ahrens het die Russiese regering by die Internasionale Raad van Wetenskapunies aangekla met die hoop dat hulle druk op die Russiese wetenskapakademie sou uitoefen om hulle regering te oorreed om die Russe te laat kom. Dit het egter nie gebeur nie.

Prof. Ahrens het gister gesê die Russiese geleerdes het 'n baie belangrike geleentheid om kimberliet in Suid-Afrika te kom besigtig (Suid-Afrika en Rusland het die wêreld se grootste voorraad kimberliet) misgeloop en ook die geleentheid om met van die wêreld se voorste natuurwetenskaplikes te meng. „Hulle het veral die geleentheid misgeloop om die diamantmyne te besigtig."

Die konferensie het gisteroggend begin nadat die 177 natuurwetenskaplikes reeds verlede week die kiberliet-afsettinge en diamantmyne in die Karoo besoek het.

Die belangrikheid van die konferensie is gisteroggend in sy openingsrede deur dr. Koornhof beklemtoon toe hy gesê het die samesyn van die natuurwetenskaplikes kan dalk lei tot die verklaring van 'n geheim wat naorsers in Suid-Afrika al lank probeer ontrafel, naamlik hoe die diamant gevorm is wat buite die kimberlietpype gevind word.

Dr. Koornhof het gesê diamante sal 'n steeds belangriker rol speel, hoofsaaklik vanwee die veiligheid wat dit in tye van politieke en monetêre onstabiliteit verskaf.

Dr. Koornhof het gesê dat die Regering sy hulp aan programme vir geologiese navorsing uitbrei en dat Suid-Afrika „meer as net gewillig is" om die kennis wat opgedoen word met ander lande te deel, „omdat dit 'n saak van meer as net nasionale belang is dat die mens in die volgende eeu en daarna in sy minerale benodigdhede moet kan voorsien."

Science Editor

A THREE-WEEK conference at which most available knowledge of the earth's interior will be pooled has brought to South Africa a large number of the world's leading scientists representing 20 countries.

The talks will be on kimberlites — blue-green volcanic rocks, primary source of diamonds, which were shot upwards from at least 100km below the surface towards the earth's crust at the speed of sound in the distant past.

"They brought with them chunks of the earth's mantle, the region between the crust and the core, and are the only direct clue we have of the nature of the mantle," Professor Louis H Ahrens, professor of geochemistry at the University of Cape Town, and conference chairman, told me in Johannesburg.

"The Americans and Russians have tried to drill through the crust in an attempt to sample the upper mantle but have failed.

"There are hundreds of these kimberlite pipes or fissures in Southern Africa. In fact, these rocks are most frequently encountered in this part of the world and in Siberia.

"It is therefore a pity that the 10 Russian scientists who were to attend the conference were prohibited from coming here by their Government. The same applies to the Czechoslovak contingent."

Professor Ahrens said South Africa would benefit tremendously by the presence of so many top scientists—geologists, physicists, chemists, mineralogists, geochemists and geophysicists.

They would lecture to academic audiences but might have a significant long-term effect on the mineral industry, which was heavily supporting the conference.

THREE VENUES

The meetings would be held in three phases — a week in Kimberley this week, and a week in each of Cape Town and Lesotho.

Sponsors are the International Association of Geochemistry and Cosmochemistry (of which Professor Ahrens is president), the Inter-Union Commission on Geodynamics, the CSIR, the Geological Society of South Africa, and the University of Cape Town.

The proceedings are to be published in "Physics and Chemistry of the Earth, Volume 9," which Professor Ahrens edits. Volume 10 will be on moon studies.

Professor Ahrens is one of the principal investigators, and the only one in South Africa, of NASA in the moon project. Following this undertaking, said Professor Ahrens, the greatest global scientific project had become the interior of the earth.

DON'T LOSE

DIE eerste Internasionale Konferensie oor Kimberliet het gisteroggend in Kaapstad begin. Die 177 natuurwetenskaplikes by die konferensie koester hoë verwagtinge oor die belangrike wetenskaplike byeenkoms. Die konferensie is gisteroggend deur dr. P. G. J. Koornhof, Minister van Mynwese, geopen. Op die foto staan v.l.n.r. dr. C. v. d. M. Brink, voorsitter van die W.N.N.R., dr. Koornhof, prof. M. F. Kaplan, waarnemende Rektor van die Universiteit van Kaapstad, en prof. L. H. Ahrens, voorsitter van die konferensie.

Restrictions on Russian and Indian scientists

Restrictions on scientists

From Mr BOB STEYN, Information Officer, UCT Development Office (Orange Street, Cape Town):

THE *Cape Times* (August 13) carries a headline: "Scientists to boycott SA."

This gives the impression that the Russian and Indian scientists referred to in the report have chosen to stay away from the international conference on kimberlite taking place at the University of Cape Town at the end of next month.

In fact, as the report accompanying the headline clearly shows, these scientists are keen to attend the conference but appear to be prevented by their governments.

This is precisely the message which Prof. Louis Ahrens, head of the University of Cape Town's Geochemistry Department, was trying to convey in the interview on which the report is based and which the headline tends to obscure.

As president of the International Association of Geochemistry and Cosmochemistry, an affiliate of the International Council of Scientific Unions, Professor Ahrens is deeply concerned about political restrictions placed upon the free movement of scientists. The very fact that he, as a South African, was elected president of this international body is an indication of the impartial approach of scientists in different parts of the world.

Professor Ahrens has asked me to say that he feels so strongly about the free movement of scientists and the free exchange of scientific knowledge that he would have resigned as conference chairman had our own Government placed restrictions in the way of scientists from other countries wishing to attend the conference.

In this instance, however, the South African Government has offered every co-operation. Already scientists from 20 countries have registered for the conference and further registrations are expected.

THE STAR JOHANNESBURG WEDNESDAY SEPTEMBER 26 1973

RUSSIAN SCIENCE BAN REGRETTED

Own Correspondent

CAPE TOWN — The Russian Government's refusal to allow 10 Russian scientists to come to South Africa for the international conference on kimberlite, now being held at the University of Cape Town, has disappointed many of the delegates from 20 countries attending the discussions.

The conference chairman, Professor L. H Ahrens of the University of Cape Town, said the conference had been weakened by the absence of scientists from Russia, where extensive research on kimberlite was being done.

Russia and South Africa, in fact, had the world's largest occurrence of this diamond-bearing volcanic rock used in studies of the earth's interior.

It had been expected, therefore, that the Russian scientists would have made a strong contribution to the discussions.

During the conference proceedings so far, the findings of Russian research workers have been quoted frequently by speakers from other countries.

India has also refused to allow a delegation of that country to attend the talks, aimed at pooling all available knowledge of the interior of the earth obtained from kimberlite studies.

The Russian Government's action apparently resulted in the withdrawal of a delegate from Czechoslovakia who was to have attended the conference.

REPORTED

Professor Ahrens said representations were likely to be made to the governments concerned about their refusal to allow free movement of scientists.

The matter had been reported to a special subcommittee of the International Council of Scientific Unions.

Professor Ahrens said Russia would probably lose more by the absence of its scientists from the conference than the rest of the delegates would lose. It meant that Russian scientists were being deprived of first-hand knowledge of the latest research in other parts of the world.

They had also lost an opportunity to visit South African diamond mines and to view kimberlite deposits here.

DIÉ RUSSE WELKOM IN S.A., DOG BESOEK AFGESTEL

PROF. AHRENS

REËLINGS is ná 'n jaar afgestel vir die koms van 'n groep Russiese en Indiese wetenskaplikes na 'n internasionale natuurwetenskaplike konferensie aanstaande maand in Suid-Afrika. Die Russe het die uitnodiging 'n jaar gelede geesdriftig aanvaar, maar nou finaal laat weet dat hulle deur die Russiese regering verbied is om dit by te woon.

„Die Regering het sy toestemming verleen en aanvoerde om visums kon by die Suid-Afrikaanse ambassade in Londen ingedien word," het prof. Louis H. Ahrens, hoof van die departement van geochemie van die Universiteit van Kaapstad, gister gesê.

„Ek het reeds in Maart geweet dat hulle die konferensie nie meer sou bywoon nie. Dit is stil gehou aangesien die Internasionale Raad van Wetenskapsverenigings druk op die Russiese regering probeer uitoefen het. Hoewel ek nie seker is of die Indiërs soortgelyke probleme van hul regering ondervind het, het ek pas aan die voorsitter van die Indiese Akademie van Wetenskappe geskryf. Dit sal hulle in staat stel om moontlik vroegtydig vertoë tot hul regering te rig."

Prof. Ahrens is voorsitter van die Internasionale Raad van Geochemie en Kosmochemie. Hy is baie nou geskakel by die besoek van die Russe en die Indiërs en die ander sowat tweehonderd natuurwetenskaplikes wat die konferensie oor kimberliet of blougrond sal bywoon.

„Die Russe was besonder geesdrigtig, en persoonlik is ek seker dat hulle as natuurwetenskaplikes baie teleurgestel is. Die konferensie sal van groot wetenskaplike waarde wees en die Russe se afwesigheid sal dit verswak. Sibirië en Suid-Afrika het die grootste dagsone kimberliet. Dié stof bevat waardevolle inligtinge oor die aarde se binnekant en is 'n prinsipre bron van diamante."

Die Internasionale Raad van Wetenskapsverenigings het 'n paar jaar gelede strenge maatreëls neergelê waarvolgens natuurwetenskaplikes van alle lande vryelik idee kan uitruil en mekaar kan besoek. Die Russiese regering se weiering van verlof aan sy natuurwetenskaplikes om na Suid-Afrika te reis, is by die Internasionale Raad van Wetenskapsverenigings aanhangig gemaak. Dié liggaam nader dan die betrokke nasionale instansies, wat op húl beurt druk op die regering uitoefen.

Prof. Ahrens kon nie sê hoeveel Russe die konferensie sou bywoon nie. Nie meer as ses Indiërs sou Suid-Afrika besoek het nie. Hulle ondervind ook geldelike probleme en hoewel twee nog probeer om toestemming te verkry, is hul kanse nie baie rooskleurig nie, het hy gesê.

Die konferensie duur drie weke en die afgevaardigdes sal eers kimberlietmonsters in die binneland versamel. Hulle sal 'n week by die Universiteit van Kaapstad deurbring, waar referate gelewer sal word. Die konferensie word deur vyf instansies, waaronder die W.N.N.R., gehorg.

The Argus, 3/10/1973

PROFESSOR INVITED BY LESOTHO

IN spite of the strained relationship between South Africa and Lesotho, one prominent South African was invited to attend Lesotho's Independence Day celebrations in Maseru earlier this month. He was Professor Louis Ahrens, Professor of Geochemistry at the University of Cape Town and head of the university's lunar research unit.

Professor Ahrens has just arrived back from Lesotho, where he was attending the third phase of the International Conference on Kimberlites.

He was chairman of the conference. He said the conference, held over three weeks in Kimberley, at UCT and in Lesotho, had drawn to this country probably a greater concentration of top world scientists than ever before.

The interest taken by Lesotho in the conference could be gauged from the fact that a social function Maseru last week at which he had been host on behalf of the conference, had been attended by Lesotho's Prime Minister, Chief Leabua Jonathan, the Speaker of the House, three Cabinet Ministers and the Chief Justice, among others.

BRIDGING BARRIERS

He said: 'As a result of this gathering, I stayed on in Maseru to attend the Independence Day celebrations. I think that the fact that I, as a South African passport holder, was accepted in this way, is an example of the way in which science can bridge international barriers.

'I saw a report over the weekend that Lesotho's Minister of Finance and Acting Minister of Foreign Affairs, Mr E. R. S. Sekhonyana, has said that Lesotho deliberately did not invite South Africa to the celebrations following the remarks made about Chief Leabua Jonathan by the Prime Minister, Mr John Vorster. Yet I was able to attend the celebrations, and 30 or 40 South Africans were among the conference delegates at the social function attended by Chief Jonathan.'

Professor Ahrens said the conference had been so successful that he was engaged with other scientists in organising another international Kimberlite conference in three years' time.

The practical benefits for mining in general which would flow from the conference would be great, thanks to the exchange of ideas by scientists from 20 countries besides South Africa.

The Cape Times, Monday, August 13, 1973 11

Scientists to boycott SA

TEN Russian scientists who a year ago enthusiastically accepted invitations to attend a top-level international scientific conference in South Africa next month have, it is understood, been told by their Government to inform the organizers that they are no longer free to come.

One of them, who was so keen to come that he wrote asking whether three more Russian scientists could be included, has now written to say that he is going instead on a research expedition in Siberia.

A Czech scientist, who was to have read an important paper at the conference, wrote in the past fortnight to say that he could not come because the Russians could not.

The withdrawal from the conference by delegates from the Soviet bloc has been reported to the International Council of Scientific Unions, which will take up the matter with the national scientific bodies concerned which, in turn, will be expected to approach their governments about the matter.

The International Council of Scientific Unions laid down strict rules some years ago providing for the free circulation and association of scientists.

INDIANS

Now it also looks as if the six Indian delegates, including the deputy director-general of Geological Survey for Southern India, are having similar difficulties with their government, although it appears no final decision has been made in their case.

The information about the withdrawals from the conference on kimberlite — which will include field trips in the Kimberley area, formal sessions at the University of Cape Town and further field excursions in Lesotho — was disclosed at the weekend by Prof Louis Ahrens, president of the International Association for Geochemistry and Cosmochemistry and head of the Geochemistry Department at UCT.

Professor Ahrends said: "We are dismayed at this violation of the ICSU rules. The South African Government, by contrast, agreed to operate according to these rules."

Kimberlite Conference Held In South Africa

During September 23-30 more than 200 geologists from around the world assembled at Cape Town, Republic of South Africa, to discuss research on kimberlite, the rock prized for its content of diamonds. Drs. Yoder, Boyd, and Eggler of the Geophysical Laboratory and Dr. Shimizu of the Department of Terrestrial Magnetism presented papers on new work and took an active part in the discussions. Professor L.H. Ahrens was chairman o[f] this First International Conference o[n] Kimberlites and Dr. John Gurney wa[s] chairman of the Organizing Committee. Alumni of the Carnegie Institution als[o] played key roles in the conference, especially Dr. A.J. Erland (Fellow, DTM 1968-1969) of the University of Cap[e]

Before the conference, field trips we[re] conducted by Dr. J.B. Hawthorne to th[e] famous diamond-bearing pipes, and som[e] of the barren ones, exposed by minin[g] outside Pretoria and in the Kimberle[y] area. Although many raw diamonds we[re] made available for examination at th[e] Central Sorting Office, the greatest inte[r]est was in the nodules believed to be sam[]ples from the mantle, carried up in th[e] kimberlite magma. It was an unusual op[]portunity for the geologists to collect a[s] much of this material as they wanted, an[d] many of them shipped crates of the rock back home for later study. The minin[g] companies cooperated with the confe[r]ence in every way, opening their prope[r]ties for inspection and taking special car[e] to protect the eager collectors. Their ge[n]erous support will no doubt be rewarde[d] by the flow of data which will result fro[m] study of the samples collected.

After the conference Dr. Peter Nixo[n] organized another field expedition o[f] about 80 geologists to the rugged Malu[ti] Mountains of Lesotho to look at som[e] dozen kimberlite pipes at two minin[g] camps. There they found kimberlites wit[h] ultramafic inclusions from deeper withi[n] the earth than any they had examine[d] before.

THE STAR JOHANNESBURG TUESDAY SEPTEMBER 25 1973

'Willing to share our knowledge'

CAPE TOWN — South Africa is more than willing to share with other countries the facilities and technical knowledge that it was building up, the Minister of Mines, Dr P G J Koornhof, told scientists from 20 countries at the University of Cape Town yesterday.

"It is a matter of more than national importance that man should be able to provide in his mineral requirements during the next century and beyond," he said.

Dr Koornhof was speaking at the official opening of a five-day international conference on Kimberlites, a diamond-bearing rock from the interior of the earth. The study of kimberlites is providing new knowledge about certain aspects of the earth's structure.

The conference is being held under the chairmanship of Professor Louis Ahrens of the University of Cape Town, who is president of the International Association of Geochemistry and Cosmochemistry, one of five organisations sponsoring the discussions.

Of 189 scientists attending the conference, 38 are from the United States, 20 from Britain and three from Japan. In addition there are 96 delegates representing seven African countries, including South Africa.

Among the delegates are Space Agency research scientists from the United States and other countries, who, like Professor Ahrens, have been working on lunar samples.

Dr Koornhof said many of the delegates had contributed in one way or another to the Upper Mantle project — an internationally co-ordinated five-year research effort to investigate all aspects of the Upper Mantle of the earth from about 33km to 300km below the earth's surface.

This programme had resulted in the re-investigation of kimberlites.

New evidence about age of earth

THE EARTH might be older than 4 500-million years, as believed by scientists until now, Professor L. H. Ahrens of the University of Cape Town told the international conference on kimberlites in Cape Town.

This, he said, was indicated by a re-interpretation of some of the scientific information available about the earth.

Addressing scientists from 20 countries at the conclusion of the Cape Town session of the conference, Professor Ahrens, the conference chairman, also speculated on the causes of a tremendous impact believed to have rocked the earth more than 2 600 million years ago — about the time life began on the earth.

MINERALS

The 'convulsion' that shook the earth resulted in the formation of minerals, rocks, mountains and other phenomena.

Professor Ahrens said one possibility was that the earth might have been hit by giant meteorites from space.

This idea came from the fact that the moon had been struck by enormous objects, particularly in its early history.

Another more remote possibility was that the core of the earth underwent some vital change affecting the earth's surface.

PRIMITIVE

Professor Ahrens said one of the best examples of the most primitive form of life, which existed 2 680 million years ago, had been found in fossilised form in Rhodesia.

The 'convulsion' of the earth took place about that time.

A connection between that great upheaval and the start of life on earth could not be ruled out, Professor Ahrens said.

Delegates to the kimberlite conference left for Lesotho at the weekend for the third phase of their conference.

Argus, Tues 25 Sept., 73.

6

Quakes will be predicted — professor

ACCURATE predictions of when and where earthquakes will occur are likely to be among the big scientific advances of the next few decades, according to a Japanese scientist now visiting South Africa.

Professor S. Akimoto, a geophysicist of the University of Tokyo, said in an interview in Cape Town last night that he expected a reliable method for such predictions would be developed within the next 20 years.

He is one of 189 scientists from 20 countries attending the five-day international conference on kimberlites at the University of Cape Town.

Professor Akimoto said much progress was being made with earthquake research. Successful predictions had already been made by Japanese scientists. Similar research was being done by scientists in other parts of the world.

PREDICTIONS

Recent earthquakes that struck the city of Nemuro in the northern region of Japan had been predicted a month earlier by Professor T. Rikitake of the Earthquake Research Institute of the University of Tokyo.

This prediction, however, had not given the exact date or time of the earthquakes, but had merely pointed to the early possibility of earthquakes in that region.

Methods used at present in attempts to make such predictions included the use of a lasar beam to study certain horizontal movements of the earth's crust and the use of other sophisticated scientific devices to study conditions in the earth.

BOLAND ZONE

Professor Akimoto had good news for the people of the Boland's earthquake-stricken towns. He said he did not believe any part of South Africa would ever be struck by a regular succession of catastrophic earthquakes, at least not for the next 10 million years.

South Africa, he said, was not in an earthquake zone and, therefore, had nothing to fear. In fact, the whole of Africa was a 'stable area' and was unlikely to develop into an 'unstable' area for the next 10-million to 100-million years.

Professor Akimoto said that Japan, which was in an 'unstable' area, experienced earth tremors every day, relatively small earthquakes every year and at least one disastrous earthquake every five or ten years.

Professor Akimoto, who specialises in high-pressure physics and studies conditions in the interior of the earth, will present a paper at the kimberlite conference.

Left her in the altogether

The Argus Bureau

LONDON. — A former fashion writer on The Argus, Vera Beljakova, fell victim to a sneak thief in a Chelsea boutique — and was left standing in only a pair of black lace panties and a string of pearls.

She arrived in a chic French skirt and blouse which were promptly stolen while she was trying on a suit in the shop in the King's Road.

Miss Beljakova's answer to the problem: She put on a nightdress she had bought earlier and made a dash for the street to hail a taxi.

She said: 'After trying on a suit I handed it back to an assistant. Then I looked for my clothes and they were gone.

'I was thoroughly embarrassed. I asked the manageress if I could borrow something to go home in, but I was told I would have to buy something.

'I was stuck in the cubicle, draping myself with a curtain, when I realised I couldn't stay there all night.'

Then came the dash for the taxi that had heads turning in Chelsea.

But Miss Beljakova's troubles were not over. A Chelsea councillor, Mr John Butcher, who lives opposite the boutique, heard of her misfortune and offered to console her by taking her to dinner at London's famous West End gaming club, Crockfords.

They left the club early this morning to find Mr Butcher's car had been stolen.

Miss Vera Beljakova

New mineral link with moon

A NEW mineral discovered on the moon as well as on the earth — in South Africa — was described today by a South African-born scientist, Dr S. E. Haggerty, of the Geology Department of the University of Massachusetts.

First details of the earth discovery, which may have some significance in studies of the evolution of the moon and earth, were made public in a paper presented by Dr Haggerty to the international conference on kimberlites, now being held at the University of Cape Town.

Dr Haggerty, formerly of Germiston in the Transvaal, is a principal investigator of the lunar sample analysis programme of the National Aeronautics and Space Administration (NASA) in the United States.

He said in an interview the first known occurrence on the earth of the moon mineral, named armalcolite, was found in rock from a diamond pipe at Dutoitspan in the Kimberley area.

Armalcolite, named after American astronauts Armstrong, Aldwin and Collins, is one of three new minerals discovered on the moon on the Apollo 11 flight.

It was found in great abundance on the moon at Taurus Littrow, the landing site of Apollo 17.

Dr Haggerty said apart from some slight differences the moon and earth samples of the mineral were similar in composition and structure, both containing the elements magnesium, iron, titanium and oxygen.

The earth sample of armalcolite was identified for the first time earlier this year. It was part of a consignment of material from South Africa sent to the mineral laboratory at the Carnegie Institute in Washington.

Dr Haggerty said experiments were now being carried out to determine what temperature and oxygen conditions were necessary for the mineral to form and to decompose.

"The fact that we have found diamond-bearing pipes suggests armalcolite on the earth, as the possibility that armalcolite on the moon may well have been generated at relatively high pressures."

Dr Haggerty said rocks from the two Apollo sites on the moon where armalcolite was found had the highest titanium content of any known rocks. The occurrence there of armalcolite, which had titanium as a major element, was therefore not surprising.

Other moon minerals had also been found to be similar to certain earth minerals.

"It would seem from studies that the moon and the earth evolved in a similar way, but this is a very generalised statement," Dr Haggerty said.

THE STAR JOHANNESBURG FRIDAY OCTOBER 19 1973

Dr S. E. Haggerty

Kalulu

THE STAR JOHANNESBURG WEDNESDAY SEPTEMBER 19 1973

ROCK SCIENTISTS GET TOGETHER

Science Editor

A THREE-WEEK conference at which most available knowledge of the earth's interior will be pooled has brought to South Africa a large number of the world's leading scientists representing 20 countries.

The talks will be on kimberlites — blue-green volcanic rocks, primary source of diamonds, which were shot upwards from at least 100km below the surface towards the earth's crust at the speed of sound in the distant past.

"They brought with them chunks of the earth's mantle, the region between the crust and the core, and are the only direct clue we have of the nature of the mantle," Professor Louis H Ahrens, professor of geochemistry at the University of Cape Town, and conference chairman, told me in Johannesburg.

"The Americans and Russians have tried to drill through the crust in an attempt to sample the upper mantle but have failed.

"There are hundreds of these kimberlite pipes or fissures in Southern Africa. In fact, these rocks are most frequently encountered in this part of the world and in Siberia.

"It is therefore a pity that the 10 Russian scientists who were to attend the conference were prohibited from coming here by their Government. The same applies to the Czechoslovak contingent."

Professor Ahrens said South Africa would benefit tremendously by the presence of so many top scientists—geologists, physicists, chemists, mineralogists, geochemists and geophysicists.

They would lecture to academic audiences but might have a significant long-term effect on the mineral industry, which was heavily supporting the conference.

THREE VENUES

The meetings would be held in three phases — a week in Kimberley this week, and a week in each of Cape Town and Lesotho.

Sponsors are the International Association of Geochemistry and Cosmochemistry (of which Professor Ahrens is president), the Inter-Union Commission on Geodynamics, the CSIR, the Geological Society of South Africa, and the University of Cape Town.

The proceedings are to be published in "Physics and Chemistry of the Earth, Volume 9," which Professor Ahrens edits. Volume 10 will be on moon studies.

Professor Ahrens is one of the principal investigators, and the only one in South Africa, of NASA in the moon project. Following this undertaking, said Professor Ahrens, the greatest global scientific project had become the interior of the earth.

MINERAAL VAN MAAN IN S.A.

'N MINERAAL, wat in 1969 deur die ruimtemanne van Apollo 11 op die maan ontdek is, is ook in 'n diamantdraende kimberlietpyp by Dutoitspan gevind. Dit is die eerste keer dat die mineraal op die aarde gevind word, en dit word as 'n opwindende geologiese vonds beskou.

Die mineraal, armalcoliet, is vorentlig deur 'n Suid-Afrikaanse natuurwetenskaplike gevind wat nou 'n sabbatsjaar-gedwaar aan die Universiteit van Massachusetts is.

Die geleerde, dr. Stephen E. Haggarty, het ook twee ander nuwe minerale in monsters uit Suider-Afrika ontdek — een in 'n monster uit Lesotho en die ander in 'n monster uit 'n diamantmyn by Kimberley.

Die ontdekking van armalcoliet is gister by die internasionale simposium oor kimberliet by die Universiteit van Kaapstad bekend gemaak. Dr. Haggerty is een van die nuwe tweehonderd natuurwetenskaplikes wat aan die simposium deelneem.

SEE VAN RUS

Nadat hy sy ontdekkings aan die simposium bekend gemaak het, het dr. Haggerty, wat in 1938 op Benoni gebore is en Suid-Afrika in 1959 verlaat het, in 'n onderhoud gesê armalcoliet is nog net op drie plekke gevind: in die maan se See van Rus, in die Taurus-Littrow-gebied van die maan en by Dutoitspan.

Die mineraal is na die drie ruimtemanne van die Apollo 11-sending genoem: ARM-strong, Al-drin en COL-lins.

By het gister gesê dit is eiesoortig dat die mineraal nog nie vroeër op die aarde ontdek is nie.

Dr. Haggerty se ontdekking het gister opgevaak by die simposium gewek. Een van die geleerdes, prof. L. H. Ahrens, voorsitter van die simposium en hoogleraar in geochemie aan die Universiteit van Kaapstad, het gesê die beteken dat natuurwetenskaplikes weer sal moet dink oor hulle van hul teorieë oor die samestelling van die aarde.

Dr. Haggerty, wie se ouers in Durban woon, het gister gesê by het nie die armalcoliet-monsterlik onder die mikroskoop bekyk nie, maar by het geweet dit is iets wat hy vir die eerste keer sien.

„Ek was baie opgewonde, maar ek het niks gesê nie. Sowat ses

+ VERVOLG OP BL. TWEE +

First 'moon' rock found in OFS

MOON ROCK MATERIAL has been found on Earth for the first time. The find — reported to the International Kimberlite Symposium in Cape Town yesterday — was made at Dutoitspan, near Kimberley.

The material found is the lunar mineral armalcolite, first brought back to Earth from the Sea of Tranquillity by the Apollo 2 expedition of Armstrong, Aldrin and Collins, after whom it is named.

Armalcolite was also found in the Taurus Littrow region of the moon by Apollo 17 astronauts Schmitt and Cernan.

The Dutoitspan armalcolite — the first lunar mineral to be found on earth — was found by Dr S. A. Haggerty, a South African-born scientist now working at the University of Massachusetts.

Dr Haggerty is also a principal investigator of lunar material for the National Aeronautics and Space Administration.

Dr Haggerty said yesterday that the mineral had been found in diamond-bearing kimberlite.

"We had no idea that anything like this would be found. It was discovered quite by chance, and when it was first examined it was not recognized for what it was.

"I would not suggest, however, that there are diamonds on the moon simply because this mineral was found in diamond-bearing ground.

"Armalcolite, which consists of iron, magnesium, titanium and oxygen, is found on the moon because of the very low oxygen level. Two other moon minerals — tranquillitite and pyrox ferroite — have not yet been found on earth.

"Tranquillitite contains titanium, zircon, yttrium and silicon, while the other mineral contains iron and silicon."

The rock where the armalcolite was found near Kimberley is estimated to be between 30 and 40 million years old.

Lesotho Field Trip

LESOTHO'S MINISTER of Education, Health and Social Welfare, Mr C. D. Molapo, told about 100 international scientists here yesterday that Lesotho hoped that their exploration of Kimberlite localities during field trips in the Maluti Mountains during the next week would directly or indirectly lead to the discovery of more Kimberlite and hopefully more diamonds in Lesotho.

He was inaugurating the Lesotho section of the International Kimberlite Conference which started here yesterday.

The scientists begin field trips into the Maluti mountains today to explore Kimberlite localities and to collect rock specimens.

Mr Molapo said Lesotho had great hopes that a diamond mine would be established at Leteng-La-Terai diamond area and added that this was more likely to come about through the research that the scientists would carry out both in their field trips and in the laboratories.

Mr Malhotra said Lesotho hoped that the deliberations of the conference and visit of so many eminent geologists to Lesotho would lead to the discovery of many more economic diamond-bearing Kimberlite so that Lesotho might have a larger production of diamonds.

The Lesotho Ministry of Posts and Telecommunications yesterday issued four special postage stamps to commemorate the holding of the conference in Lesotho.—SAPA.

ASSISTANCE

Welcoming delegates, Lesotho's Commissioner of Mines and Geology, Mr T. B. Malhotra, said the primary objective of any mining or geological conference of this nature should be to assist in the development of the mineral resources of a country.

He added that mining was a very important development, too, because of the economic activities it attracted once the mineral deposit had been discovered.

Garnet Websterite from Matsoku

Lesotho hopes for further diamond finds

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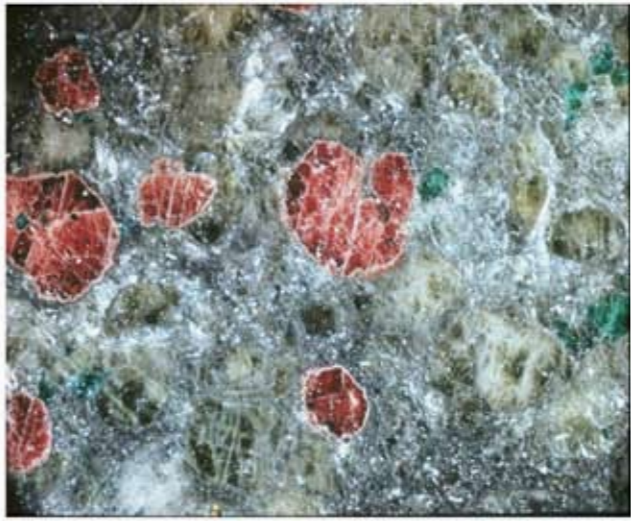
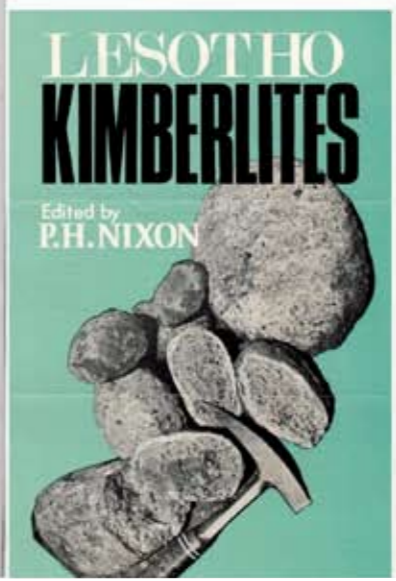


Garnet Lherzolite from Matsoku

THE International Kimberlite Conference, held in South Africa and Lesotho over the last three weeks, ended today. Both countries have issued special covers to commemorate the conference. Philatelists may obtain the Lesotho first-day cover from the Ministry of Posts and Telecommunications in Maseru, and the South African commemorative cover, which features the University of Cape Town badge, from the Post Office.



Special Report March 1974

First Kimberlite Conference, Republic of South Africa

Ian D. MacGregor, Department of California, Davis, California

The First International Conference on Kimberlites was convened in the Republic of South Africa from September 17 to October 8, 1973. The program was divided into two sessions of field trips, one in the vicinity of Kimberley and the other in Lesotho, and a session of prepared papers and discussions in Cape Town. Approximately 190 scientists from 20 countries attended the sessions, in which 81 papers were delivered. The conference was sponsored by the International Association for Geochemistry and Cosmochemistry, the Geological Society of South Africa, the Council for Industrial and Scientific Research, and the University of Cape Town.

The field excursions were very well organized. Visits to all of the most important kimberlite pipes enabled us to collect from the full range of the kimberlite suite. The first field trip started in the Pretoria area with visits to the National, Schuller, Montrose, and Premier kimberlite pipes. We then went to Kimberley for six days of examining kimberlite pipes and collecting samples that make up the kimberlite suite. Underground visits to the De Beers, Wesselton, and Dutiotspan mines allowed us to examine in detail the nature, structural relations, and mechanisms of kimberlite intrusion. Trips were also organised to the Kimberley, Kamfersdam, Koffyfontein, Ebenhaezer, Klipfontein, Bellsbank, Frank Smith, Newlands, Roberts Victor, and Loxtondal kimberlite pipes, as well as to the Benfontein sill. At each locality, we examined the local geology and scoured the dumps and heavy concentrate piles for samples of kimberlite and rock of inclusion sites.

A visit to the DeBeers Central Sorting Office gave us an interesting insight on the problems of sorting and grading diamonds. The accumulation of wealth evidenced by all the mining activity gave us perspective on the special role that diamonds play in the aesthetic and industrial organization of our culture.

In Lesotho we were able to visit localities in the western low lands and pipes in the northeast highlands. On the way home we visited Monastery mine in the Orange Free State. The incredible complex of pipes, blows, dykes, and complex interacting intrusions afforded excellent insights of the geology of kimberlite intrusions and the complex petrology of the magmas. The most abundant and freshest supply of mantle-derived xenoliths were in the smallest pipes. Our courteous and generous hosts were very flexible and allowed deviations from the program so that the conferees could spend time at localities particularly suited to their interests.

Those of us who survived the endurance test of the field trips, suffered the pains of treks by foot or on Basutoland ponies, and feel that we have earned a place to study kimberlites can only thank our organizers for this confidence. Our special thanks go to B. Hawthorne and his team of DeBeers and Anglo-American geologists in the Kimberley area, and to P. Nixon and his staff in Lesotho.

Between field trips, we journeyed to Cape Town for a week of formal papers and discussions on the current status of kimberlite geology. As with kimberlite magma, the topics were varied, we began by examining the general geology of a kimberlite pipe. In the South African Shield, there are some broad generalizations concerning the distribution of kimberlite. Sediment-filled pipes are generally found northwest of a line trending northeast of the center of Botswana. Similarly, it was noted that diamond-bearing kimberlite dies out from east to west, and the proportion of melilite basalt and other alkali and carbonatitic magmas increases. The regional variations parallel the concentric zonation of a central core of diamond passing to pyrope subfacies kimberlite through picrate, carbonatite, and alkaline-ultramafic magmas at the margins of regional occurrences, suggested by Russian authors, and point to a deep-seated control of their distribution.

More specific descriptions of kimberlite or associated rock-type provinces included discussions on the Bushmanland, Namaqualand, and South West Africa areas in South Africa, the American continent, Greenland and Norway, and in extrusive equivalent in Tanzania. The association of kimberlite with monticellite peridotite, olivine melilite, and carbonatite magmas, may provide an important key to understanding the kimberlite magmatic associations. J. Ferguson and his colleagues suggested a primary kimberlite magma fractionating in magma chambers of successively shallower depths to give melilite, carbonatite, and monticellite peridotite. Experimental evidence by H. S. Yoder would seem to confirm this opinion.

Also discussed was the petrology of kimberlite, leading to a description of a complex phenomenon, coupling origin at depth with intrusion mechanisms to the surface, that defies simple definition. A new approach was offered by the study of Danchin and others of autoliths that represent successive stages of a kimberlite magma concentrically precipitating on a mineral or rock nucleus; this allows the examination of the evolution of the kimberlite during its fractionation and cooling. Their study indicated that olivine fractionation is the primary process, paralleling a conclusion by A. E. Moore for the Namaqualand and nephelinite and melilite association. Textural evidence for immiscible carbonatitic and potassium-rich silicate liquids (Clements) indicates a further portion of the history of a kimberlite, yet contrasts with the obviously later vein-filling calcite and points to the complex cooling of these enigmatic magmas. A stepchild of kimberlite petrology has finally been adopted – S. E. Haggerty described the wide variety of opaque phases extant in these rocks. It is apparent that the sensitivity of the oxide and sulphide phase chemistry to the composition of the gas phase will allow the use of textural evidence as a base for monitoring this critical component of a kimberlite magma. As a start, Clark and Mitchell observed late stage zoning of oxide and silicate minerals that indicate concentration of TiO_2 and CO_2 in the final liquid. Despite the problem of contamination by foreign inclusions and the processes of secondary alteration, kimberlite geochemistry shows some interesting systematics. Relations between the refractory elements Ti, Zr, Hf, Ta and Nb are systematic from mine to mine and suggest kimberlite evolves from basaltic to micaceous types. A similar trend is shown by the rare earth metal patterns. Zr/Hf and Ti/Nb/Ta ratios show interesting similarities from mine to mine and suggest a uniform source region or possibly indicate that the elements are not fractionated during the process of kimberlite fractionation. A courageous study by Barrett and Alsopp showed that the isotopic chemistry of Rb and Sr of kimberlite micas could be used to date the time of intrusion of different kimberlites. Small differences of calculated ages of mica in different textural locations hint at further useful studies. A number of studies showed that fresh kimberlite has mantle-type Sr^{87}/Sr^{86} initial ratios and values comparable to those found in carbonatite and autoliths. The stable isotopes of C, O, and H point to the importance of meteoric water contamination. However, systematic difference between micaceous and serpentine-rich kimberlites, and the variation in the deep-seated D/H ratios point to the problem of making single variable conclusions from the group of isotopes. In general, the geochemical studies point more to interesting areas of future research and emphasize the need for carefully controlled studies of carefully collected samples.

Inclusions of crystal – and mantle-derived wall rocks and minerals are an integral and characteristic component of kimberlite. The mantle-derived samples were the basis for considerable discussion on the nature of the upper mantle and the processes responsible for kimberlite genesis in the source region. Of particular interest were diamonds. Harris and others described classification schemes based on morphology, color, and size, which can be used to distinguish suites of diamonds from different localities. Inclusions in the diamonds had chemistries which generally correlated with the two groups of mantle xenoliths - eclogite and ultramafic rocks. Only rarely is more than one mineral found in one diamond. Other rare primary phases observed were rutile, ilmenite, magnetite, corundum, pyrrhotite, zircon, kyanite, sanidine, phlogopite, and possibly quartz, while epigenetic phases included muscovite, amphibole, and sulfide. The chemistry of diamonds reflects that of their inclusions. In a number of cases, it was possible to calculate the chemistry of small droplets of trapped silicate melts, giving answers comparable to a picrite possibly high in CO_2 and H_2O, and generally similar to values obtained by mass balance calculations using the bulk chemistry of the ultramafic xenoliths.

Mafic and ultramafic xenoliths formed a major focus of the discussions. The high-pressure phase assemblages for these compositions indicate a source in the mantle and represent the best method for directly examining the petrology of the mantle and the processes of forming kimberlite in its source region. Of special interest in eclogite was the importance of subsolidus reactions, indicating that the rock had once existed at significantly higher temperatures. A study by Harte and Gurney on the complex exsolution of garnet from clinopyroxene gave a good example of the cooling history. Similar evidence of pervasive exsolution in the ultramafic rocks illustrates that the whole mantle xenolith suite formed at higher temperatures and cooled to its final pre-extrusion equilibrium. An understanding of the textures is an important component in understanding the history of the rocks. Boullier and Nicolas offered a rigorous classification scheme to illustrate that textural differences could be related to different degrees of deformation.

Interpretation of phlogopite as primary or secondary also occupied a central theme; Carswell offered a potential chemical solution. Wilshire and Shervais pointed to the importance of textures in trying to distinguish between liquid and solid component in the rocks and in reconstructing geologic history. Studies by F.R Boyd and P. Nixon, and J. Johnson and myself, using experimentally derived geothermometers and geobarometers, concerned determining the temperatures and pressures of the samples prior to extrusion. Sharp distinctions were observed: rocks with granular texture were found to occur at shallower depths than highly sheared rocks; within the granular suite; the degree of deformation generally increased with depth. Similarly, it appeared that "primary" phlogopite occurred only in under formed rocks. Reconstructed temperatures and depths of formation of xenoliths from individual mines fell along simple curvi-linear paths, suggesting the direct mapping of paleogeotherms. The paleogeotherms varied from region to region, generally being shallowest in the Kimberley region and steepening outward towards the continental margins. Of special interest was the observation in a number of localities of a sudden steepening in the interpreted geothermal gradient at the boundary between the sheared and granular rocks. Boyd has previously hypothesized that the increase in slope is a "perturbed" geotherm resulting from frictional heating in the asthenosphere during the breakup of Gondwanaland. The base of the lithosphere was shown to occur at progressively shallower depth as one moved east or west from Kimberley. The regional thinning of the lithosphere parallels other changes, such as the decrease of diamonds in kimberlite and the systematic increase of alkalic basalt and carbonatite over kimberlite from Kimberley westward.

Sheared xenoliths have higher contents of Ti, Cr, and Na and are generally more lherzolotic than granular counterparts. Similarly, the sheared rocks have K/Rb and K/Cs ratios approximately 10^2 to 10^3 higher, and much lower initial Sr^{87}/Sr^{86} ratios (0.7027 to 0.7033 compared with 0.706 to 0.708 for the granular rocks). A group of xenocrysts, discrete nodules consisting of coarse single-phase crystals, described by Boyd and Nixon, have temperatures and pressures of equilibration and chemistries that are essentially identical to the sheared xenoliths. However, the discrete nodules are not sheared and are interpreted as megacrysts precipitating from a rising kimberlitic magma.

An important consideration of mantle petrology is the chemistry of the "parent" material - and the derivative liquids and residue that result from melting and crystallization processes that lead to the formation of the crust mantle system now observed. Systematic variations in the chemistry of the ultramafic xenoliths and interpreted evidence of fractional crystallization in the Matsoku Pipe gave authority to papers that used mass balance calculations to derive estimates of the chemistry of mantle liquids. Liquid composition estimates converging to magmas of picritic or komatite composition are comparable to estimates of liquid inclusions in diamonds.

Experimental data showed the importance of the chemistry of the gas phases. Ultramafic compositions melt at progressively higher temperatures, with an increase of the CO_2/H_2O ratios. CO_2 is significantly less soluble than H_2O in ultramafic liquids, and, unlike H_2O-rich vapor, vapors rich in CO_2 dissolve excess alkalis rather than excess silica.

General papers on the origin of kimberlite were lacking, although a model was presented in which alkalis and H_2O, degassed from the upper mantle and fixed in a stability field of phlogopite and amphibole, contribute to the low-temperature melting of this region, giving rise to kimberlites and other alkali-rich magmas. Anderson and Perkins introduced the concept of local diapiric up rise of mantle material resulting from pressure gradients between regions of reverse flow near the lithosphere-asthenosphere boundary. The diapirs are responsible for the transport of source material for the kimberlite pipes and, although locally appearing as random events, are regionally associated with the major motions of plate tectonics.

This summary brushes over the contributions of many speakers whose papers added color and perspective of the general statements presented here. Documents published as part of the conference include a volume of Extended Abstracts of Papers, and two field trip guides, one for the Kimberley area and one for Lesotho.

It is a pleasure to acknowledge the industry of our convenors, L.H. Ahrens, F.R. Boyd, and J.B. Dawson. Credit for organization efforts of the conference go to Ahrens and his staff at Cape Town University. J.J. Gurney bore the brunt of our problems and managed the circus. The superbly organized field trips were an integral component of the conference; B. Hawthorne and his staff of DeBeers and Anglo-American geologists stood this test in the Kimberley area while P. Nixon and his staff succeeded in Lesotho. Financial contributions from the DeBeers Consolidated Mines, Anglo-American Corporation of South Africa, Council for Scientific and Industrial Research, and University of Cape Town were an essential aid to the meeting. We are grateful to our sponsoring organizations, the International Association of Geochemistry and Cosmochemistry, the Geological Society of South Africa, the Council for Scientific and Industrial Research, and the University of Cape Town.

The conference provided a focus on kimberlite studies for the first time. For the new perspectives and insights that arose, and the stimulus for future cooperation and better conceived experiments, the above individuals and organizations deserve credit and thanks.

Kimberlite conference in Africa May 1974

Nearly 200 delegates from 20 countries gathered September 17th/October 8th in South Africa and Lesotho for the first International Kimberlite Conference. This meeting brought together field geologists occupied with the discovery and development of kimberlites as sources of natural diamonds, and petrologists, geochemists and geophysicists whose interest in kimberlites is primarily theoretical. The explosive eruption of kimberlites in Southern Africa and elsewhere has brought to the surface an extraordinary suite of rocks from the upper mantle and crustal basement. Study of these rocks has already provided many insights into the petrology of the mantle. Nevertheless, the full interpretation of this mantle sample requires that we understand the origin of kimberlite itself. Hence, there was a strong community of interest between the mining geologists and those engaged in research.

A primary aim of the conference was to provide delegates with opportunities to see kimberlite pipes in outcrop and underground and to make extensive collections of kimberlite and kimberlite nodules. Such samples have been rather difficult to obtain in the past and their relative scarcity has inhibited research. This problem should be considerably alleviated by the shipment of 15-20 tons of samples (mostly ultramafic nodules) from South Africa and Lesotho to research laboratories in other countries at the end of the conference.

In addition to individual collections, 2 extremely large lherzolite nodules are being sliced in Cape Town for distribution to interested and qualified research workers for a wide variety of geophysical and geochemical experiments. One of these is a sheared lherzolite, believed to be of very deep origin, from Mothae, and the other is a granular lherzolite from the Bultfontein Floors. (Anyone interested in obtaining a split of these samples should send a resume of the intended project to Anthony J. Erlank, Department of Geochemistry, University of Cape Town. Rondebosch 7700, South Africa.)

The conference opened with a weeklong field trip to the Premier Mine and to a large variety of localities in the Kimberley area. Diamond mining in these areas for the last century has provided fascinating exposures of 'hardebank' kimberlite at depth in the mines and a rich store of nodules on the dumps. Delegates were guests of the De Beers Consolidated Mines during the first field trip and this trip was organised and led by J. Barry Hawthorne, De Beers' chief geologists for the Kimberley area. The organisation of the Kimberley trip can be described only as superb. Delegates were divided, each with well-informed, individual leaders, and these groups were taken in rapid succession to carefully prepared underground sites and surface localities. Most delegates were primarily interested in nodule collecting at such classic localities as the Bultfontein Floors and the Roberts Victor Mine. Nevertheless, exposures of kimberlite with apparent flow structures in the De Beers' mine and at the Benfontein still generated much interest and discussion.

After the Kimberley trip, delegates flew to Cape Town for a week of formal meetings. These meetings were held at the University of Cape Town and were organised by Louis H. Ahrens and his staff at the Department of Geochemistry. (John J. Gurney of this department carried a particularly heavy load as secretary/treasurer of the conference.) Extended abstracts of 90 papers presented at the conference are available (see advertisement on page 42) and the full papers will be published in a proceedings volume that is now in press. These papers cover a wide range of topics related to kimberlite genesis.

Field relations were described for kimberlite occurrences in Greenland, Norway, Canada, and the Rocky Mountain states, Tanzania, West Africa, Bushmanland and the Kimberley area. A few papers described use of the electron probe to study the complex mineralogy, reaction times and autolith structures in the kimberlite groundmass. This promises to be a fertile field for future investigations. A considerable number of trace-element and isotopic studies of bulk samples of kimberlite were also presented. It is interesting to note that structural and textural relations in South African kimberlites have persuaded virtually all the field geologists working with these rocks that the erupting kimberlites contained a liquid phase up to rather shallow levels in the crust before explosive disaggregation by a gas phase.

Many authors provided results of mineralogic, petrographic and trace elements studies on the ultramafic nodules from kimberlites. Particular attention is now being paid to the textures of these rocks as clues to their origin and in the last few years lherzolite that have undergone severe deformations have been recognised as much more abundant as was previously realised. Estimates of the P-T conditions of equilibration of these rocks suggest that the sheared lherzolite come from depths as great as 200 km and are of deeper origin than the granular varieties.

Electron-probe, trace-element and isotopic studies of diamond inclusions continue to be of great interest. Thus far it has not been possible to relate the diamond inclusions to particular types of nodules and thus the origin of natural diamonds remains an enigma. A variety of experimental studies bearing on the melting of garnet peridotite, the role of CO_2 in the mantle, the relations between melilite-bearing rocks and kimberlite, and the olivine-spinel transition provided many intriguing insights.

The climax of the conference was a week-long trip to the Maluti Mountains in northern Lesotho led by Peter H. Nixon and colleagues from the Department of Mines in Maseru. The kimberlite province of northern Lesotho comprises over 200 kimberlite intrusions, 2 of which have undergone preliminary development as diamond mines. Nodules are abundant and are unusually fresh. Delegates were taken over the 10,000 ft Moteng Pass in Land Rovers and lodged at the diamond-mining camos of Kao and Letseng-la-terae. The barren highlands of Lesotho have stark beauty, accentuated by a late-spring snow. Highlights of this trip included a pony trek (for those fortunate enough to get horses) into the Matsoku pipe where nodules comprise 20-30% of the kimberlite and weigh up to half a ton. The Thaba Putsoa pipe was reached by a long hike along a ridge top; here are the highest-temperature mantle rocks thus far discovered.

The impact of this conference on kimberlite research and on the field of mantle petrology promises to be very great. One measure of its success is that during sessions in Cape Town delegates began to refer to the meeting as the First International Kimberlite Conference. Informal plans are being made for a second conference perhaps in the western United States, in about 3 years' time.

Francis R. Boyd

Geophysical Laboratory

Carnegie Institution of Washington

Washington, D.C.

A daunting view of the terrain in the vicinity of Matsoku

Trails on "The Roof of Africa"

Letseng-La-Terae waste dump to the fore, basalt behind

View of the Maletsunyane Falls

About the Course

This three-day course provides a practical overview of all aspects of exploration drilling for practicing geologists and related professionals. The course is interactive and questions and discussions of on-site problems are encouraged. Participants will receive a set of printed course notes and a copy of "The Diamond Drilling Handbook "by Dr W.F. Heinz.

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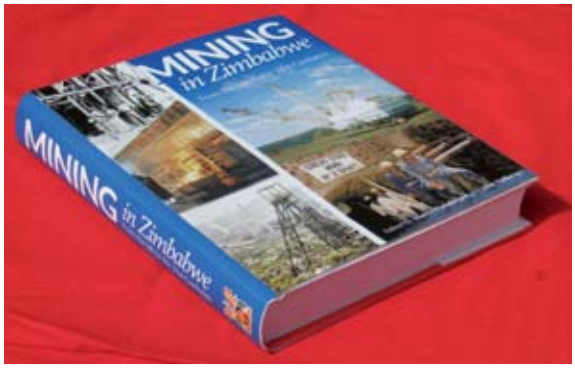
book review

Mining in Zimbabwe: From the 6th to the 21st Centuries
Martin Prendergast and John Hollaway (eds.),
(Harare: Chamber of Mines of Zimbabwe, 2019), xlii, 645 pp. Maps, colour illustrations.
ISBN 978-1-77906-610-7. Hardcover. US$170.00.



Tendai often passed me in the corridor at unexpected times of the day or night, usually very late on weekdays or weekend afternoons, always trying to catch up on an overdue practical assignment or desperately preparing for a supplementary exam. He was great in the field and most practical activities, but his grey cells went walkabout in the exam environment. Anyway, Tendai managed to complete his senior geology courses at UCT after several years but his academic record prevented him from being accepted into Honours. Ultimately he was accepted into an alternative Honours course in Materials Engineering, so he literally crossed the car park between our two departments and laboured over another two years, repeating the odd module on the way. It was in that car park we passed on one late Sunday afternoon, where sporting a pleading look on his face, he requested news of the geological world and expressed a desperate desire to fight back in.

Touched by his predicament and impressed with his resolve, I hired him as a student assistant helping me in undergraduate geology classes and also insisting that he accompany me to academic and professional meetings, in order to rub shoulders with industry personnel. It was during one of those meetings in Cape Town that I introduced him to Roger Tyler, who was looking for Zimbabwean graduates and, as the saying goes, the rest is history. Tendai is now Technical Services Manager for Farvic Consolidated Mines in Gwanda, thanks mainly to the support and mentorship of Roger, now Chief Geologist at Prospect Resources, the Australian based holding company.

Since 2012 starting as a professional geologist in Gwanda, Tendai kept me up to date with his activities and has highlighted the periodic recovery of spectacular free gold specimens worthy of display in museums. Such rich ore is reminiscent of that produced in Gwanda during the heyday of the Great Zimbabwe culture in the 12th-14th centuries, and may have been the source of the foil covering the famous Mapungubwe rhinoceros.

Peter grew up on a farm in SE Zimbabwe, where one of the principal crops was bananas; and while he excelled academically and on the sporting field at UCT in the early 1990s, there was much concern expressed about the practical and strategic economic and social benefits that such endeavours could provide after graduation.

One afternoon Peter burst in to my office seeking advice with respect to his application for a Rhodes Scholarship to Oxford, where he could read for a D.Phil. in his chosen field of Geochemistry. At that time in the early 1990s Oxford Earth Science was sort of playing second fiddle to Cambridge, the latter head-hunting certain rising stars from the former. It was an embodiment of the academic sideways shuffle where ambitious younger staff could bypass older colleagues in a rigid vertical hierarchy. To allay fears of unfortunate timing scuppering his Oxford experience, I highlighted two very important positives; both immune to any deficiencies in research excellence. The first is the quintessential Oxford culture that never fails to instil, where Peter will make contacts and develop networks that last forever. Secondly, deficiencies at an esteemed institution such as Oxford are both transient and usually localised in terms of discipline. Peter's first choice of Geochemistry was replaced with Geotectonics, with my

recommendation to seek placement with Prof Michael Searle, who was a noted researcher in the Himalayas. Again, the rest is history … now working from his base in Zimbabwe through his holding company Manica Minerals Ltd, Peter and colleagues have tracked, acquired, promoted and developed several mineral prospects throughout Southern Africa.

The above reminiscences were triggered as I opened and started reading the new book Mining in Zimbabwe, superbly compiled and edited by Martin Prendergast and John Hollaway, containing contributions from 17 Zimbabwe-based (past and present) mining professionals (see contents list).

This comprehensive account of the Zimbabwean mining industry has the following main themes:
The nature and occurrence of the country's main mineral deposits, together with the associated mining and metallurgical processes adopted to exploit them over time.

Starting with a comprehensive and informative overview summary chapter by Prof. Tom Blenkinsop, the reader is well prepared for navigating the protracted geological history of Zimbabwe in its southern African context. With 15 of its 38 pages devoted to an all-encompassing reference list, the chapter serves as a major source for extra follow-up detail.

The development of mining from pre-colonial times and the way it influenced the colonial occupation of the country and the exploitation of its mineral resources into the twenty-first century.

Practically all colonial mining ventures starting from the late 19th century were located on early African sites dating back to the 6th century, and which peaked during the 12th - 14th centuries, long before European navigators rounded the Cape. Three chapters are devoted to pre-colonial mining, with particular focus on gold (by K. Viewing), Iron (M. Prendergast) and copper (H. Solberg). Clearly a widespread sophisticated mining infrastructure was developed by early African cultures, most probably in response to Arab traders working the Indian rim from the mid-first millennium AD.

These relatively primitive surface workings were subsequently exploited on a larger industrial scale, resulting in little or no original exposures being preserved, together with the almost total erasure of the prehistoric infrastructure. Despite these obstacles the respective authors have done a superb job in providing an informative chronicle highlighting the skills and capabilities of early African communities.

The events that shaped the development of the industry, together with some of the people who influenced it.

The authors highlighted the important influence of the late Prof. Keith Viewing in the production of this encyclopaedic magnus opus, acknowledging him as a legend in the Zimbabwe mining industry, who personally sowed the seed in their minds, provided significant early encouragement, but sadly passed just before the publication.

Mining in Zimbabwe is a document of record, with contributions from many of the country's most knowledgeable, mining-related professionals, covering every aspect of the industry. The triumphs and tragedies of mining since the 1890s hold many lessons for the future of Zimbabwe and its mining industry, and the authors believe that this document will be of value to all those who are, or who may become, entrusted in some manner with that future.

A very useful reference is the seven page timeline at the beginning of the book, where one can track a chronicle of key events in the history of Zimbabwe, starting from around the 6th century AD until 2016. The timeline is augmented right at the end of the book with a postscript featuring dramatic political and social developments up to 2018, perhaps presciently sensing further agitation going forward, what with 2019 heralding the death of Robert Mugabe.

From within its 645 pages packed with intricate detail, came a similar story of "hard grind", recovery from cruel setbacks, sheer bloody-minded persistence, occasional small victories and bonanza windfalls. However, despite the past and current hardships, future uncertainties and seemingly parlous state of the Zimbabwe mining industry, the editors' final postscript

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remarks emanated a scent of resolve, a whiff of encouragement and a nascent intent to continue the rejuvenation of THEIR country, THEIR peoples, THEIR natural resources, THEIR Zimbabwe. It is the belief of the authors of this book that the mining industry will revive. When this happens, it is essential that the experience and knowledge of the industry's remaining senior members are not lost.

It will be the Tendais and the Peters of the brave new Zimbabwe that will carry those banners forward and ultimately restore the country and its people to the level worthy of global recognition.

The book has been professionally produced, printed on quality glossy paper, efficiently copy edited and with great continuity of presentation throughout the 19 chapters. Despite the multi-authorship, the editors have succeeded admirably in removing any abrupt changes in literary style, language and formal expression that can appear in compilations of this type. Typical of any historical account, old photos, plans and maps figure prominently throughout, but the care and attention given to their reproduction has merged them seamlessly with their modern counterparts. Apparently a very limited initial printing was possible and thus no widespread circulation has been attempted, which means a price for a copy has not been set. Hopefully this positive review can help in persuading appropriate sponsors to allow the Zimbabwe Chamber of Mines to print more, or at least provide access to an e-copy of Mining in Zimbabwe.

Review by **David L. Reid**
Professor Emeritus,
Department of Geological Sciences,
University of Cape Town,
South Africa

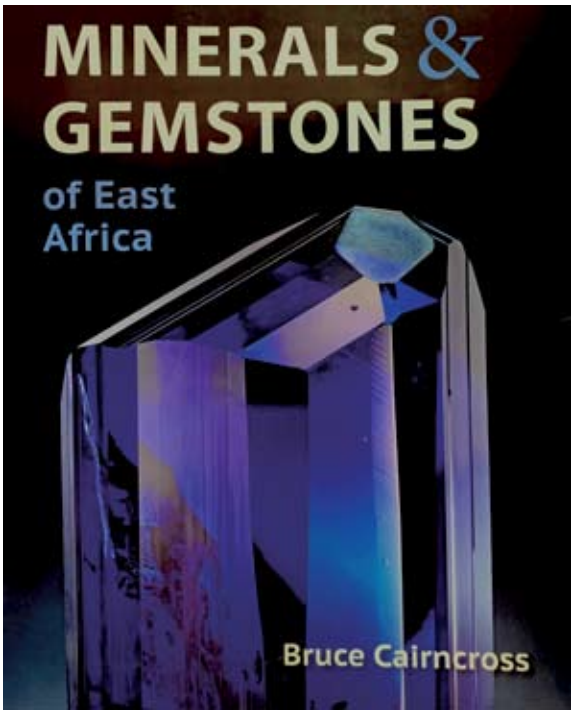
book review

Minerals & Gemstones of East Africa
by Bruce Cairncross

Minerals & Gemstones of East Africa is written by the well-known Prof. Bruce Cairncross who has authored and co-authored several books on the minerals (and rocks) of southern Africa. In his new book, the perspective shifts from the southern African context to focus on the astonishing array of minerals and gemstones that have been produced in East Africa, notably in Kenya, Tanzania, Burundi, Rwanda and Uganda. East Africa is more conventionally known for its spectacular array of game in the Serengeti and Masai Mara and the volcanic landscapes around the Great African Rift. However, the region's mineral and gemstone heritage, although not generally as well known, is indeed a diamond in the rough: the more information comes to light, the more significant these resources become!

At a first glance, the book cover showcases the tantalising beauty of tanzanite. On the inside cover, it is explained and illustrated why this mineral, along with several other gemstones, has established East Africa as an important source of fine gem materials, from which facetted stones found in the most fashionable retail outlets worldwide are produced. The book outlines the region's production of mineral and crystal specimens of, for example, tsavorite, crystalline graphite, alabandite and diopside, that rival the most desirable collectors' specimens globally.

The book is elegantly designed with a simple and practical presentation of text and illustrations. A pleasing aspect of the copy reviewed is that the images of the mineral specimens and facetted gemstones are perfectly clear and a pleasure to behold. The book comprises 144 pages, each measuring 29.7 x 37 cm (the same width as, but 5 cm shorter than A4 format) and is 12 mm thick. The book will be published by Struik Nature in 2019 and is printed on *Forest Stewardship Council*® certified paper.



The introduction provides a brief outline of what minerals and gemstones are, how they are used, covers aspects of their durability and marketability, explains what "fancy" gemstones are and highlights their known associations with specific rock types to aid further discovery. The geology and economic geology and types and quality of minerals and gemstones found at the various locations in each of the five East African countries are briefly described. Interestingly, the author also alludes to why it is that Tanzania and Kenia are more richly endowed with gemstones than Burundi, Rwanda and Uganda, a phenomenon that seems to be linked to the Neoproterozoic Mozambique Belt extending north–south through the eastern halves of these countries. This conclusion is founded on numerous geological, mineralogical, geochronological and gemmological research papers, also referenced in the book. Much of the research on tanzanite and tsavorite, the main gemstones of East Africa, provides a wealth of knowledge on their modes of origin, the evolution of their geological settings and age dating constraining the time of gem formation. A simplified geological

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map of the Merelani Hills area (near Arusha, Tanzania) is also shown. This is considered to be the most prolific gem-producing area of East Africa and a prime locality for tanzanite and tsavorite.

The main gemmological properties (refractive index, birefringence and pleochroism), which are typically used to identify gemstones and minerals, are briefly defined and discussed. Their importance in affecting the final appearance and value of cut gemstones is emphasised as is their utility in identifying facetted gem stones.

This section leads the reader into the A-Z listing of the minerals and gemstones of East Africa. Each mineral species listing includes the name of the mineral, its chemical formula, how and when the mineral was named, its crystal properties, a general description, gem varieties/colour variations and the localities where it is found in the region. This is the "bread and butter" section of the book and is truly an eye-opening experience giving credence to East Africa as a source for some of the most desirable mineral and crystal specimens of the world. Some of the more notable beauties include aquamarine, emerald, chrysoberyl, ruby corundum on green zoisite, diopside, almandine, tsavorite, pyrope, tabular graphite, sapphirine, scapolite and tanzanite. For Ethiopia, although not part of the five East African countries defined initially for this book, the author features some precious stone types that he seems to have found too irresistible to exclude, namely emerald and opal. The final sections of the book include the type mineral listings of each of the five East African countries and an extensive section on "references and further reading".

The wealth of information on collectable minerals and gemstones in this book will undoubtedly appeal to students, professional geologists, armature geologists, geotourists, mineral collectors and people from the gem trade. Since this is the first book to systematically cover the collectable minerals and gemstones of East Africa, the author is filling a distinct niche which should go a long way to popularising the minerals and gemstones of the region and adding an extra arrow in the quiver of the curious tourist to look up some of the localities mentioned.

As a mineralogist, I found the book stimulating and beautifully put together and was happy to see that both gemstones and mineral specimens have been combined in the same publication. Personally, I favour gem quality-natural specimens, but it is also wonderful to see the facetted gemstones, which provide visual verification of the quality of the specimens. What I liked about the book is that I could actually use the locality descriptions of the figure captions and the geological map in the introduction to find the geographical positions of some mines on *Tracks for Africa (GPS software)* and on *Google Earth*. This means that if I should travel to that part of the world, I would have the opportunity myself to collect some specimens, for example, either at the sites themselves (if permissible) or from the local village market. I am also curious about the correct mineralogical identification of, not so much the natural specimens, but of the facetted gemstones, which is not always easy, as testing should understandably involve only non-destructive techniques. It is mentioned early in the book that refractive index, birefringence and pleochroism, for example, are important techniques for gemstone identification, although these techniques are not always conclusive. A illustrative anecdote in the book, recounts, for example, that a beautiful facetted sapphirine was mistakenly identified as idocrase and that more sophisticated testing confirmed the misidentification! It would be comforting to know whether expensive facetted gemstones have indeed been accurately identified by independent authoritative (certified) specialists or whether there is an element of risk when purchasing them.

Reviewed by **Marthinus Cloete** (mineralogist)

obituary

Felix Mendelsohn

Felix Mendelsohn †

Felix Mendelsohn was a calm, gracious man, born in Berea, Johannesburg on the 3rd of July 1922. He passed away in Johannesburg on the 29th of August 2018 at the age of 96. After matriculating from King Edward VII high school in Johannesburg he completed a mining course at Wits Tech and joined the City Deep Gold Mine as a learner official. His pursuit of a geological career was curtailed for a few years however when in 1942, he joined the South African air force as a spitfire pilot serving in campaigns over Italy. After the war he enrolled at Wits graduating with a mining geology degree.

Felix's early career was spent in the then Rhodesia's. From 1950 to 1961 he worked for Selection Trust in Northern Rhodesia on the Roan Antelope Mine on the Copperbelt where his meticulous research on the structure and metamorphism of the copper deposits earned him his PhD degree through Wits University.

He accepted a teaching post in June 1963 at Berkley, California as a visiting Professor and at Kingston University in Canada as Miller Memorial Research Professor at Queens University in 1964. He had many happy memories of the families stay in Northern America but the call of Africa prevailed and the Mendelsohn's returned to the then Southern Rhodesia in 1966. Here Selection Trust had established an exploration branch under George Woodward to search for another Copperbelt in the Lomagundi Formations. Application by Felix and geologists Doug McCloud, Keith Viewing, Bob Man, John Rogers, Peter Gordan, and Lawrie Minter using a new exploration procedure that was based on the geochemical analysis of stream sediments and soils, resulted in the successful identification of five mineral deposits in six years (1 gold, 1 nickel and 3 copper). The exploration activity was then shifted to the Bamangwata Concession in Botswana where the team discovered the Selibi Pikwe Nickel deposit.

While on the Copperbelt Felix became well known for his outstanding contribution to our understanding of the copper deposits and for having edited a classical Monograph on The Geology of the Northern Rhodesian Copperbelt. The book was launched at the Seventh Commonwealth Mining and Metallurgical Congress in 1961. Some of the 23 colleagues who contributed to the publication included his good friend Bill Garlick (geological expert on the Copperbelt, stationed at Kalalushi), JJ.Brummer at Roan Antelope, Steve Malan and Chris Potgieter at Mufulira, and many others from various companies including Pete Pienaar and Fred Cornwell, both from the Anglo American Corporation's Copperbelt team.

In 1970 Felix returned to South Africa to set up practice as a Consulting Geologist in Johannesburg. He was involved in mineral project evaluation in South Africa, Africa and overseas, dealing with a wide variety of deposits. He published a number of papers and wrote over two hundred reports mainly on stratiform copper deposits and ore reserve estimations.

During his time back in South Africa and with his passion for geology, Felix made a significant contribution to the affairs of the Geological Society of South Africa having served on council from 1979 to 1992. He was president of the society in 1991. He had a special interest in geoheritage and geological conservation and for many years chaired what was at the time called the Conservation Committee of the Society.

He made an important contribution to geoheritage as a co- editor of a book, with Dr. Chris Potgieter, on the geosites of the greater Johannesburg area entitled "Guide Book to Sites of Geological and Mining Interest on the Central Witwatersrand",. published by the GSSA in 1986. Descriptions of 62 sites, the location of which were plotted on a street map of Johannesburg were included.

The Conservation Committee under his chairmanship embarked on a project of documenting important South African Geological Sites in general as well as the routes taken by various geological excursions over the years.

He was chairman of and for many years played an important role in the running of Geological Society Trust, now the REI Fund. This fund has and still is helping many young geologists along their career paths.

Felix was also for a number of years, from 1977, a member and chairman of the Johannesburg Museum Consultative Committee responsible for the magnificent collection of rocks and minerals originally owned by the Geological Society and now housed in the geological section of Museum Africa in the Newtown precinct. He also served on the Johannesburg Public Library Consultative committee from 1979 and the friends of Museum Africa committee

In 1958 he received the Silver Medal from the Institute of Mining and Metallurgy for a paper on the structure of the Roan Antelope mine and in 1986 he received the Honours Award of the GSSA.

He was a Fellow of the Institute of Mining and Metallurgy, the Society of Economic Geologists and the Geological Society of South Africa and served as Regional Vice President of the Society of Economic Geologists for Africa.

Geological Society meetings were held regularly at the Mendelsohn home in Greenside, Johannesburg where the hospitality of Felix and his charming wife Ros will be remembered by all. Ros was always supportive of Felix's Geological Society affairs and was very active as a member of the legendery ladies support group, the "Geogems" who played such an important role in the social programmes particularly during the Witwatersrand Centenial Congress in 1986, and the GSSA Centenial Congress in 1995.

Felix was a founder member of the informal GSSA "old Boy's" club which met for lunch every few months over a period of some thirty years, mainly at the Wanderers club. He will be fondly remembered by members of this group for his comaraderie and for his organization of many of the lunches. He also maintained his membership of his airforce unit which met for lunch on the last Friday of every month up until a few years ago.

Felix married Ros Sandberg on the 27th June 1948 and they spent their early years on the Copperbelt where his three children were born. After Seventy years of marriage, he leaves his wife Ros, two daughters Gill and Carol, a son Ivan, six grandchildren and nine great-grandchildren. To Ros and the family we extend our condolences from all his friends in the society and elsewhere. Felix was a knowledgeable, humble and friendly man who went about his business without any fuss and who contributed enormously to our profession. He will be greatly missed.

Lawrie Minter, Richard and Morris Viljoen

obituary

Aylva Ernest Schoch †

Aylva Schoch, geologist, teacher, philosopher, author: died on October 23rd 2019, aged 86.

For a man who spent his career delving into and illuminating the petrology and genesis of granitic rocks from the Cenozoic to the Proterozoic, Aylva Schoch's life was remarkably non-linear. He first became interested in his major field, petrology of plutonites, in the granite plutons around Nelspruit as a scholar. After graduating from Stellenbosch University (US) in 1954, he was employed by SWACO in Namibia as field-geologist. There he mapped and sampled U-bearing rocks; and at night returning to his tent and under the star-lit Namibian sky, he would crank-up his record player and indulge his passion of opera and classical music.

The exploration experience served him well and received an MSc cum laude in 1961 for his work on "The cataclasites of Northwest Bay" for which he was awarded the S.J. Shand memorial medal. His doctorate at US on the "Darling granite batholith" in 1972 was the start of a long and productive academic relationship with the Cape granites and later with the granites of the Namaqua Metamorphic Complex. He pioneered research into the U-Th distribution in granites and after a sabbatical with Jacques Touret in France - fluid inclusion studies in rocks and ores using microthermometry; he subsequently founded and chaired "Fluimus" - study group for Fluid Inclusions.

His academic career was productive and varied. He was a fixture at conferences and seminars and the lecturer/senior lecturer and later Research Professsor, for two decades of US's and later Free State University's Introductory and Advanced Petrology and Petrochemistry courses. Some of his professional leadership activities involved being elected National President for the Geological Society of South Africa; the chairing of several committees and task groups of SACS (Cape Granites and Namaqua Metamorphic Complex, NW Cape); chairman Geocongress 1992 (Bloemfontein); secretary, organizing committee for Geocongress 1975 (Stellenbosch); member of Work Group 290 UNESCO (origin of anorthosites), Work Group for Geostandards and the Commission for the study of ore-forming fluids in inclusions (COFFI).

His academic wings took him on many visits, conferences and excursions that included France, Germany, Hungary, Spain, Portugal, Russia, the UK and the USA. One of the tales he liked to recount was his visit to Siberia and Magadan, and the UNESCO study group's anorthosite field excursion in 1988 where the excursion leader created a bit of panic by running out of "vodka" as a result of the boatman imbibing himself whilst negotiating the rocky shores and dangerous cross-currents between islands in a leaking and unstable boat! During the 1984 International Congress in Moscow, he photographed the KGB buildings in Moscow without being arrested. And often debated whether he should sent it to President

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Vladimir Putin who may have been peering out at that stage as a young KGB agent.

Aylva Schoch's most enduring endeavours are likely to be the regional geology of the NW Cape (Namaqua Province; 1982 to 2019). As team leader of some 19 participants, he mentored and inspired colleagues and young post-graduates alike involved in the unraveling of the region's complex structure, stratigraphy and ore-deposits - notably the stratiform Aggeneys-Gamsberg Cu-Pb-Zn deposits and the cupriferous Koperberg Suite. In work with Johan Conradie, an association with massif type anorthosites and a classification system for the enigmatic Koperberg Suite were proposed. For his MSc dissertation Johan Conradie was awarded the Corstophine medal; the results of their research reported at the 1988 Penrose Conference on anorthosites in Wyoming.

With his vast experience in map-making, Aylva Schoch expressed the opinion that maps were fundamental in the provision of data recorded and the aggregated knowledge of the individual researchers. He was instrumental in motivating the production of two 1:100 000 maps of western and central Bushmanland (respectively: Strydom 1985; Colliston et al.,1986) and a 1:250 000 summary map (Strydom et al.,1987) which included areas covered by the International Geodynamics Programme in Namaqualand and Namibia. These maps illustrate the structural complexities of the terrains and charted the birth of the new stratigraphy for the Proterozoic age Orange River Group and Aggeneys Subgroup; the latter illustrating the regional position of stratiform sulphide deposits in the structurally controlled stratigraphy. Mineralogical studies of metamorphosed aluminous rocks sparked the discovery of a new mineral "Hotsonite" and a co-authored paper published in "American Mineralogist" (1984).

Retirement meant freedom to continue with geological research and involvement with the Boyden Observatory (Chairman Friends of Boyden), and planetary geology. Aylva's last major publication (co-author) appeared in 2017 in Precambrian Research (vol.300; 25 pages): Colliston, W.P., Schoch, A.E., Cole, J. "The Grenvillian Namaqua fold belt adjacent to the western Kaapvaal Craton: 2. Archaean Craton and supercontinent connections". His last contribution was in 2018 as co-editor of a special issue of the SA Journal of Geology (vol. 121) in commemoration of the centenary of the Department of Geology at the University of the Free State.

Aylva Schoch wrote or co-authored over 58 peer-reviewed papers covering a variety of geological themes. He also co-authored a chapter on "Cape Granites" in the Textbook "Geology of South Africa" of the Geological Society of SA, 2006. Furthermore he gave over 45 public lectures, 73 conference contributions and 72 unpublished technical reports on beryl, tantalite, kaolin, dimension stone and the U, Sn-W and V-Zn deposits in Namibia.

He cherished his students' potential too much to let them wallow in sloppy thought. He examined their work with as much scrutiny as he devoted to the writing and editing of papers, and scientific theory. His post-graduate students would remember how their writing would be responded to with a thoughtful version of his own in the margin and back of the page. Acceptance of "text" would be a golden moment. "I am a better human being because of him," said one of his MSc graduates. Aylva was supervisor/promoter for 21 dissertations/theses.

In September 2019 he was hospitalised with bronchial complications and passed away 7 weeks later at the age of 86. But his voice can still be heard - generous, knowledgeable and encouraging.

He is survived by his wife, son and daughter.

He took the words of Hamlet as his own motto: "Give every man thine ear, but few thy voice; Take each mans censure, but reserve thy judgement"; this quote sums up three of the many outstanding characteristics that he consistently displayed namely wisdom, patience and diplomacy.

Still at a time when tectonic plates grind ever more fiercely, his life is a reminder that little in destiny is truly fixed.

His passing is a great loss to the geocommunity, friends and family.

Wayne Colliston

Council for Geoscience

December 2019

The Council for Geoscience (CGS) is one of the science councils in the country that is mandated by the Geoscience Act (100 of 1993) (as amended) to undertake all geoscience research in South Africa and to utilize this research towards finding solutions to some of the challenges facing the people of South Africa. In particular, this includes generating knowledge on South Africa's underlying onshore and offshore geology and allowing this to be used to inform the Government on important decisions pertaining to the country's development. According to the Geoscience Amended Act, the CGS is mandated to serve as the custodian of geotechnical information collected nationally, with an overarching intention to compile a comprehensive, integrated dolomite and geotechnical data that are easily accessible to the public and other stakeholders.

The CGS has an Engineering & Geohazards Department which consists of engineering geology and seismology disciplines. The department deals with the application of geoscience information to engineering and structural concerns. This is done for the purpose of assuring that the geological factors affecting the location, design, construction, operation and maintenance of engineering works are recognized and adequately provided for.

The department is also tasked with the continuous monitoring of seismicity in the region and conducts seismic hazard assessments including developing microzonation models within South Africa, that are meant to inform mitigation strategies from possible earthquakes.

Furthermore, under this Act, the CGS is required to advise local, provincial and national authorities concerning the geohazards that may affect infrastructural development, and to review and evaluate all geotechnical reports submitted from external stakeholders. A particular focus has been given to areas underlain by dolomite, as these are susceptible to sinkholes and subsidence formation. Over the last three years, the CGS has received over 500 dolomite related submissions per year for review and evaluation. These reviews are conducted on behalf of the municipalities to ensure compliance with the industry standards and to promote safe, sustainable land use and development.

Dolomite stability investigation Skeyfontein located within the jurisdiction of Tsantabane Local Municipality.

Geotechnical drilling @ km 2.9 bridge sites of Road D4166 at Ga-Riba in Sekhukhune District, Limpopo Province.

Other geotechnical and engineering geological investigations which are offered by the CGS include site-specific studies for township/housing developments, buildings, dams, tunnels, pipelines, cemeteries, waste disposal sites and constructions materials assessment for road and concrete use.

The CGS operates the South African National Seismograph Network (SANSN) as well as local cluster seismograph networks in the Far West Rand, Central Rand and Klerksdorp gold mine areas. The research associated with the interpretation of recorded seismograms from the cluster networks contributes towards the identification of seismically active zones in the mining areas, and the development of statistical models used to estimate the probability of occurrence of large, mine-related seismic events.

Get in touch with Us

The CGS has a national footprint with research o ces in the Western Cape, Northern Cape, Eastern Cape, Kwa-Zulu Natal and Limpopo. The Head O ce is situated in Pretoria, Gauteng. For more information, visit www.geoscience.org.za, send an email to info@geoscience.org.za or call +27-12-841-1911

obituary

Anton Linder Hales †

A geophysicist whose career spanned three continents: Professor Anton Hales

Johan de Beer

Anton Hales was a highly respected South African geophysicist that achieved a very rare feat. During his lifetime he managed to build leading earth science research groups on three continents. The first was the Bernard Price Institute of Geophysical Research at the University of the Witwatersrand in Johannesburg. Then he moved to University of Texas at Dallas as first Director of the Geosciences Division. Eventually he moved to Canberra Australia where he became the first Director of the Research School of Earth Sciences.

Anton Linder Hales was born in Mossel Bay on 1.03.1911 and passed away in Queanbeyan, Australia on 11.12.2006. He studied at the University of Cape Town where he was awarded a BSc in Mathematics and Physics (with distinction) at the age of 18 and an MSc in Applied Mathematics at the age of 19. After advice from Dr Basil Schonland, Anton changed his future studies from quantum mechanics to geophysics. He then studied with the famous geophysicist Sir Harold Jeffreys at St Johns College, Cambridge where he was awarded a BA in 1930 and an MA in 1952. After returning to South Africa he was awarded a PhD in Physics, but with Geophysical applications in 1936.

The year prior to going to Cambridge he spent at the University of the Witwatersrand as Junior Lecturer in Applied Mathematics and he returned to this university in 1933. Over the following years he advanced to Senior Lecturer. During World War II he served as Captain in the North African Campaign exploring for sources of fresh water. In 1946 he moved to the Bernard Price Institute of Geophysical Research as a Senior Research Officer. A network of gravity base stations was set up by Anton Hales and Ian Gough (working for the CSIR), in close co-operation with the Geological Survey. This was the start of the gravity survey of the Union of South Africa.

In the period 1949-54 Hales was Professor of Applied Mathematics and head of the Department of Mathematics at the University of Cape Town. Following that he became Director of the Bernard Price Institute of Geophysical Research (BPI) and Carnegie-Price Professor of Geophysics at the University of the Witwatersrand. When Dr Gane left the BPI in 1955 he became the leader of the seismology programme and soon was recognized as an important researcher in the area of crustal structure and crustal thickness. The group, including Selwyn Sacks and Neville Cook also made huge contributions in the location and study of deep mine seismic events. In collaboration with Ian Gough he now also completed the gravity survey of South Africa with the computation of the isostatic anomaly field over South Africa and a study of the isostatic anomalies. They were especially intrigued by the large negative isostatic anomaly over the eastern part of the Cape Fold Belt. This feature was interpreted to be due to a mass deficiency caused by the erosion of a mountainous area that previously was in isostatic equilibrium (Hales and Gough 1960; 1961).

He was also an important driving force behind the "International Indian Ocean Expedition" that collected seismic refraction data for oceanic crustal studies. Hales also re-built the palaeomagnetism research initially started by Ian Gough and through the work of Ken Graham and later also Jan van Zijl the BPI became a leader in this area. The most important result was that reversals of the geomagnetic field were real and prominent during the outpouring of the Karoo basaltic lavas.

At this point the BPI was a prominent geophysical research group. However the group lost several leading researchers in the late 1950s. In 1962 Hales also moved to the University of Texas at Dallas as first Director of the Geosciences Division, where he worked till 1973, spending 1970-71 as Acting Vice President for Academic Affairs. The 1960s were years of great activity in geophysics and geochemistry and Hales made his laboratory a front-runner in a number of key areas. One was seismology, in which he conducted experiments designed to understand the structure of the crust and upper mantle.

In 1973 Hales, now 62 years old, moved continents again when he became Foundation Director of the Research School of Earth Sciences at the Australian National University. Here he combined the Department of Geophysics and Geochemistry with the Research School of Physical Sciences. He actively pursued science focused on the Australian continent and its setting. During his time at the ANU the SHRIMP ion microprobe was developed.

On his retirement from the ANU in 1978 he returned to the University of Texas at Dallas as Professor, Programs in Geoscience. He retired to Australia in 1982 after a career in science of more than 50 years.

Hales was a leading researcher in several fields, but is best known for his research on the application of body-wave travel-time studies to determine the structure of the Earth's crust and mantle. These studies done on land and at sea represent a major contribution to knowledge of the earth's interior. He was one of the first to study the detailed structure of the low-velocity zone in the in the upper mantle and to interpret the unusual seismic properties in terms of partial melting. In addition he understood the key significance of the low-velocity zone in tectonic processes. He was also a pioneer in the study of convection processes in the Earth's mantle.

Hales received wide recognition for his work. He was elected Fellow of the Royal Society of South Africa, the Royal Astronomical Society, the American Geophysical Union and Fellow of the Australian Academy of Science. In 1988 he was amongst the first three recipients of the Krahmann Memorial Medal, the highest honour of the South African Geophysical Association. The University of Texas at Dallas founded an endowed graduate fellowship in geophysics in his name and the ANU established the AL Hales annual honours year scholarship.

Acknowledgements

Mike Jones and the **University of the Witwatersrand** are thanked for providing the photograph of Anton Hales. **Edgar Stettler** provided the image of the isostatic anomaly.

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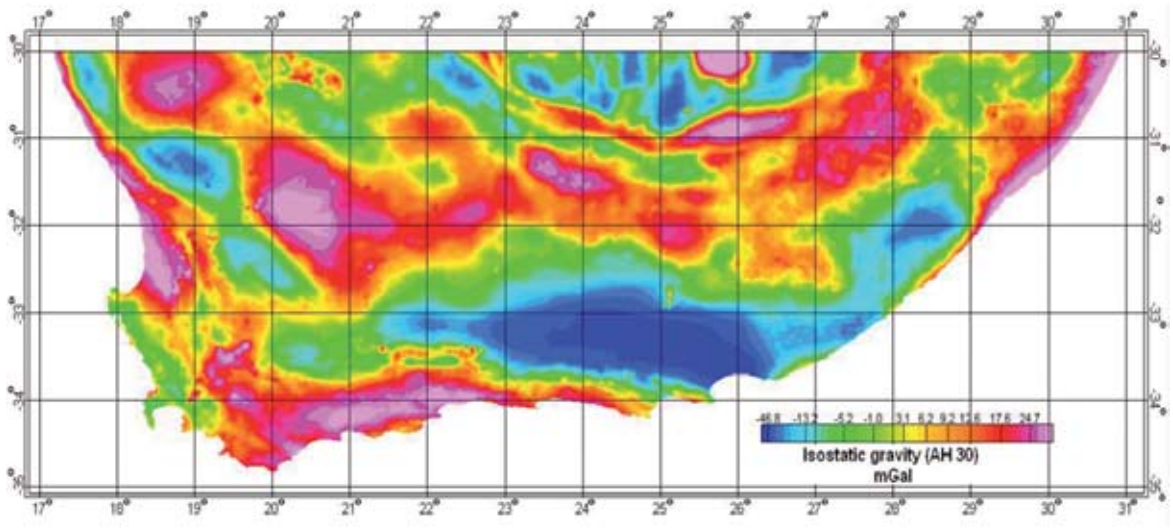
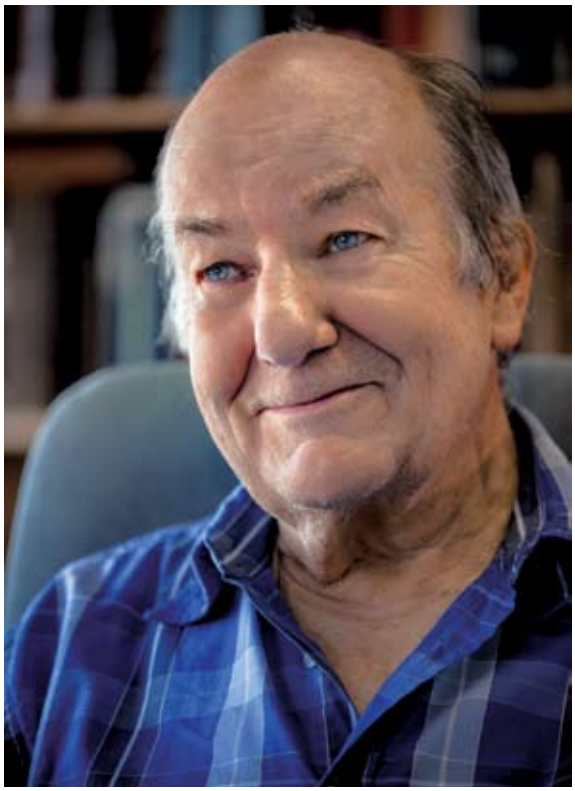


The isostatic anomaly (AH30) gravity data for the southern part of Africa. The very large negative anomaly over the eastern part of the Cape Fold Belt is clearly visible.

obituary

John Joseph Gurney †

John Joseph Gurney (1940-2019)



John Gurney spent most of his early life in Liverpool, England, UK, where he was an avid sportsman, particularly in football. He moved with his family to Cape Town, South Africa, and enrolled at the University of Cape Town in 1959. No doubt influenced by Prof. Louis Ahrens (Professor of Chemistry and later Geochemistry), who was chairman of the UCT football and cricket clubs, John obtained his BSc in Chemistry and undertook postgraduate study in the newly formed Department of Geochemistry, under the supervision of Prof. Ahrens, where he completed his PhD in 1968 on the geochemistry of eclogite xenoliths.

This was an exciting time in geochemistry when, in anticipation of the Apollo moon landings and the return of lunar rocks, many new analytical techniques, such as the electron microprobe, were being applied

to samples of the Earth's interior. John spent 1970 in Washington DC, USA, as a postdoctoral fellow at the Smithsonian Institution under mineralogist George Switzer. It was during this time that he first made the crucial link between the composition of peridotitic garnet inclusions in diamonds and that of Cr-rich subcalcic garnets occurring in harzburgite xenoliths and as indicator minerals in some kimberlites (Gurney and Switzer, 1973). This was later formalised into the "G10" garnet brand based on the low CaO and high Cr_2O_3 contents of such garnets (Gurney, 1984), and their association with diamondiferous kimberlites was more firmly established.

Soon after returning from the USA, John was hired as a member of academic staff in the Department of Geochemistry at UCT. John was co-convenor of the first International Kimberlite Conference (IKC) in Cape Town in 1973. This conference was pivotal in creating the symbiotic relationship between academia and the diamond industry, a relationship that continues until today. Shortly after the IKC, John established the Kimberlite Research Group at UCT, which has had a prolific record of peer-reviewed publications. John authored or co-authored over 300 research papers and articles in journals and books over his 50+ year academic career in virtually all aspects of mantle petrology and geochemistry, kimberlites, diamond geology and exploration. Some highlights include his highly productive collaborations with Ben Harte (U. of Edinburgh) on peridotite xenoliths and megacrysts (e.g., Gurney and Harte, 1980; Harte and Gurney, 1981), Jeff Harris (U. of Glasgow) on diamond inclusions (Harris and Gurney, 1979; Gurney et al., 1982), Steve Richardson (UCT) on isotope geochemistry and dating of diamond inclusions (e.g., Richardson et al., 1984; Richardson et al., 1993), F.R. Boyd (Geophysical Laboratory of the Carnegie Institution of Washington) on diamond inclusion thermobarometry (e.g., Boyd et al., 1985; Boyd and Gurney, 1986) and Hewart Helmstaedt (Queens University, Kingston, ON, Canada) on tectonic controls on kimberlite magmatism and diamond exploration (e.g., Helmstaedt and Gurney, 1995; Gurney et al., 1993). John established himself as a world authority on mantle petrology and diamond formation and earned the highly prestigious designation of an A-rated researcher by the National Research Foundation of South Africa until he retired from academia in 2003.

Additionally, John was a highly sought-after and prolific supervisor of postgraduate students, supervising approximately 20 BSc (Honours), 18 Masters and 16 Doctoral students to graduation at UCT and acting as co-supervisor for several PhD students at other universities. Notable collaborations with students include those with Rory Moore on ultra-deep diamond inclusions and megacrysts (Moore and Gurney, 1985; Moore et al., 1991; Moore et al., 1992), Melissa Kirkley on the carbon isotope composition of diamond and kimberlite carbonates (Kirkley et al., 1991), Jenny Hops on kimberlite megacrysts (Hops et al., 1992), Leon Daniels on mantle mineral chemistry and diamond inclusions (Daniels and Gurney, 1991; Daniels et al., 1996) and Ingrid Chinn on microanalytical studies of diamonds and diamond inclusions (McCammon et al., 1998; Fitzsimmons et al., 1999).

Over the span of his career, John established the world-famous UCT Mantle Room, now the John J. Gurney Upper Mantle Research Collection, the world's most extensive collection of southern African mantle xenoliths and kimberlites. John generously made the collection available to researchers from around the world. In the last few years of his life he used his collection to create a museum-type exhibition, Messengers from the Mantle. The exhibit was unveiled at the 2016 International Geological Congress and has been displayed at several international scientific meetings and other venues to great acclaim.

Alongside being an exceptional scientist, John applied his entrepreneurial skills to be equally successful in business and industry. In 1995, John and his son James founded the Mineral Services Group of companies providing specialist consulting and laboratory services to the diamond industry. John also led several successful public company diamond exploration and marine mining ventures, notably Benguela Concessions

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and Motapa Diamonds (merged with Lucara Diamond Corp. in 2009). It was the application of John's mineral chemistry approach that was crucial to the discovery of diamondiferous kimberlites in northwestern Canada, yielding a major economic benefit to the region and to Canada's economy.

John received a number of academic and research honours through his career: he was a Life Fellow of UCT and a Fellow of the Royal Society of South Africa and the Geological Society of South Africa (GSSA). He received the Draper Medal from, and was an Alex du Toit Memorial Lecturer for, the GSSA. He was awarded the Hugo Dummett Award from the BC/Yukon Chamber of Mines, and won the Silver Medal from, and was a Distingushed Lecturer for, the Society of Economic Geologists. In addition to his impressive professional achievements, John was an accomplished sportsman and had a great enthusiasm for life. He had a remarkable talent for storytelling and a wonderful sense of humour. He was an extraordinary role model and mentor, not only to young scientists, but also to his children and grandchildren. The world is a lesser place without him, but he has left a vast and enduring legacy, including students and colleagues who will carry his vision forward. He will be remembered with fondness by a great many.

Philip Janney, Rory Moore and **Steve Richardson**

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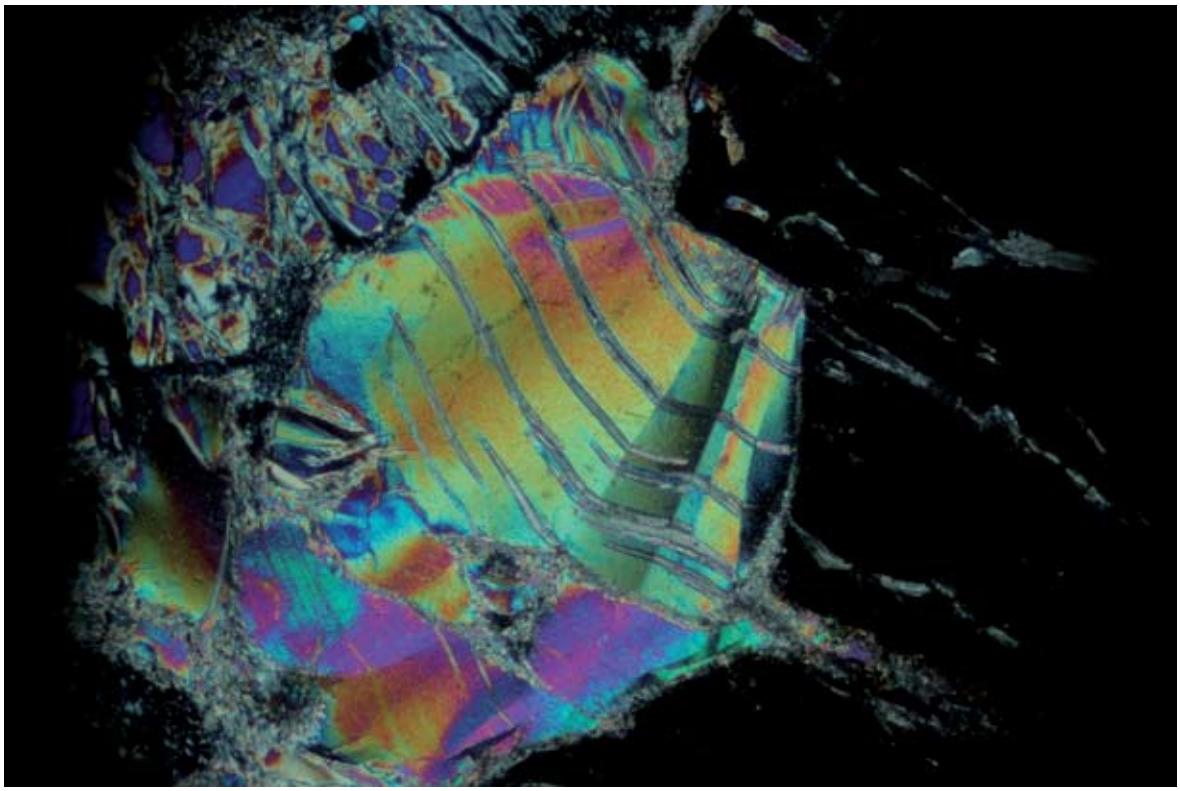

'The mantle has gone dark….' Kinked twin planes in a deformed olivine crystal included within garnet. Crossed polars. FOV = 3mm. Mantle Peridotite nodule collected from the Boshof Road dumps, Kimberley.
Photo by D.L. Reid.

obituary

William David Northrop †

William David Northrop
(13 April 1942 – 20 September 2019)

Bill was born in Mombasa Kenya in April 1942, his father was Commissioner of Customs for Kenya and Uganda. His father loved the outdoor life, and Bill learnt from very young to also love the bush and sport. When Bill was four, his father retired to Grahamstown, where his mother's sister lived, and there they spent the next two years.

Retirement wasn't for his father, so they moved back to Kenya, and later his father took over Customs and Exercise in Eritrea. Sadly, he passed away there when Bill was only 9 years old, and the family then settled in Nairobi, with Bill going to boarding school.

Aged 16 Bill began his studies at Rhodes University, and as Professor Mountain was a great friend of his parents, he decided to study Geology. He used to drive up to Kenya, either by himself or with friends during the longer holidays, with trips reportedly attendant with much mischief and mayhem whilst they were on the road.

Bill started his working life in 1965, in Zimbabwe working for Falcon Mines as an Assistant Geologist. In 1967, Bill moved to Botswana doing exploration work for Roan Selection Trust, which he loved as he mainly camped out in the bush, shot meat for the pot, and explored remote areas where he had occasional exciting encounters with the local large wildlife. One evening his cook called him to look at the vegetable patch, as there was an 'animal' there. The animal was a giant elephant in musth, and the two men had to make a very fast exit. He was instrumental in first discovering what was later to become the large Selebi-Pikhwe Copper Mine and remained there assisting with its development until 1968.

When life in Botswana became too 'civilised' for Bill, he changed jobs to join Anglo American in Zambia, who were conducting exploration on the Copperbelt, and spending a lot of his off time at Luangwa, or with his family based in Malawi.

Bill then moved on to Zimbabwe in 1972, initially working for the Dept of Roads, and then for Rio Tinto (1974 – 1978), conducting exploration work at the Great Dyke of Zimbabwe. In this time, he had a couple of close calls with 'freedom fighters'. He once stopped at a little shop to buy some beer, and the owner warned him to get out fast as there were militants behind the shop. Bill always bemoaned that he had to leave before getting his beer. Another time in the bush Bill looked up to see a man with a gun far in the distance, both he and the distant figure rushed off in opposite directions!

Due to the political situation in Zimbabwe, Bill then moved to Namaqualand, where he worked for NAMEX, doing exploration work while based on a remote diamond mine. It was here he met Annabelle, his future wife. Annabelle had been sent from Johannesburg to assist in the accounts department. Both Bill and Annabelle were ex-Kenyans and by chance Annabelle and Bill's sister, Peggy, had both done serious amateur swimming

under the same coach, both representing Kenya, and Annabelle's father had served under Bill's during the Second World War. Both Bill and Annabelle loved sport and the bush, and they clicked immediately, and within a few months got married at Springbok.

In 1982 after their son John was born at Port Nolloth, the family moved to Mowe Bay on the Skeleton Coast in Namibia, where Bill managed a diamond project for DIMACOR. The family had many adventures there, with lions roaming through the camp at night, driving up along the remote Skeleton Coast, finding the many shipwrecks and the elusive desert elephants.

In 1983 the DIMACOR project was shut down and with Annabelle pregnant with their second child ,Amanda, Bill and Annabelle decided they should live in a more 'civilised' area, and so Bill started work for Harmony Gold Mines as an Exploration Geologist in the Free State. Bill remained with Harmony Gold Mines until 1989, taking up the position of Senior Mine Geologist in 1986.

It was whilst working in the Free State, Bill became interested in how the new technology of computers could be used in mining. This passion with computing technology would eventually lead to his Doctorate in Geostatistics, completed in 1996.

In 1989, Bill took up a position as Chief Geologist at Rand Mines' Durban Roodepoort Deep (DRD). After leaving Rand Mines in 1994, Bill changed his focus to his growing passion for geostatistics and he returned to the Free State Goldfields to join Avgold's developing Target Mine as a Geostatistician. Bill remained with Target Mine (later purchased by Harmony Gold Mines in 2002) until 2004 when he retired.

After his retirement to Bushmans River Mouth, Bill remained very active in the Mining and Exploration industry, consulting for Harmony, and joining ExplorMine Consultants as an associate, consulting on a wide variety of mineral projects throughout Southern Africa, South and North America and Turkey. It was at this point in his career that his wealth of varied geological, mining and geostatistical experience really came to the fore. Bill was still consulting up to his passing in September 2019.

Bill was actively involved in professional affairs and was a fellow of the SAIMM and GSSA. He was also a member of GASA and served on the SAMREC Committee in 2006. Bill, a patient and generous colleague, will be remembered for his clear rational thinking and passion for finding a practical solution to every problem. Bill had a passion to teach and mentor geologists throughout his career, imparting his geological and geostatistical wisdom, teaching techniques that have largely been forgotten, but are still highly applicable today.

Bill's retirement to Bushmans River was not a quiet one. Aside from his busy consulting schedule, Bill was also active in the Bushmans – Kenton-on-Sea community, where Bill became very involved with various committees, especially those that had an ecological bias.

Bill leaves behind his wife Annabelle, their two children John and Mandy and their families. We encourage all who read this tribute to join us in celebrating the exciting and varied life and career of Bill Northrop.

Andre Deiss and **Garth Mitchell**

mineral scene

Schizolite, Kalahari Manganese Field, South Africa
(Subtitle: When is a mineral name no longer valid?)

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Schizolite $NaCaMnSi_3O_8(OH)$ is a member of the pectolite-sérandite series of minerals that form part of the wollastonite group. The type-locality of schizolite is Tugtup Agtakôrfia in the Ilímaussaq complex in Greenland which begs the question: what does this have to do with the Kalahari manganese field? The answer is somewhat intriguing and has been described in detail by Origlieri (2014) and Pohwat (2014) and details are summarized here.

In 2011, a Tucson-based mineral collector and semi-dealer Marshall Sussman acquired several dozen specimens of an attractive pink mineral from the Kalahari manganese field (KMF) in South Africa. The specimens ranged from a centimetre up to several centimetres and the most aesthetic ones are a vibrant pink. In same year at the September Denver Gem and Mineral Show in the USA another well-known mineral dealer had specimens of exactly the same material and was selling these as bustamite, another pink mineral from the KMF albeit only known as a massive, lapidary material. At that time, it was reported that preliminary analyses done in South Africa identified the mineral as ferro-bustamite. These specimens created quite a sensation as they were well crystallized and very aesthetic. The Smithsonian Institution acquired one of these at the Denver show and subsequently analyzed it using chemical analyses and X-Ray diffraction. This produced an intriguing result – it showed the mineral to most likely be pectolite but containing a small amount of manganese. For various reasons the Smithsonian returned the specimen to the dealer. Shortly thereafter Marcus Origlieri from the University of Arizona happened to hear about this pink mineral and decided to pursue the matter further. To cut a long story short, his work revealed that the mineral was neither ferro-bustamite nor Mn-rich pectolite but was a new species. After submitting all the data and proposing a name for the new species, the IMA approved marshallsussmanite as the then latest type-species from the KMF (Origlieri et al., 2013). Marshall Sussman was one of the first to bring the specimens into the USA and for this and other reasons, the mineral was named in his honour. Later work by Nagashima et al., (2018) refined the structure of marshallsussmanite. This new mineral created somewhat of a flurry with the mineral dealers who still had specimens for sale because the price of a new type-species is somewhat more than something already known, and those who still had specimens for sale, withdrew them from their respective websites. (The specimens featured here was somewhat fortuitously acquired when the mineral was still being offered as ferro-bustamite).

Unfortunately, the nomenclature surrounding this mineral's nomenclature did not end in 2013. This year, in 2019, marshallsussmanite was discredited because it is an already known and named species schizolite! (Grice et al., 2019). It turns out that marshallsussmanite and schizolite are one and the same, the latter having been described over 100 years ago (Winther, 1901). Historical precedence sets the priority of this renaming process. So while the name has changed from that of a well-known American aficionado to the Greek derivation of the word for perfect cleavage, the KMF can now claim to have the best known examples of schizolite!

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The mineral first identified as ferro-bustamite, re-analyzed as manganese-rich pectolite, then published as a new type-species marshallsussmanite, now officially named schizolite. The white crystals are hydroxyapophyllite, 6.8 cm, Kalahari manganese field, South Africa.
Bruce Cairncross specimen and photo.

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Pink schizolite with minor white hydroxyapophyllite, 6 cm. Kalahari manganese field.
Bruce Cairncross specimen and photo.

Malvern Hills Geopark

THE GEOTRAVELLER

By Roger N Scoon

Malvern Hills Geopark, England:
Ancient Rocks, Silurian Fossils, and Healing Waters

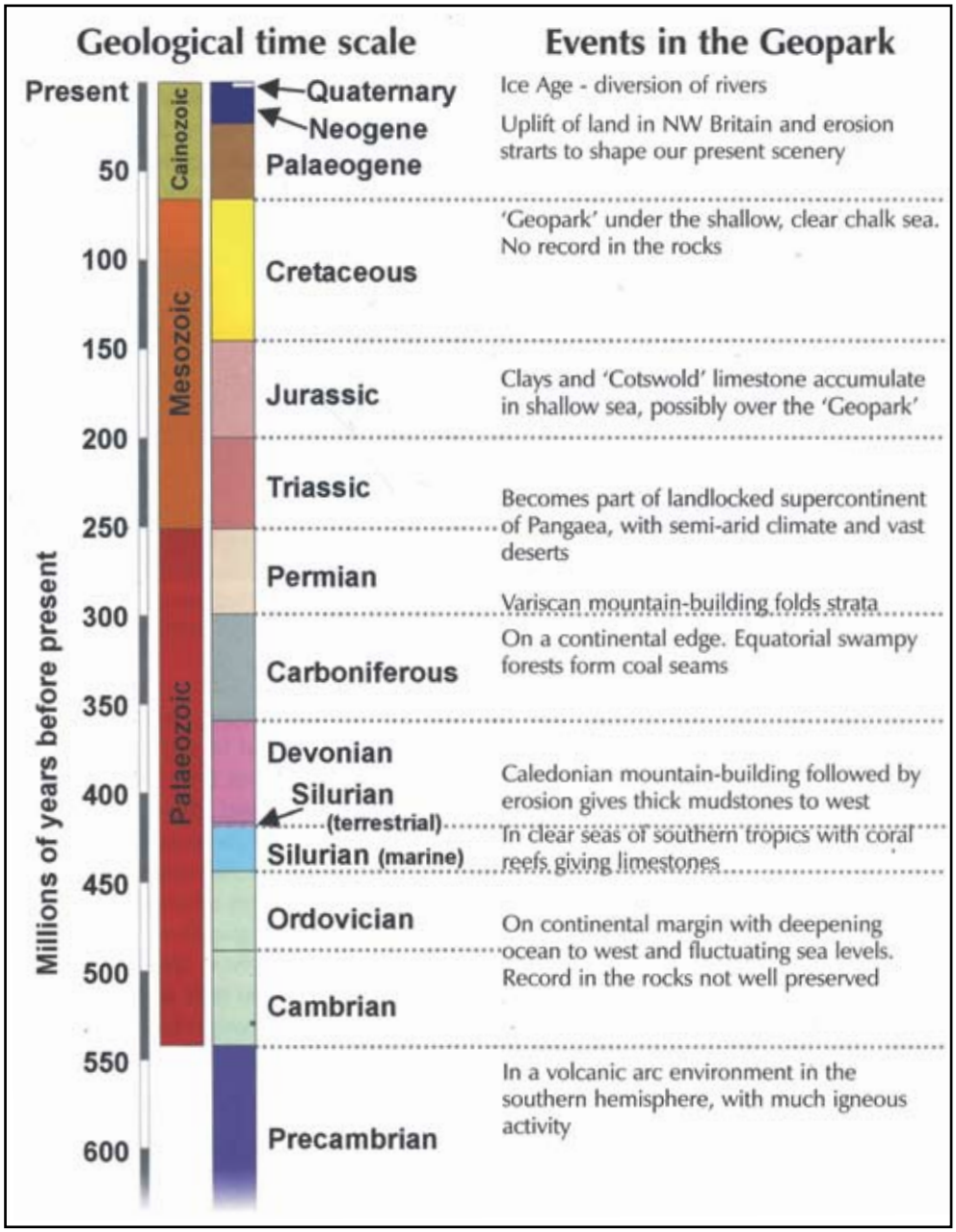
View looking north along the spine of the Malvern Hills. The hills are associated with an anticline of hard, crystalline rocks (Neoproterozoic)

The Malvern Hills is one of the most famous geological localities in England. The hills extend approximately north-south for 13 km and are located in the West Midlands, at the border between Worcestershire and Herefordshire. The highest summit of Worcestershire Beacon has an elevation of 425 m. To the east of the Malvern Hills is the broad, fertile Severn Plains and to the west are the rolling hills of the Welsh Border region. The town of Great Malvern lies at the foot of the hills on the eastern side, located approximately 165 km west-northwest of London. Great Malvern is widely known for the occurrence of natural springs and the healing properties of "Malvern Water".

View looking east over the market town of Great Malvern with Severn Plains (Worcestershire) in the background. This area is comprised of flat-lying sedimentary strata (Triassic)

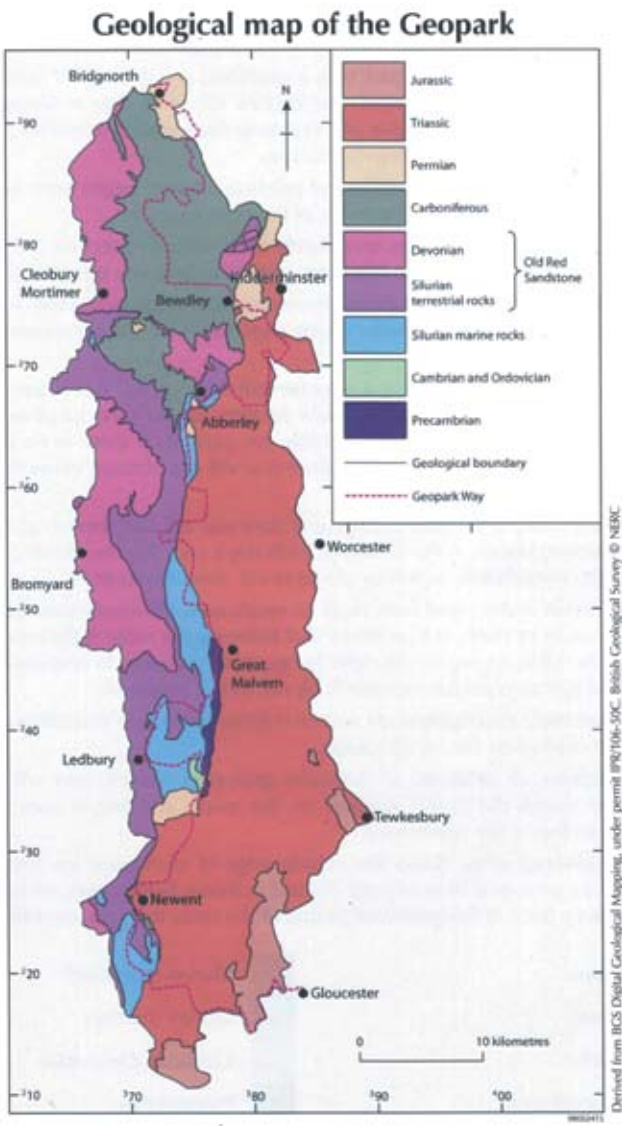
The core of the Malvern Hills consists of ancient crystalline rocks associated with the Malvern Axis. This approximately north-south trending basement high forms a broad anticline, terminated on the eastern side by low-angle faults. Sedimentary strata are draped on the fringes of the basement high. The sedimentary strata encompass a broad section of Earth History, but are particularly well known for outcrops of the Silurian and Triassic. The structural setting and stratigraphy of the Malvern Hills was entrenched into the earliest principles of geological science (e.g., Lyell, 1830-1833). Locally-published guides to the geology are widely available (e.g., Malvern Museum, 1991; The Geopark Way, 2009; Explore the Malvern Hills 2015).

View looking west over the rolling hills of Herefordshire. This region is comprised of steeply-dipping sedimentary strata (Palaeozoic)



Stratigraphy of the Abberley and Malvern Hills Geopark (the Neoproterozoic strata are depicted as Precambrian). Source: Herefordshire and Worcestershire Earth Heritage Trust (2009)

Footpaths to the Malvern Hills commence in the market town of Great Malvern (Far right)



Simplified geological map of the Adderley and Malvern Hills Geopark. The Geotrail is shown as a red dashed line. Source: Herefordshire and Worcestershire Earth Heritage Trust (2009)

The Malvern Hills has long been a Site of Special Scientific Interest (established in 1959). In 2004, the Abberley and Malvern Hills Geopark (area 1250 km^2) was established. The Geopark is situated within four counties; the park overlaps to the southeast into Gloucestershire and to the northwest into Shropshire. Shropshire has a remarkable geological heritage, with outcrops of the Cambrian, Ordovician, and Silurian periods, including many of the more important boundaries. This part of the British Isles was entirely covered by ice sheets during the Main Ice Age (ice extended as far south as the Severn Estuary) and the Geopark includes glacial features.

The geological heritage of the Malvern Hills is protected in a region of open hillsides with numerous footpaths. The Geopark also includes traditional villages and market towns where locally produced building stones can be observed. The "Geopark Way" is a 175 km-long walking trail that accesses the entire Geopark, including the hillsides, farmlands, villages and towns (The Geopark Way, 2009). The Geopark Way starts in Bridgnorth and extends southward through the Abberley and Malvern Hills to Gloucester. The trail is divided into seventeen sections, each of which can be completed in 3-4 hours.

Simplified geological section of the Malvern Hills. Source: Malvern Museum (1992)

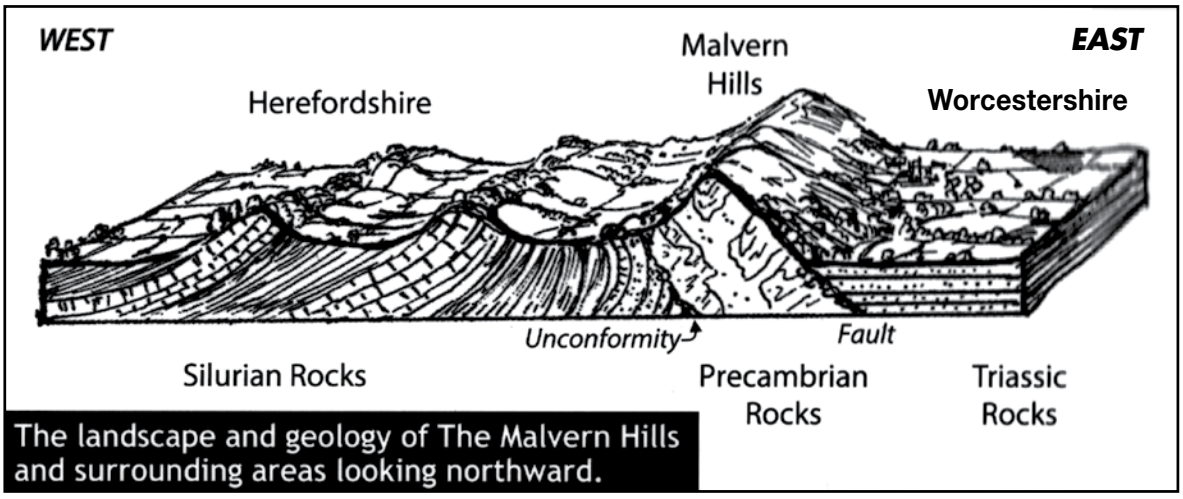


DIAGRAM ADAPTED FROM DREGHORN, THE MALVERNS AND MAY HILL.

The Malvern Complex is exposed on the crest of the Malvern Hills adjacent to the Worcestershire Beacon. The dark rocks in the foreground are mostly diorite. Veins of pinkish granite can also be observed here

The core of the Malvern Axis is comprised of the Malvern Complex, a group of hard crystalline rocks dominated by granite, granophyre, granitic pegmatite, and diorite. The Malvern Complex is one of a number of Neoproterozoic-age basement complexes which occur in the Welsh Border region. Most complexes are associated with isolated upland areas. Prior to radiometric dating techniques, the basement complexes were assigned to the Precambrian, and this approach is still followed in geological displays and booklets. The basement is part of the palaeo-continent of Avalonia (Keppie and Dostal, 1998; Keppie et al. 2003). Most complexes are associated with cycles of arc-related magmatism (Schofield et al., 2010). The basement complexes encompass two periods of the Neoproterozoic, 765–660 Ma and 635–550 Ma (Schofield et al., 2010).

Diorite (grey) of the Malvern Complex intruded by granitic pegmatite (pink) is exposed on the crest of the Malvern Hills

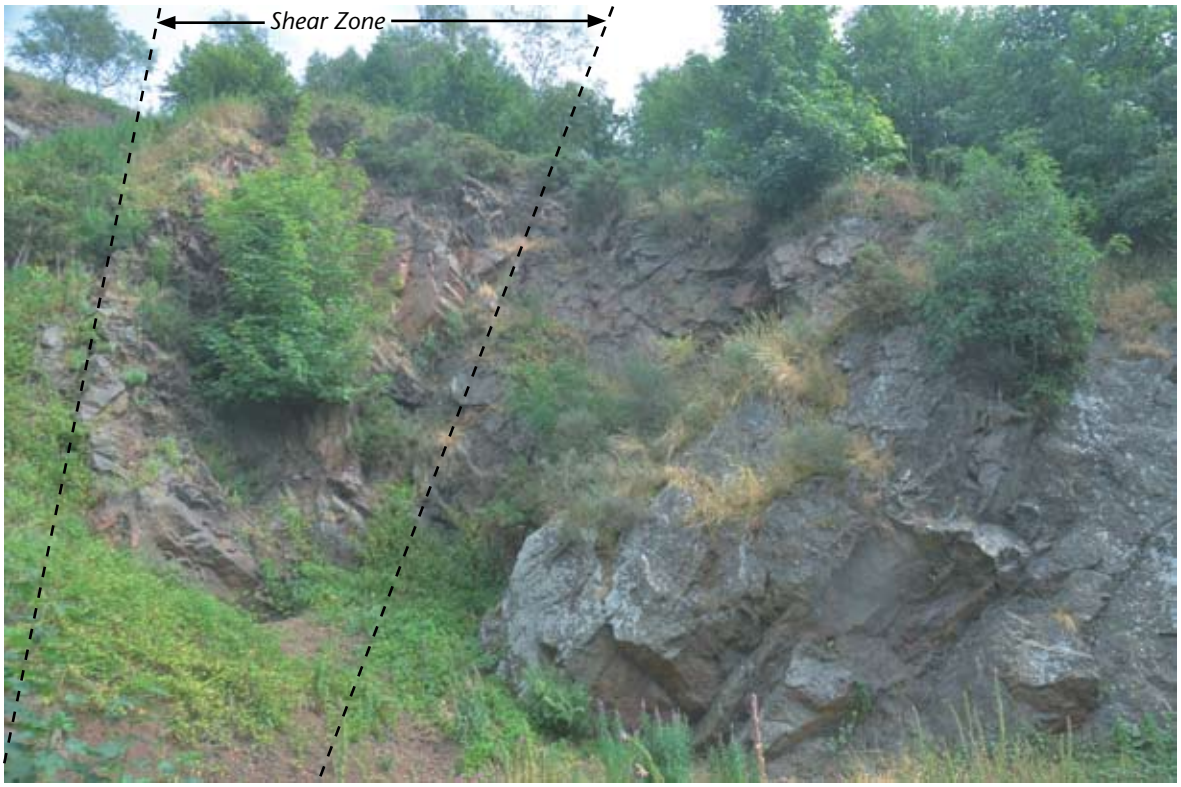
The Malvern Complex has an age of approximately 667-650 Ma (Strachan et al. 2007).

The hardness of the rocks associated with the Malvern Complex has resulted in their preservation within uplands. Outcrops occur on the crest of the hills, including at the Worcestershire (or Malvern) Beacon (named for the fires lit during medieval times as part of regional warning systems). Several cross-cutting relationships can be examined here. A dyke-like body of coarse-grained diorite intrudes a granitic body. A granite dyke crosscuts an older body of microdiorite. Diorite is also exposed in small quarries on the northern flanks of the Malvern Hills. A vein of pink aplite and patchy replacement of the diorite by green epidote can be observed in one of the workings. The Ivy Scar Rock, located near the crest of the ridge, reveals evidence of a slightly younger component of the Malvern Complex: fine-grained diorite is relatively unaltered and shows no evidence of veining.

Diorite from the Malvern Complex has been extensively quarried for building stone and road aggregate. The Geotrail incorporates several quarries. Gardiner's Quarry located in the southern part of the Malvern's exposes part of a granitic body which includes a major shear zone. This quarry is included in a short trail that starts at the Malvern Hills Geocentre (Explore the Malvern Hills, 2015). The Geocentre includes an interactive display with booklets, and pamphlets. Information includes details of the paleoenvironment during formation of the broad range of rocks exposed in the Geopark. Descriptions of geosites are invaluable as they include maps showing tracks and footpaths, in addition to tarmac roads.

The trail to Gardiner's Quarry takes in Wyche Cutting, used in the Iron Age as part of the route for transporting salt from Droitwich (Midlands) to South Wales. The cutting occurs at the base of Perseverance Hill, the vista from which includes the hills of the Welsh Border and is said to have inspired scenes in J.R. Tolkien's "The Lord of the Rings". The hike switchbacks down the western side of the hill and passes onto Silurian rocks. At a locality called the "Knapp", the steeply-dipping nature and westerly dip of the thinly-bedded limestones and shales are prominent. Tank Quarry, located at the base of the Malvern Hills on the northern side, is accessed from the "Clock Tower" (the base of which is constructed of stone from the quarry). This site includes a geological display with large rock samples and information boards arranged in stratigraphic sequence. The quarry face is dominated by relatively dark, coarse-grained diorite, together with subordinate and distinctly pink-coloured granite.

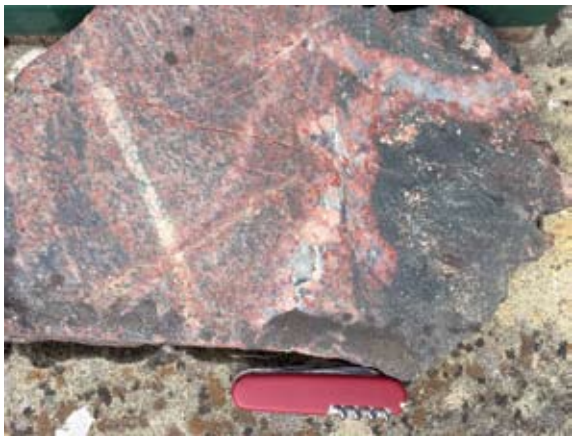
The Malvern Complex is unconformably overlain on the western side by Cambrian, Ordovician, and Silurian strata. These rocks are part of the British Caledonides,



A shear zone in Gardiner's Quarry associated with a regional fault includes pink-coloured granitic fragments enclosed by darker diorite

Geological display at Tank Quarry includes plinths of each component of the stratigraphy with rock samples and detailed explanations

isolated sequences linked to similar rocks in the north-eastern parts of North America. All of the Caledonide terrains developed on the palaeo-continents of Laurentia (North America and Scotland) and Avalonia (England and Wales). Laurentia and Avalonia were separated by the Iapetus Ocean. The isolated nature of the terrains is ascribed to closure of the Iapetus Ocean and subduction of sediments which had accumulated in the Lower Palaeozoic geosynclines (e.g., Windley, 1977). The Caledonide stratigraphy in this region was uplifted along the Malvern Axis during the Carboniferous and Permian. Uplift is related to closure of the Iapetus Ocean.



(a) Granitic pegmatite with later veining, Malvern Complex

(b) Diorite (dark grey) intruded by younger granitic veins (pink), Malvern Complex. Source: Displays at Tank Quarry

The Cambrian and Ordovician strata are restricted to rather poor outcrops in the geopark, but the Silurian rocks are well exposed. The gently rolling landscape of the Abberley Hills, located approximately 15 km to the north of the Malvern Hills, is dominated by Silurian strata. Many of the ridges are associated with the relatively hard Aymestry Limestone (Upper Silurian with an age of 420 Ma); softer shales and mudstones occur in the valleys. The Aymestry Limestone has been extensively quarried. Quarries can be traced to Roman times and small pits occur on some of the ridges in the Abberley Hills. Most of the modern day quarries (despite being disused) require permission to access. Woodbury Quarry, located approximately 3 km south of the village of Abberley, is a well known site for collecting fossils. The material used for building stones is typically a hard, blue-grey, nodular limestone which contains ribbed brachiopod (Kirkidium knightii) fossils. The most abundant fossils, in addition to brachiopods, are molluscs, corals and crinoids. Some shale-rich beds in the limestone reveal worm tubes and other evidence of bioturbation.

Whitman's Hill Quarry, located a few kilometres west of the Geotrail, near the village of Storridge, and was afforded a special protection status in 1999. Possibly the most famous of the fossils located in the Aymestry Limestone at this site are trilobites, including the genus Calymene (locally known as the "Dudley Bug"), which typically has a length of approximately 2 cm (e.g., Siveter, 1985). The paleoenvironment of the Silurian rocks found here is compared with a shallow tropical sea, such as in the Seychelles or Bahamas.

In areas to the south of the Malvern Hills, the Upper Silurian is represented by the Wenlock Limestone, a pale grey, nodular, and thinly-bedded oolitic limestone. The Wenlock Limestone is extremely fossiliferous: these rocks were formerly shallow water coral reefs (Ratcliffe and Thomas, 1999). Wenlock Limestone can be examined in many buildings and is often used for memorials.

The Silurian strata are overlain to the west of the Malvern Hills by outcrops of Devonian sandstones. Thick sequences of Carboniferous limestones occur on the western flanks of the Abberley Hills. The Permian strata are restricted to isolated outcrops in the northern and southern parts of the Geopark.

The eastern side of the Malvern Hills is underlain by Triassic sandstones and marls. These rocks underlie large parts of the fertile Severn Plains. Triassic sandstone is exposed in the valley associated with a small steam, Leigh Brook, located south of the village of Alfrick, part way between Adderley and Great Malvern. The red,

Views of the Abberley Hills, looking northeast

Whitman's Hill Quarry, near Storridge was afforded a special protection status in 1999 due to the abundance of marine fossils preserved in the Aymestry Limestone (Upper Silurian)

War memorial at Ledbury is constructed of fossiliferous oolitic Wenlock Limestone (Upper Silurian)

pebbly sandstone contains angular fragments of igneous rocks, derived from the Malvern Complex. An outcrop of sandstone with fractures infilled by quartz is interpreted as fossilized stream channels.

The Geotrail continues southward from the village of Alfrick into the Knapp and Papermill Reserve. Here, the small stream occupies a gorge which has developed within resistant, green-coloured Silurian limestones. The enhanced stream flow in the gorge was formerly used to drive water mills. The valley and gorge is relatively well-formed in comparison to the size of the current stream. Prior to the Ice Ages a much larger palaeo-river eroded the soft Triassic sandstone which unconformably overlies

☞

Triassic pebbly sandstones reveal fractures infilled by quartz which are interpreted as fossilized stream channels, Alfrick

the Silurian rocks. Perched river gravels located at the current height of the hills, suggest the landscape was tens of metres higher. The valley and gorge was cut to its present level by torrents of meltwater released from melting ice sheets during a localized warm period in the Main Ice Age (at approximately 55,000 BP). Screes located on the crest of the Malvern Hills are also linked to glacial activity.

The Malvern Hills have a long history of human settlement and evidence of Bronze Age activities dates to approximately 3,000 BP. The summit includes evidence of Iron Age fortifications. These sites are poorly preserved and there is a disputed story that the English chieftain, Caractacus, made a stand here against the Roman invaders. Iron Age fortifications are, however, far better preserved in the Shropshire Hills located to the northwest of Great Malvern.

The quality of Malvern Water is linked to the source of the water: the hard, crystalline rocks of the Malvern Complex. The low porosity of these rocks, together with prominent fissures, results in rainwater percolating slowly downward. The groundwater emerges as natural springs on the flanks of the Malvern Hills, which provide sufficient hydrostatic pressure to maintain substantial flow rates. The water is essentially uncontaminated by chemical dissolution and the fractures act as natural filters. Rainfall is generally sufficient to maintain flow rates. The importance of Malvern Water is traced to the 1840s when two local doctors introduced the concept of hydrotherapy. The reputation of the water spread rapidly and during the mid-late 19th Century, Great Malvern became fashionable with the Victorian elite. The most popular spot to administer the water cure (essentially an open air cold shower) was the St. Ann's Well, which can still be visited. The difference between here and other spa towns is that the Malvern Water is renowned for its purity and has few healing properties. Malvern Water is bottled and marketed internationally, despite a local saying that it "is famous for nothing at all".

Scree associated with glacial erosion during the Late Pleistocene Ice Ages can be observed on the crest of the Malvern Hills

Many of the original springs and wells in the Malvern Hills have been refurbished

All photographs by the author except where referenced.

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19 – 21 February	Drilling Methods in Johannesburg	Mandela Mining Precinct, JHB
25 - 26 February	SAMCODES Conference	Birchwood Hotel, JHB
18 March	SAMOG Code in JHB	Mandela Mining Precinct, JHB
15 April	CPD Workshop	Mandela Mining Precinct, JHB
30 April	Bushveld PGE Day	Glenhove Conference Centre, JHB
21 May	Hydrothermal and alteration systems short course	Glenhove Conference Centre, JHB
19 June	Geoskills "pop-up" event	TBC
29 June – 1 July	Geocongress 2020	Stellenbosch
16 July	Mineral Rights in Southern Africa: the current state of affairs	JHB
16 July	AGM	Johannesburg Country Club Auckland Park, JHB
14 – 16 August	Advanced structural geology field trip	KZN
20 August	3-D Geological modelling	Glenhove Conference Centre, JHB
September	Diamond Conference	Kimberley
16 – 18 September	Drilling Methods	Avianto, Muldersdrift
8 October	CPD Workshop	Mandela Mining Precinct, JHB
16 October	REI colloquium	JHB
22 October	Project Management for geologists	JHB
6 November	Geoskills "pop-up" event	TBC
11 November	Fellows Dinner	Johannesburg Country Club Woodmead
12 -13 November	Technology Day African Exploration Showcase	Glenhove Conference Centre, JHB

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