GSSA
Geological Society of South Africa

# geobulletin

QUARTERLY NEWS BULLETIN ~ SEPTEMBER 2020

VOLUME 63 NO. 3

Coal beyond electricity generation
Heritage month
Craters of the Moon, Idaho

## news


**CENTREFOLD: pg 36 and 37**

The committee members of the newly expanded Bridge the Gap mentorship program—a student-led initiative designed to assist undergraduate geoscience students to better transition into the university landscape and to ignite their passion for geosciences. For more about Bridge the Gap and information on how to get involved, go to pg. 36 and 37.

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# contents



**Front Cover:**

Sharp, well-formed cuprite with the outer surfaces partially altered to malachite, associated with tiny colourless rhombohedral calcite, from Onganja mine, Namibia. Matrix specimens of cuprite like this one are rare from Onganja.
(Specimen and photo: Bruce Cairncross.)
For more about cuprite and this iconic deposit, see Mineral Scene on pg. 40.

Geological Society of South Africa

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# guest editorial

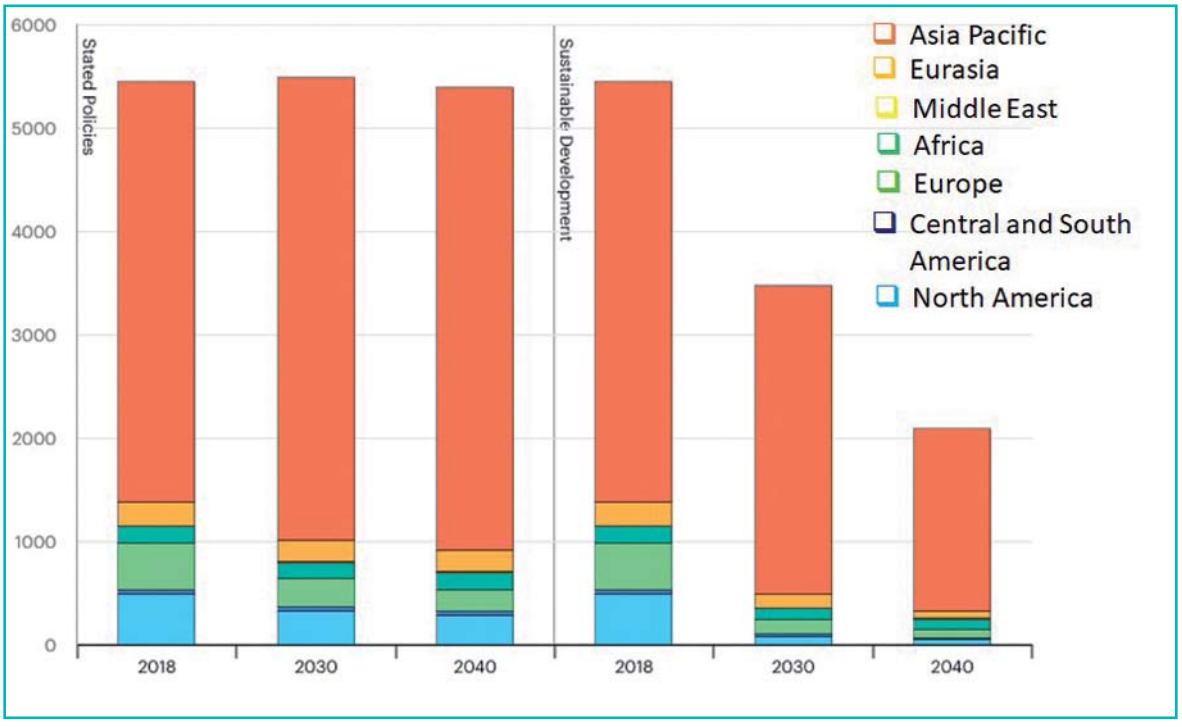
Nikki Wagner

**The significance of coal beyond electricity generation**

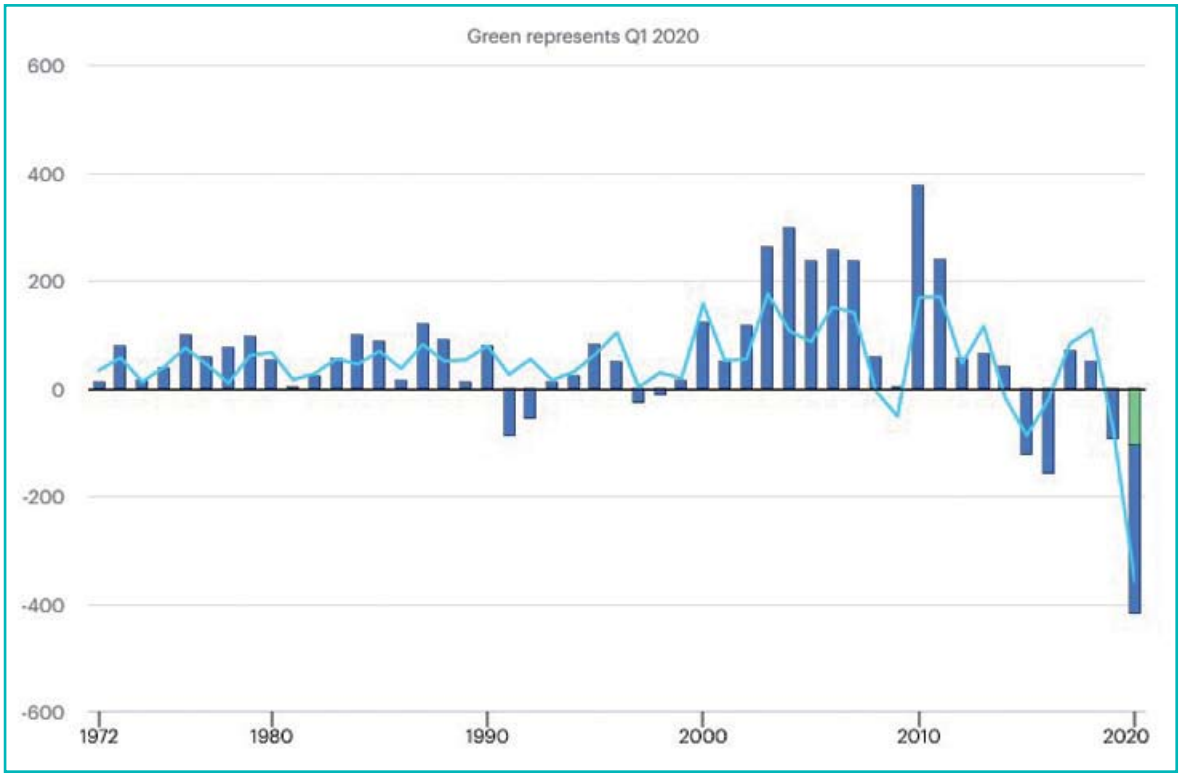
Coal does matter—as a significant geological resource, and through playing a crucial role in our daily lives that reaches beyond electricity generation alone. It is vital to ensure that the sustainable, environmentally responsible use of coal is enforced across the globe, and it begins by understanding the geological commodity itself.

Coal is a complex, heterogeneous sedimentary rock; a hydrocarbon fossil fuel composed of organic components (macerals) and inorganic components (minerals). The properties of coal are a result of vegetation accumulation in a swampy peat deposit, followed by a number of subsequent processes. It is important to note the various interlinking properties of coal in order to understand its variety of applications and conversion behaviours, as well as to understand its environmental footprint. In the characterisation of its chemical properties (such as volatile matter, ash content, sulphur, and calorific value), rank (degree of maturation), type (organic composition), mineralogy, and physical properties, the complexity of coal is revealed. The geochemistry of coal (C, H, S, N, as well as trace and rare-earth elements) has received much interest in extending the applications of coal deposits and conversion by-products, as well as enhancing our understanding of pollution reduction.

Coal is what feeds our hungry, pollution-heavy power stations in South Africa, while providing us with the electricity that we devour by the minute, day in, night out. Thirty to thirty-eight percent of the world's electricity demand is supplied by burning coal, making it the largest source of electricity generation globally.[1] Despite the fact that coal is more accessible than oil and gas, and can readily meet the steeply rising demand for electricity around the world, international policies discourage its contribution due to its perceived conflict with sustainable development




*Coal demand by region and scenario, 2018–2040.*[3]



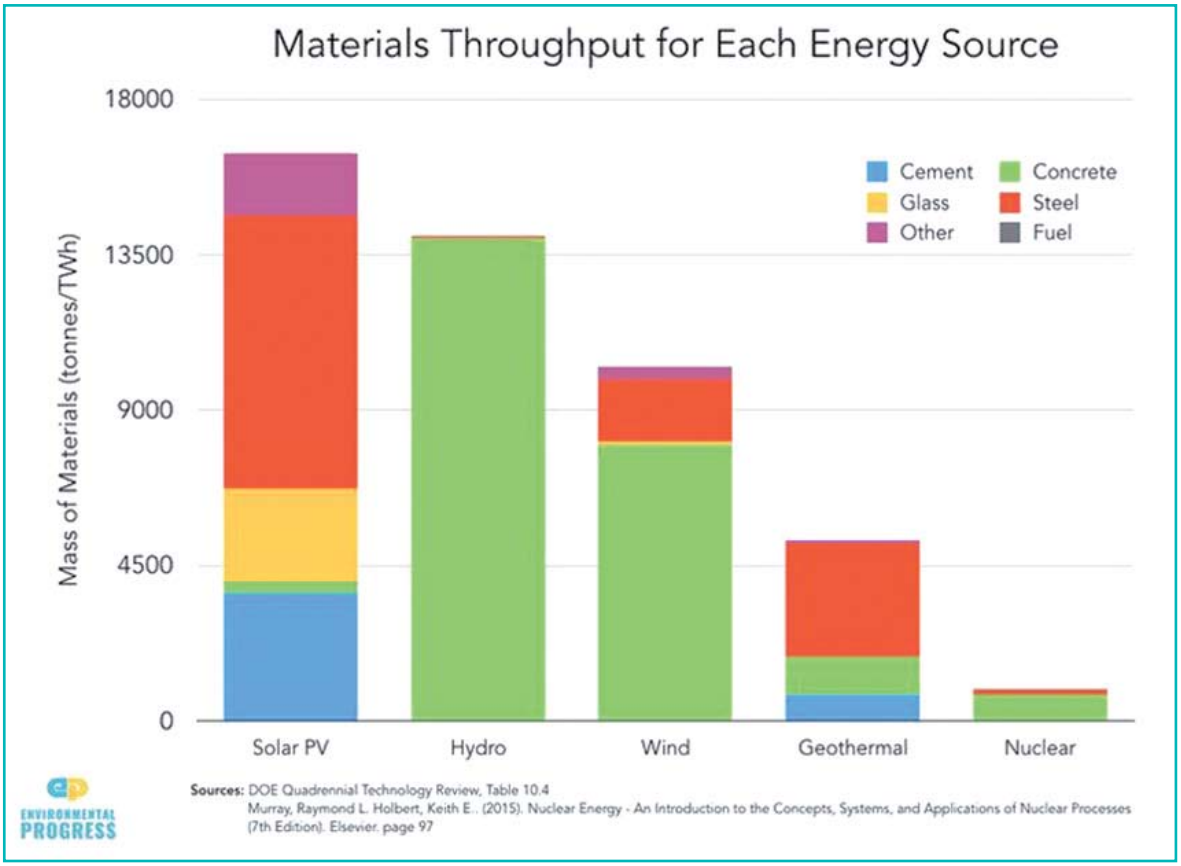

*Annual change in coal demand, 1971–2020.[4] Last updated 30 April 2020.*

goals. The World Energy Council report titled "World Coal Perspectives to 2030",[2] despite being published over 15 years ago, provides an interesting read: carbon-constraining policies and market-driven scenarios will lead to a decline in coal demand. Yet the International Energy Agency, in its 2019 reference scenario on coal demand,[3] expects the demand for coal to carry on growing year-on-year. Global coal use rose in 2017 and in 2018. Although coal-fired electricity generation has decreased in the USA and EU, it continues to increase in emerging economies. The IEA Stated Policies Scenario extrapolates an essentially flat global coal demand, but the Sustainable Development Scenario predicts coal demand to fall rapidly.[3] The flat demand is reflective of a decrease of coal in power generation and an increase in industrial use. It is interesting to note the effect of COVID-19 on global coal demand, as the global lockdown dramatically curtailed electricity demand and industrial use throughout early 2020.

We all agree that the world must transition to a more sustainable, lower emission, energy mix. Solar power, hydroelectricity, wind energy, and geothermal sources are some popular and readily available renewable, 'clean' energy sources. Once the capital costs are dealt with and installation issues addressed (such as the utilisation of massive tracts of land for solar power, and the flight paths of birds for wind-turbine installations), these power sources are considered 'free' and don't produce polluting gases or waste materials during operation (after operation is a different story). However, without coal, it is nearly impossible to construct and install these sustainable forms of energy. The production of cement, concrete, glass, and steel, will most likely continue to require the use of coal.

Coal is a fuel source providing heat or liquid energy. It is also a vital reductant in metallurgical applications, is a significant contributor to the success of transportation and construction industries, and is a potential source for rare-earth elements required for the operation of clean technologies.

The demand for personal vehicles, delivery trucks, and public transport continues to rise. The world produces 89 million barrels of oil a day and liquid fuels derived from coal supply a viable addition to conventional oil supplies for transportation fuels. Transport-derived coal fuels, via the coal-to-liquids (CTL) process, provide 20%




*Materials required for the construction of various renewable energy technologies.*[5]

of SA's transport needs and 7.5% of jet fuel demand. CTL fuels are sulphur-free, low in particulates, have low NOx levels, and are economically competitive as an alternative transport fuel.

The Sasol CTL process enables the production of petrol, diesel, and jet fuels, as well as ammonia, tars and pitch, cokes, phenols, ethylene, polyethylene, polypropylene, alcohols, hextene, oxtene, propane, butane, illuminating paraffin, and pipeline gas.[6] Former coal-derived products generated by Sasol, such as waxes, methanol, fertilisers, explosives, and acrylic acids, are now produced using natural gas piped from Mozambique.

Hydrogen is another transport fuel that can be derived from coal. According to the World Coal Association (2020),[7] about 19% of the world's hydrogen production is coal based, and it is set to become a major component of clean sustainable energy systems in the long term. Hydrogen is extracted from syngas produced via gasification. Gasification is a lower polluting conversion technology compared to pulverised fuel combustion, but it does produce large volumes of concentrated $CO_2$. If the $CO_2$ is sequestered following gasification, hydrogen from coal could be considered as a zero-carbon fuel for the transport industry.

As well as supporting the global demand for liquid fuels to power vehicles, the material for the construction of cars and aeroplanes also involves coal. New cars, on average, use 132 kg of aluminium per car. Aluminium is a non-ferrous metal known for its lightweight, corrosion-resistant properties. The resultant weight reduction of a vehicle significantly reduces its energy consumption. Over 50% of the power mix used to produce aluminium from bauxite is coal based, with coal fuelling the process and providing carbon for cathodes used during electrolysis. Carbon cathodes, used to line the cells to attract the liquid aluminium metal, are made of anthracite, graphite, and coke/petroleum coke. Anodes—large carbon blocks used to conduct electricity during the aluminium reduction process—are also made of coke or petroleum coke, mixed with coal-tar pitch.

Carbon fibres are used in advanced composite materials, such as reinforced plastics, and are increasingly used to replace steel in the aerospace and automobile industries. The composite is ¼ of the weight of traditional materials and is 10 times as strong. Carbon fibres are produced from coal or coal-tar pitch (a by-product of coal carbonisation or gasification) via a series of processing steps. The reduced weight in planes and cars improves the energy efficiency and reduces their carbon footprint. Nearly 50% of the frame of the new Airbus A350 is comprised of carbon-fibre reinforced plastics.[7]

For cars, trucks, trains, etc., to function, a transport infrastructure is required. The steel, cement, and aluminium industries use coal-based energy and reductants.

Steel is used to construct bridges, railroads, aeroplanes, cars, electricity pylons (also required to distribute renewable energy), offshore oil platforms, wind turbines, and so on. A specific category of coal, referred to as coking coal, is added to iron ore and limestone in a furnace to make molten iron, which is then further treated and heated to make steel. The integrated steel-making process in blast furnaces consumes 770 kg of coal to produce 1 ton of crude steel, while the electric arc furnace requires 150 kg coal to produce 1 ton of crude steel.[7]

The cement industry requires coal to produce concrete—an essential building material for transport infrastructure and the construction of dams for hydropower. About 200 kg of coal are required to produce 1 ton of cement, and about 300–400 kg cement is needed for 1 $m^3$ of concrete.[7] Fly ash, a coal combustion by-product, is a useful, low-cost material used to supplement cement in concrete.

Returning to the need for, and rapid development of, the clean energy industry and the significance of coal, it is estimated that 250 tonnes of coal are used to install an offshore wind turbine, and 150 tonnes to install an onshore turbine, over their respective lifecycles. The Three Gorges Dam, Hubei Province, China—the world's largest hydropower station—required almost 2 million tons of coal in the preparation of the estimated 28 million $m^3$ of concrete used to construct the dam.[7]

Coal matters as a source of critical raw materials, including rare-earth elements. Global economies largely depend on these critical elements for clean energy and for technological advancement. As conventional sources become stressed, alternative supplies are being sought. There is interest globally in coal deposits and coal combustion by-products, such as fly ash and bottom ash, as promising alternative sources for some critical elements.[8] I refer you to a 2018 landmark paper by Prof Shifeng Dai and Prof Bob Finkelman: 'Coal as a Promising Source of Critical Elements'.[9] As quoted: "Coal can be considered as an economic source of strategically important elements such as germanium, gallium, uranium, vanadium, selenium, rare-earth elements yttrium, scandium, neodymium, silver, platinum group metals, and rhenium, as well as base metals Al and Mg". In 2019, the USA introduced the Rare Earth Element Advanced Coal Technology Act, stipulating an annual budget of $23 million to the Department of Energy and the National Energy Laboratory (NETL) up until 2027 to develop rare-earth extraction technologies from coal and coal by-products.[10] The origin of rare-earth elements in coal is varied—organic, terrigenous, tuffaceous, hydrothermal, and/or infiltration.

Coal exploration and mining is still very much needed. The future and importance of coal as a geological resource will be related to the industrial production of coke, carbon materials, carbon derivatives, liquid fuels, other chemical products, and critical raw materials. In the IEA World Energy Outlook,[1] coal remains at the backbone of the iron and steel industries and use of coal in the cement and chemical industries continues to increase. Until renewable energy can provide the substantial heat energy required for the steel, cement, aluminium, and transport industries, coal will be required. Until alternatives are found for reductants,

anodes, and cathodes in the metallurgical industry, coal will be required. Until we reduce our dependence on plastic, coal and other fossil fuels will be required. So too does the global transport industry benefit with the inclusion of coal-derived fuels. Clean coal technologies are at the forefront of research globally for large-scale electricity production, while there are easy alternatives to coal in the supply of domestic electricity. Research is ongoing to reduce and/or reuse and/or sequester $CO_2$ that is inevitably produced during coal conversion.

As noted by Dr Klaus Brendow from the World Energy Council[2]: "Coal's global image does not reflect the realities of the industry".

I developed much of this content in preparation for my inaugural lecture, scheduled for May 2020, but was derailed by the lockdown. The title was amended from the original 'Coal Matters' in recognition of the Black Lives Matter campaign that has made months of headline news globally, and of which the long-term impact of that campaign can only be positive. It is hoped that the case for the continued need for, and understanding of, coal in a sustainable scenario too remains positive.

**Professor Nikki Wagner**

Director, Department of Science and Innovation–National Research Foundation Centre of Excellence for Integrated Mineral and Energy Resources Analysis (DSI-NRF CIMERA)

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# executive manager's corner

Craig Smith

The pandemic is still with us, and looks to be a feature of our world for some while to come. The GSSA membership has been affected significantly, as indicated by the results of a poll reported on in the end of July newsletter. The two key findings were that, as of mid-June, about 40% of poll respondents had reduced incomes as a result of lockdown, but of those a relatively small proportion had been retrenched or furloughed and lost all income. Second, there was a wide range of opinion as to when travel for field projects might be possible, possibly reflecting a variety of local and international destinations, as well as difference of opinion as to when lockdowns might be eased. We will repeat the poll in early September to see if there are significant differences from the June findings.

But life goes on—at least for now. As a result of the pandemic, the GSSA Meetings Committee has advanced rapidly in changing GSSA events into online offerings. The 60+ free lunchtime lectures have attracted over 5000 registered delegates from all corners of the globe (see events schedule). The lectures are lodged on the GSSA YouTube channel. Several paid events staged over the last three months have attracted more delegates than would be the case for face-to-face meetings. It is likely that meetings and events will never revert to the pre-pandemic way of doing things, but rather morph into hybrid meetings attracting smaller numbers of face-to-face delegates, and larger numbers of online participants. These events will probably require platforms with greater capability than webinar packages; it will be an interesting journey.

Not being able to frequent restaurants and bars for the last couple of months has allowed some reading time in the evenings (one can watch CNN or BBC for only so long!). Although a bit depressing, a must-read for all earth scientists is "*The Uninhabitable Earth—a Story of the Future*" by David Wallace-Wells (2019, Penguin Random House). The evidence for anthropogenic climate warming is becoming more and more difficult to refute, ignore or deny, and the future painted in this book is not pretty. But it does not matter whether you believe it is 'our fault' or not, because global warming is happening anyway; debates about causes and baselines are irrelevant. The focus is on consequence and not cause, so it does not matter that Milankovitch Cycles do not get a mention. The book is written for the informed citizen, and not specialist scientists, so you will not find detailed descriptions of, for example, global climate models. But the consequences of climate change are dealt with, and the most likely futures are stark. The author covers a large range of subject matter, including the economic fall-out from climate change, the limits of technology, and the impact of global warming on the proliferation of plagues—among many other topics. The book was written well before the current outbreak; we can expect many more pandemics to come that are much worse in severity as a direct or indirect consequence of warming. There are gems of information throughout this book. I did not know that the annual carbon dioxide production from Bitcoin equates to a million transatlantic flights, for example. Earth Scientists tend to be comfortable in thinking about deep time, and that underlies ideas that since the planet 'has been there before', the planet will recover. The problem is that we are about to witness geological processes compressed into the human time scale, and I do not mean the time scale of the species, but the time scale of a human lifetime. We have, maybe, three decades to get to a partial fix. It is important that practitioners of our profession understand not just the scientific facts but the societal consequences of human response to the issue. The book is highly recommended.

**Craig Smith**

# president's column

Sifiso Siwela

Fellow Members,

As the Society begins the new 2020/2021 term, I would like to show appreciation for the achievements and highlight the resilience and grit (the passion and perseverance for long-term and meaningful goals) we displayed in the past year, especially during the tough autumn and winter seasons of 2020. This time also represents the height of the COVID-19 pandemic globally, and especially in South Africa, which compounded the predicament of an already-depressed market.

Fortunately, we had already implemented corporate video conferencing and webinar software long before the pandemic was declared a National Disaster. This led to the hugely successful free lockdown lunchtime lectures that were hosted by the Meetings Committee and kept members and worldwide participants glued to their screen every weekday of the hard lockdown period, and these continue at a regular rate to date. We also held highly successful virtual events from our Meetings calendar including PGE Day, Geoskills, SAMREC/SAMVAL, 3D Geomodelling and CPD workshops. We held our first virtual 120th AGM, which was well received. We also endorsed the online Drilling Course presented by Colin Rice Exploration and Training, which is an assessed course using a tested learning management system and is an extension of the Drilling Methods course Colin Rice has presented for the GSSA for more than 25 years.

Another major achievement this year was the launch of our Mentorship Programme, initially through the Candidate Mentoring Programme (CMP) in conjunction with the statutory body SACNASP. The mentoring subcommittee had already completed research and had drafted guidelines for the greater GSSA mentoring plan long before SACNASP approached voluntary associations for the CMP. We were therefore adequately prepared for the flagship CMP, which was a launchpad for our greater Mentorship Programme. We are grateful to the mentors for dedicating their time to this important mission.

At the time of writing, we are still celebrating Women's Month and I would like to highlight the resilience, grit and leadership shown by some of the women within the Society. These women have been instrumental in the success of the Society during the tough year that was. Noleen has been instrumental in the success mentioned above for the Meetings Committee. Tania has also been involved in running some of the meetings, but more importantly has launched our Mentorship Programme. Our new Geobulletin editor, Trishya, has been doing a great job that is being acknowledged by readers, with support from Belinda on design and layout. Marlina has been key for the quality of the South African Journal of Geology. On Communications, Natalie, Tahnee and Robyn have been keeping the Society up to date and sane with useful content via Facebook, Instagram and LinkedIn. We also welcomed Prof. Judith Kinnaird as the Chair of the Fellows Committee and MANCO, and she already exhibits enthusiasm and inspiration. Thank you to all the women who participated in the women-focused lunchtime talks during August. Lastly, I would like to thank the Society's administrative staff (Sally, Lully

and Marliese) for keeping the office running during this tough time. The Society is exemplary, not only in transformation in general, but for women showing crucial leadership in trying times.

As we are about to enter Heritage Month, we should not forget our diversity as a country as well as our legacy and beginnings. We should also not forget our beginnings and legacy as a Society. Therefore, throughout September we will focus on Geoheritage, with at least 10 lunchtime talks lined up already on this topic. Readers are also directed to our Western Cape Branch website, which contains numerous Western Cape Geoheritage booklets for download.

With regards to beginnings, we are still celebrating our 125th anniversary as the GSSA and this is something of which we should all be proud.

As we spring into the season of new beginnings, I do hope that the time during lockdown has given us an opportunity for some introspection and inspired us to turn over a new leaf for the tough year ahead. I do believe that we have gone through the worst of the pandemic and that as travel opens up and the industry hopefully blooms, we can continue to change the world as geoscientists and show grit, resilience and leadership during these tough times. And more importantly, we should always continue to stay safe.

In the words of Malcolm X: "*There is no better than adversity. Every defeat, every heartbreak, every loss, contains its own seed, its own lesson on how to improve your performance next time.*"

Yours in safety,
**Sifiso Siwela**

# who is the GSSA?

**Who is the GSSA? Finance, Meetings & DPP, Networking and Academic Affairs**

The Geological Society of South Africa (GSSA) is a not-for-profit Scientific and Professional Society for earth scientists first established in 1895. Our objective is to promote and advance the earth sciences, including the study of the earth sciences, the associated public interests in the earth sciences, the earth sciences professions and the interests of the practitioners of the earth sciences, and to encourage and uphold the highest professional and ethical standards among its members.

As of July 2020, the GSSA has eight portfolio committees, each headed by a Vice President. These are:

- Finance (Mr Thomas Molelengoane)
- Meetings & Directorate of Professional Programmes (Ms Noleen Pauls)
- Networking (Dr George Henry)
- Academic Affairs & SAJG (Prof Steve McCourt)


- Membership & Transformation (Mr Dumi Sibaya)
- Branches & Divisions (Mr Gordon Chunnett)
- Fellows Committee (Prof Judith Kinnaird)
- Professional Affairs (Dr Tania Marshall)

This month we will look at the roles and responsibilities of the Finance, Meetings & Directorate of Professional Programmes, Networking and Academic Affairs & SAJG portfolios.

**Finance**

The VP of the Finance portfolio is Thomas Molelengoane. The actions of the Finance portfolio include:

- Reporting to both ManCo and Council monthly and bimonthly consecutively on the financial position of the society;
- Responsibility for the system of internal financial control established by the society and placing considerable importance on maintaining a strong control environment. To enable the society to meet these responsibilities, the ManCo sets standards for internal control aimed at reducing the risk of error or loss in a cost-effective manner. The standards include the proper delegation of responsibilities within a clearly defined framework, effective accounting procedures and adequate segregation of duties to ensure an acceptable level of risk. The controls are monitored throughout the society and all employees are required to maintain the highest ethical standards in ensuring the society's business is conducted in a manner that in all reasonable circumstances is above reproach.
- Maintaining adequate accounting records and responsibility for the content and integrity of the annual financial statements and related financial information;
- Ensuring that the annual financial statements fairly present the state of affairs of the society as at the end of the financial year and the results of its operations and cash flows for the year, in conformity with International Financial Reporting Standard for Small and Medium-sized Enterprises;
- Presenting the financial position of the society annually in the AGM.

**Thomas Molelengoane** (N.Dip. (Geol) B. Com, MDP, FGSSA, Pr.Sci.Nat.) is an Associate of ExplorMine Consultants. Thomas began working in the South African Gold Mining industry in 1986 and obtained a National Higher Diploma in Geology from the Technicon Witwatersrand in 2004 and has since worked as a mining and exploration geologist and a Mineral Resource Manager for several large South African mining companies. From 2007 to 2014, Thomas was engaged in senior management positions as an Ore Reserve Manager, where he gained valuable leadership and Mineral Resource management experience. Since 2014, Thomas has been an independent geological consultant in the mining and exploration industry in various commodities, including gold, base metals, and diamonds. He has been involved in mining and exploration projects throughout Southern Africa, for numerous multinational mining and exploration companies.

**Meetings and Directorate of Professional Programmes**

The GSSA Meetings and Directorate of Professional Programmes portfolio (run by the Meetings Committee) provides forums for geologists and scientists from related disciplines to share ideas on advances in the science and emerging technology. These forums include meetings, workshops and conferences mostly held in and around Johannesburg, with some regional events in mining hubs around South Africa:

- The Meetings Committee also arranges field trips, which in the past have included advanced structural mapping in KwaZulu Natal and visits to the Vredefort Dome and SANSA Space Operations at Hartebeesthoek.
- Together with a South African university, the Meetings Committee arranges a two-yearly Geocongress, where southern Africa-based geoscientists present their latest research. Geocongress was originally a GSSA-endorsed conference held every second year at a university in South Africa. In 2008 it was successfully combined with the Society of Economic Geologists Conference. Considering the increase in post-graduate students and post-doctoral research fellows, and the world-class quality of geoscientific work produced in southern Africa, the GSSA reinstated Geocongress in 2018.
- Every two years, the Meetings Committee stages the Alex du Toit Memorial Lecture Series, which is aimed at highlighting and comparing modern

scientific endeavour to the achievements of Alex du Toit (1878–1948).

- Through the Directorate of Professional Programmes (DPP) section, the Meetings Committee also organises specialist courses for members and non-members. These comprise stand-alone courses, including Drilling Skills for Geologists, Structural Geology, 3D Geomodelling and Competent Person's Reporting, and conferences with a single theme such as specific commodities or the annual African Exploration Showcase.
- 2020 saw the addition of online webinars and courses to the Meetings Portfolio contribution. We have teamed up with Colin Rice Exploration Drilling Advisory to bring the online "Drilling Skills for Geologists" to our members. The Meetings Committee has so far successfully run the PGE Webinar and the annual Geoskills courses remotely and we anticipate that most of the meetings and courses for the remainder of 2020 will be online.
- At the beginning of the Covid-19 lockdown, we started the Lockdown Lunchtime Lectures to bring free talks to our members. Speakers and delegates join from all over the world, and we plan on continuing these talks past lockdown.
- Leading on from the wide interest in our talks, the Meetings Committee has formed associations with international geoscience organisations including the Geological Society of Africa, Geological Society of Zimbabwe and the Botswana Geoscientists Association. This association enables a pooling of knowledge and opportunity for all these members to attend and present at each other's events.
- The Meetings Committee supports the GSSA Regional Branches in their meetings. It also provides an opportunity for recipients of the Research, Education, and Investment (REI) Fund to report on their research at meetings attended by their peers and lecturers.

None of these events would be possible without the support of industry, and the Meetings Committee is also responsible for sourcing sponsorship.

All of these events qualify for Continuing Professional Development (CPD) points, either in the Formal Learning Category, Informal Learning Category or Professional Development Category (also as Category 1 or 3B activities under SACNASP or ECSA).

**Noleen Pauls** is Principal Geoscientist for Europe, Middle East and Africa at Reflex, a subsidiary of Imdex Limited. She has more than 20 years' experience in multi-commodity mineral exploration and evaluation of gold, platinum, chrome, iron and coal exploration projects throughout Africa and gold exploration in South and Central America, based in Peru. Noleen is a fellow of the Geological Society of South Africa and VP of the Meetings Portfolio. She is a registered professional with SACNASP. She is an advocate for women in mining and is a patron and past chairperson of Women in Mining South Africa (WiMSA), and a life member for The Worldwide Association of Female Professionals.

**Networking**

The objective of the Networking Portfolio is to promote the GSSA to all members of the geoscientific community, the public and other interested parties through effective communication via social and other media. The 2020/2021 committee consists of Dr George Henry (Vice-President), Mr Mike Knoper (co-opted), Dr Craig Smith (ad hoc), Mrs Lully Govender (ad hoc), Ms Tahnee Otto, Ms Robyn Ormond, Ms Natalie Brand, Mr Andries Botha and Dr Trishya Owen-Smith (Editor of Geobulletin).

***Geobulletin***

Our quarterly publication informs our members about the happenings within our geological fraternity, including news about members, important government legislation affecting the mining industry, popular geoscientific articles, a regular geotourism column, and news from South African universities. The print copy was mailed to all GSSA members in the past, but as a result of the prolonged postal strike, a decision was taken to go entirely digital. In addition, the e-

☞

Geobulletin is now open to all for perusal, not just for members.

***Monthly GSSA e-Newsletter***

This is a mail-drop that conveys GSSA news and events to members compiled by Lully Govender. Members are welcome to submit articles for inclusion in the newsletter to her at lully.govender@gssa.org.za

***Website***

Our website continues to be a work-in-progress, especially the objective of refreshing the front page with new information weekly. It is an ongoing challenge to source new material of interest to our members, and again we would welcome suggestions. Nevertheless, all the functionalities are in place, and we hope that the site continues to be the face of the GSSA. Items of interest can be emailed to ghenry@uj.ac.za

Facebook

The GSSA presence on this social media platform is managed by Tahnee Otto with assistance from Robyn Ormond. Members who wish to post items should email them to George Henry for forwarding to Tahnee and Robyn.

***LinkedIn***

Natalie Brand manages our LinkedIn presence, which is of great use to members to keep in touch with one another on a semi-professional basis, and to inform the public about GSSA events.

***YouTube***

Noleen Pauls of the GSSA Meetings Committee organised a highly successful series of free remote lunchtime talks during the Covid-19 lockdown. Many of the talks were recorded and posted on YouTube to be made available for viewing by the general public. Andries Botha is managing this demanding process. The continued popularity of the series is reflected in the number of "views" logged on YouTube, with the highest being 957.

**Dr George Henry** is the Administrative Manager of the South African Department of Science and Innovation–National Research Foundation's Centre of Excellence for Integrated Mineral and Energy Resources Analysis (DSI-NRF CIMERA) hosted at the University of Johannesburg and co-hosted at the University of the Witwatersrand. He has had a varied career in both industry and academia, having worked for Randgold Resources after doctoral graduation, the Council for Geoscience, and the Council for Industrial and Scientific Research, amongst others. He is interested in economic and exploration geology, and the origin of mineral deposits.

**Academic Affairs**

The Vice-President for Academic Affairs is responsible for the learned functions of the GSSA and the portfolio of Academic Affairs is the home of the South African Journal of Geology (SAJG). Within the GSSA's organisational structures, the VP Academic Affairs serves on ManCo and Council and is de facto the Chair of the GSSA Publications Committee. S/he represents the geoscience community based in academia, science councils and related institutions and serves as the voice of this community within the GSSA. In addition, the VP Academic Affairs is directly involved with the management of the SAJG and represents the GSSA on the South African Committee for Stratigraphy (SACS).

The South African Journal of Geology is the primary publication of the Geological Society of South Africa and publishes peer-reviewed scientific papers, notes and discussions that are related, directly or indirectly, to the geology of the African plate. In addition, a section of the SAJG is devoted to formal descriptions of lithostratigraphic units compiled for the South African Committee for Stratigraphy (SACS). The print version of the journal is distributed to a small number of Fellows and Members but the great majority accesses the content online using GeoScienceWorld (www.geoscience.org). Fellows and Members of the GSSA are able to download published manuscripts in PDF format free of charge provided they access GSW via the members' portal on the GSSA website.

**Publication of the SAJG** is managed by a team of editors assisted by an editorial board. The current editorial team comprises a Managing Editor (Steve McCourt), a Scientific Editor (Marlina Elburg) and a Technical Editor

(Mike Knoper). Within the context of Open Access, the SAJG is a "hybrid journal", which is defined as a closed subscription journal that elects to publish a percentage of manuscripts that are immediately and freely available to readers who are not members of the linked scientific society (i.e., are Open Access).

**The South African Committee for Stratigraphy (SACS)** regulates the nomenclature and definition of lithostratigraphic and lithodemic rock units, unconsolidated deposits and soils. Since issue 118-3 (September 2015), the SAJG has published 25 descriptions of approved lithostratigraphic units on behalf of SACS.

**Prof Steve McCourt** is a respected and seasoned geological scientist and academic who immigrated to South Africa after completion of a PhD in Geology at the University of Exeter (UK) in 1975. Between 1976 and early 1983, Steve was a field geologist with the erstwhile Geological Survey of South Africa and then Mining Corporation. During this period, he was involved in regional mapping in the basement terranes of northern South Africa (Kaapvaal Craton, Limpopo Belt), the Karoo Supergroup within the northern part of the Kruger National Park, and supervised a gold exploration programme in the Giyani Greenstone Belt. Steve moved into academia in 1983, initially at the University of Pretoria (1983 to 1995) and then as HOD at the University of Durban Westville (UDW), now part of the University of KwaZulu Natal (1995 to 2016). Steve was a GSSA Council Member between 1991 and 1998 and during this term served as Honorary Scientific Editor of the South African Journal of Geology (1995–1998). He was re-appointed as Scientific Editor in 2015 and currently serves as Managing Editor, with responsibility for production and quality control.

Compiled by **Tania Marshall** with contributions from **Thomas Mololengoane, Noleen Pauls** and **George Henry.**

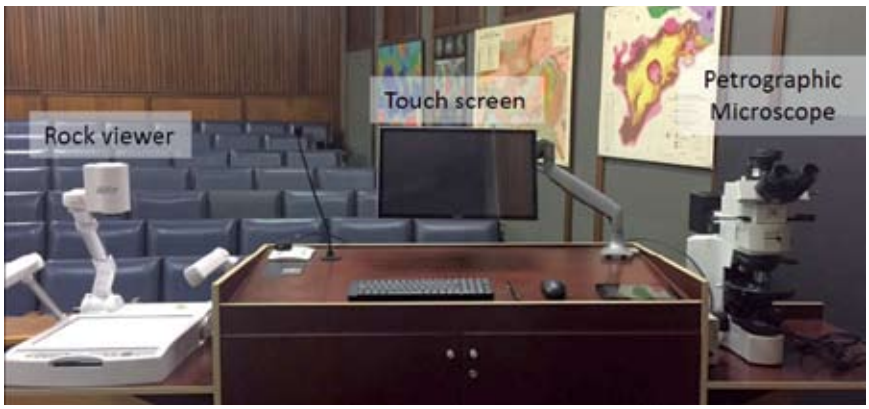
SOCIETY NEWS

# all the news fit to print

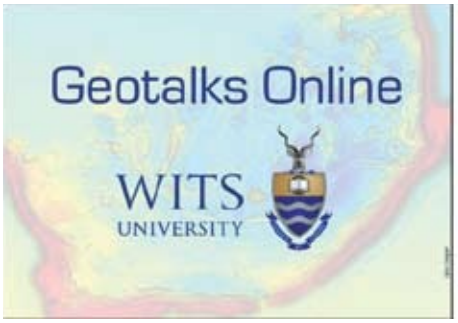
UNIVERSITY NEWS

## Wits School of Geosciences

2020 has thus far been an interesting and challenging year for the School, and the University as a whole, with the need to embrace Emergency Remote Access Learning (ERAL) from the start of the second teaching block, and the continuation of this format for the remainder of this academic year. As part of ERAL, lectures have been modified to enable integrated voice-over and video sessions using the student-learning platform SAKAI. Practical work was always going to be a challenge to implement remotely, but the introduction of a new WiFi-based microscope camera to our existing interactive lecture theatre setup has allowed our lecturers to record or live-stream integrated theory and practical lectures to students. This has added tremendously to student engagement, with a variety of practical material, including reflected and transmitted light microscopy, structural geology,




*The updated interactive lecture theatre setup.*




*(QR code)*

etc. Once students are able to return to campus, the Faculty will facilitate intensive catch-up boot-camps, where students will be able to complete the practical and field-based components of their studies.

Notwithstanding the COVID-19 pandemic, the School has had a productive and successful year so far, with highlights such as the School continuing to hold its ranking within the top 150 Earth Science departments globally (according to the QS World University Rankings for 2020). This is a tremendous feat and the School would like to thank all the hard-working staff and students that keep us there! Also, our weekly seminar series, sponsored by CCIC Coal, has shifted into an exciting new online mode—Geotalks Online—allowing many more viewers to be involved, including students, researchers and industry professionals from around the country. It has also allowed a far wider range of speakers from around the world to participate and share their latest research or new industry-related work. We're passionate about keeping the geoscience community up-to-date with the latest Earth Science research and networking opportunities. If you'd like to subscribe to these weekly mailers, simply take a picture of the QR code here or follow this link: http://eepurl.com/g1iBZj. To view the record of recent Geotalks on our YouTube channel, simply search for "Wits Geosciences", then sit back and enjoy.

On the laboratory front, the International Association of Geoanalysts (IAG) established an international proficiency-testing program (G-Chron) with a focus on U–Pb dating, where participating labs are sent a single unit of zircon and asked to determine its age. Benefits to this program are two-fold: the labs contribute towards zircon reference material development and are given the opportunity to test the quality of their data obtained under routine conditions. In 2019, 63 labs participated in the inaugural round of testing (the Wits Earth Lab included). When the results were announced earlier this year, the LA-ICPMS setup at Wits achieved a score that places the Earth Lab within the top 20% of geochronology labs worldwide.

*Prof. Kinnaird pictured after winning the NSTF–South32 Management Award.*

**Staff and student achievements**

Congratulations to Prof. Judith Kinnaird on winning the Management Award at the National Science and Technology Forum (NSTF)–South32 Awards on the 30th of July. This prestigious ceremony, often referred to as the "Science Oscars", recognises outstanding contributions to science, engineering, technology and innovation. Prof. Kinnaird was recognised for her role as the co-director of CIMERA, where she has been able to steer economic geology research for the past six years. In an interview after receiving her award, Prof. Kinnaird was quoted as saying "I have had great opportunities at Wits especially to be able to co-direct CIMERA, a national Centre of Excellence for the study of Minerals and Energy. The CoE is nationally relevant to government and industry and internationally recognised for the quality of its research. Through the CoE, it has been possible to make a difference to student lives and careers. I count myself privileged to have such an interesting and rewarding opportunity."

*Willem Kruger (right) and Prof. Rais Latypov out in the field.*

Congratulations also go to Prof. Raymond Durrheim who was a finalist in the Lifetime Award category.

The School is excited to welcome Dr Glen Nwaila, back after a short diversion into industry, and Dr Ben Hayes onto the teaching staff. Together Dr Nwaila and Dr Hayes will strengthen the team in Economic Geology teaching and research. And as is the nature of change, we also said goodbye to Dr Matthew Brayshaw, who has returned to KZN where he is currently enjoying recording music.

PhD candidate Willem Kruger, together with his supervisor Prof. Rais Latypov, had an article published in *Nature Communications* in early June. Willem's work challenges the notion that magma chambers are predominantly made up of crystals and very little melt, by showing that basaltic magma chambers may develop as large bodies of crystal-free melt within the Earth's crust.

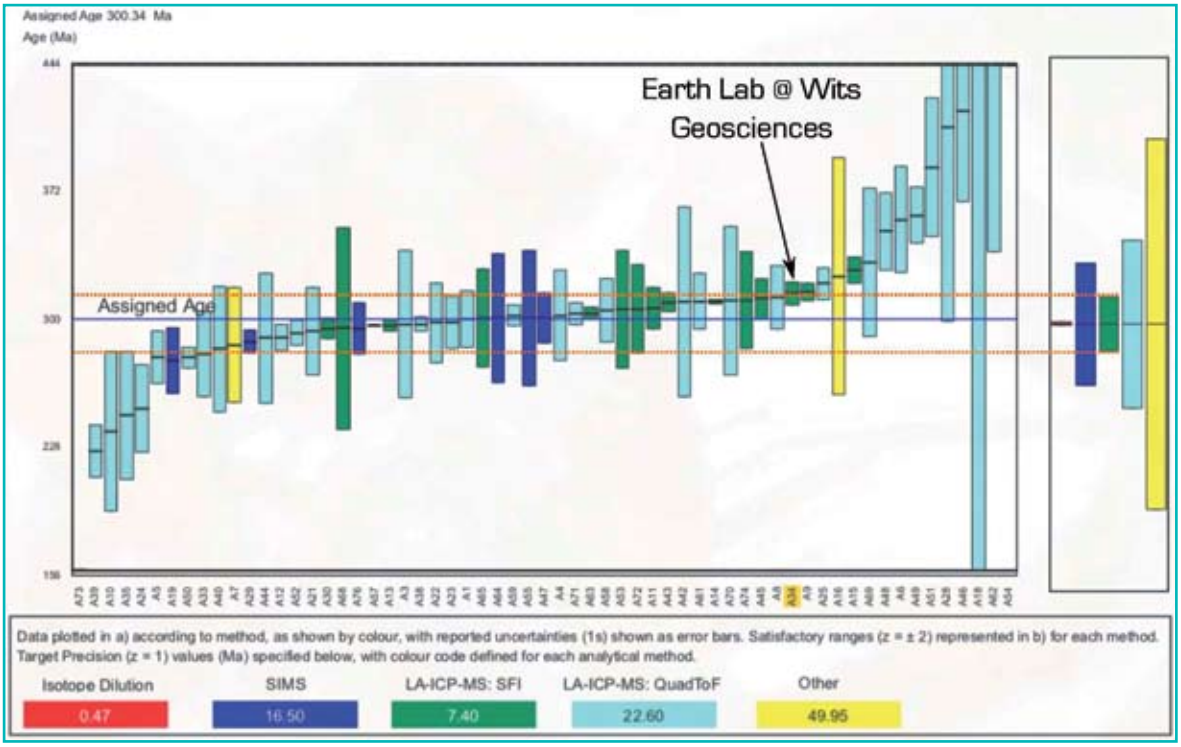
Willem was not the only student to have had a paper come out in the last few months: both recent graduate Dr


*Sandiso Mnguni (centre). The title slide of his presentation describes his thesis project and contribution to the ESSA Young Researcher Lecture Series.*

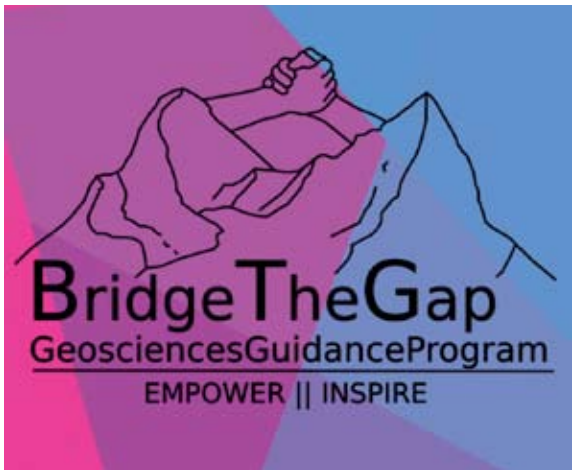
Sara Burness and Leonidas Vonopartis have published work on their respective PhD theses.

In news from our neighbours on campus, Sandiso Mnguni (a Palaeontology PhD candidate) was awarded a Young Entomologist Travel Grant from the Entomological Society of Southern Africa (ESSA) to present at the 36th International Geological Congress (IGC) in New Delhi, India, which would have taken place in March of this year. Ultimately, the IGC was postponed, but Sandiso—not one to be deterred—arranged to give his talk on the 13th of March 2020 (just before the country went into lockdown) to a more local audience with staff and students from the School of Geosciences, the School of Animal, Plant and Environmental Sciences (APES) and the Evolutional Studies Institute (ESI) in attendance.

As the title of Sandiso's talk suggests, he is using fossil insects and sediments collected from a crater-lake at Orapa Diamond Mine in Botswana to reconstruct the palaeoenvironment of this locality. During his presentation, Sandiso had the audience actively trying to guess what kind of insect(s) they were seeing—a challenge I'm sure for any geologists in the room.




*The distribution in $^{206}Pb/^{238}U$ age results determined by the various participating labs. The G-Chron zircon for 2019 was assigned an age of 300.34 Ma (RAK-17 determined by ID-TIMS), and the Earth Lab falls within the "satisfactory range" of the assigned age with a result that is z = ±2. More information on the G-Chron programme and the next round of testing can be found here.*




Last but not least, we have an exciting announcement from Bridge the Gap:

**Bridge the Gap is expanding!**

The Bridge the Gap (BTG) team is excited to announce that our mentorship program has recently been launched within the Geology departments at the University of the Free State and the University of Johannesburg. Take a look at the centrefold of this issue to meet the newly expanded BTG team!

The BTG mentorship program (operating primarily within the School of Geosciences at Wits since May

2017), is a student-led initiative designed to assist undergraduate geoscience students to better transition into the university landscape and to ignite their passion for geosciences. We aim to connect undergraduate students with either postgraduate students or industry professionals in order to present them with an academic role model, thus allowing for a positive mentor–mentee relationship to develop. The program entails regular academic assistance, practical advice and strategies for success in geosciences at both the tertiary level and within a work environment. BTG also regularly invites industry professionals to present insightful talks pertaining to relevant skills and opportunities. Previous talks include: "CV Writing Skills" with Briony Liber Coaching, "Transitioning into the Workplace" with Fabian Francis (Sasol), "Professionalism in the Geosciences" with Tania Marshall (GSSA), and "Preparing for Interviews" with Peter Roberts (Anglo American Coal), among many others (some of which can now be found online on our YouTube channel). All the membership perks mentioned above are offered free of charge to students taking part in the program.

Sadly, due to the circumstances surrounding the current pandemic, numerous planned talks, workshops and networking events fell through. The upshot though, is that our team has taken this opportunity to focus their energy on expanding the program into other universities and institutions. The program has recently been initiated at both the University of the Free State and the University of Johannesburg; and we are also corresponding with representatives from other universities interested in running the BTG program within their geology departments. In addition to this, we are also collaborating with the Mineralogical Association of South Africa (MINSA) to encourage more industry professionals to join the program and spread the value of mentorship. We have also partnered with Women in Mining South Africa (WiMSA), who were generous sponsors of data that allowed three students to attend the recent "Foundations of a Geological Career—GeoSkills" Webinar hosted by the Geological Society of South Africa.

Lockdown has also given us the opportunity to focus on our social media presence, as being active across various platforms gives us the chance to connect with students and professionals throughout the country, and has helped us recently to increase the number of industry professional sign-ups as well as spark interest from other universities. We regularly use social media as a way to engage with our audience. Some examples include canvasing which geology-related and practical advice conversation topics students are most interested in, giving young professionals the opportunity to share their recent publications on #ResearchTuesdays, and their experience in the workplace via #ILoveGeology every Wednesday.

As we expand into other universities, our aim is to adjust our mentorship model to suit the needs of each department. This brings an exciting challenge to the BTG teams at the various departments, where we hope that the customised model approach will inspire more students to pursue postgraduate research within their institutions, knowing they have an additional support structure in place. BTG believes that mentorship is vital for student development and greatly enhances their chances for success because of the knowledge and skills that can be transferred from mentor to mentee. Our platform gives students the opportunity to develop into self-confident and independent individuals, by allowing them to take responsibility for their personal development beyond their university experience and into their working life.

The BTG team is grateful that despite the challenges posed by COVID-19, we continue to empower students through mentorship and inspire future leaders. As the program continues to expand, we would like to acknowledge the unrelenting support of our overseers from the various university departments. BTG looks forward to future collaborations and launches, and we hope to continue to empower and inspire others!

If you are interested in getting involved, please complete this Google form, or for more information, please email bridgethegap.wits@gmail.com or reach out via WhatsApp: +27 64 836 4185.

Compiled by **Sarah Glynn** from various departmental contributors and the **Wits BTG team**.

# the geological hot pot

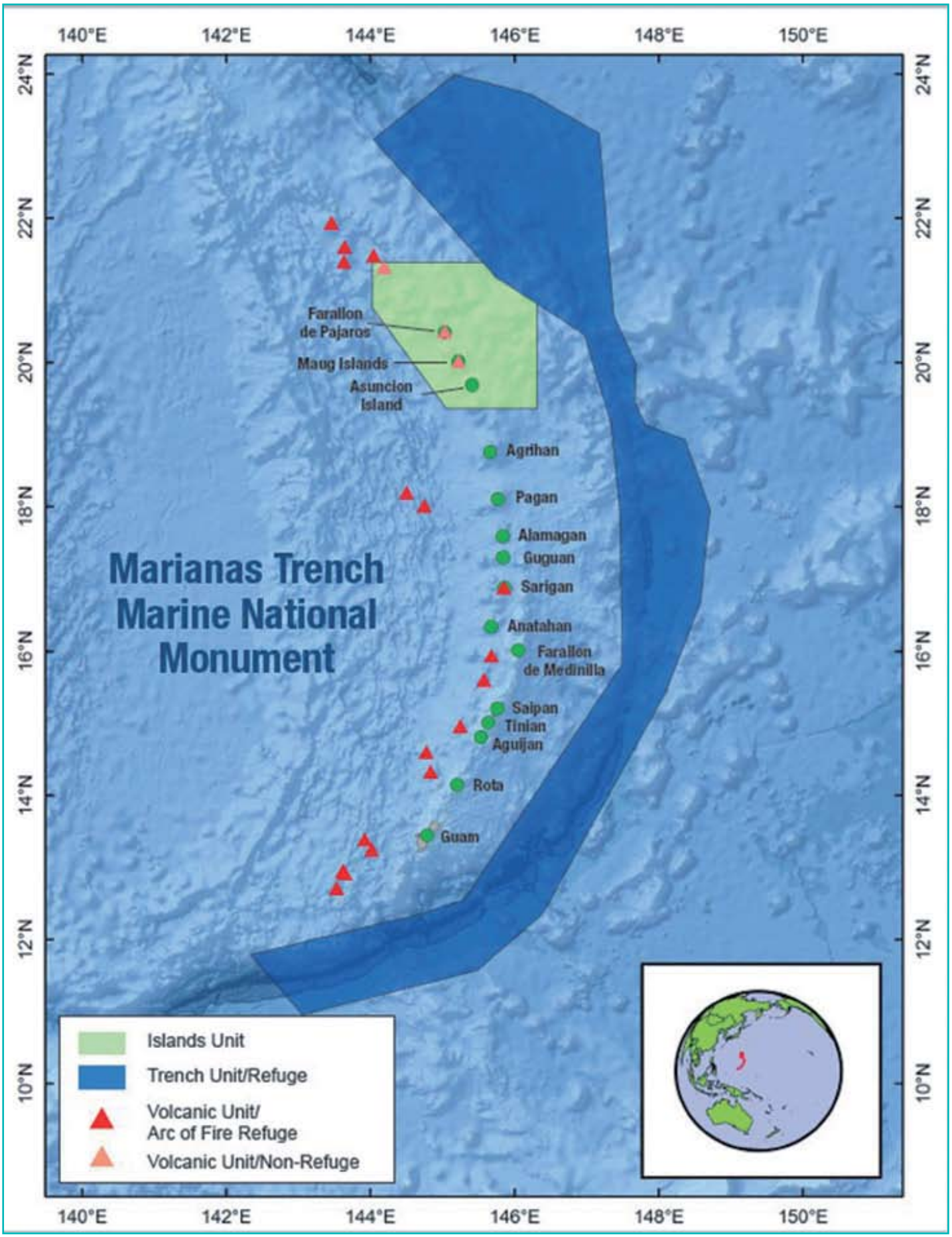
**The Geological Hot Pot**

This issue opens with a huge scientific breakthrough in the fact that we can now see atoms! The imaging technique known as cryo-electron microscopy is several decades old. It determines the shape of flash-frozen samples by firing electrons at them, and recording the resulting images. The technique was mainly used to image organic materials such as proteins. Recent advances have improved the resolution of the technique to such an extent that individual atoms can be imaged at the 1.2 ångström diameter level. You can read more about Cryo-EM in this *Nature* article.

From the very small to the very big… Have you ever wondered what controls the height of mountains? We geoscientists study recent and ancient mountain belts that are formed due to tectonic interactions at plate boundaries. Once the mountains are formed, what determines the height they potentially reach? Mountains are subject to erosion that tends to lower their altitude. A recent analysis of the forces acting on mountains near plate boundaries provides evidence that tectonic forces, rather than erosion, control the heights attained. A summary of the findings is provided in this *Nature* article.

We all wish we can go travelling around the world to visit other countries to experience their tourist sites and culture, and may do so soon once the COVID-19 pandemic abates. America's oldest National Park is Yellowstone, and should be a must-see not only for the layman, but for all geoscientists. The park is centred around the caldera of a huge volcanic structure that is driven by an intra-plate hot spot. The volcanic activity in Yellowstone is under continuous scrutiny because

*Castle Geyser in Yellowstone National Park (source: Brocken Inaglory, Wikipedia Commons).*




*Map of the Marianas Trench (source: NOAA, Public Domain).*

of the perceived "Big One" that will cause a major disaster in the country if and when it happens (read Hollywood script). A recent article in *Geology* reports the discovery of the biggest ever eruption of the Yellowstone supervolcano around 8.7 million years ago. This event blew out an estimated 2 800 cubic kilometres of volcanic material, on a par with the Toba eruption in Indonesia about 74 000 years ago that almost wiped out the human race.

On the theme of volcanoes and their effects on humans, recent research has provided very strong evidence that an eruption of the Okmok volcano in Alaska's Aleutian Islands in 43 BC contributed to the fall of the Roman Republic. A most readable account of the multi-disciplinary research is given in this *Science* article. Those of us who had the good fortune (or not) to have Shakespeare's Julius Caesar as a set work in English literature will recall that he was assassinated during the Ides of March in 44 BC His death triggered the troubles of the Roman Republic, with the final straw being the chaos brought about by the Okmok eruption. Scientists studying ice cores from northern Greenland found a heavy spike in sulphur at 43 BC that they attribute to a major volcanic eruption. This caused global cooling that led to widespread crop failures in Europe and peasant uprisings, followed by the fall of the Roman Republic and the birth of the Roman Empire.

It is well known that we have mapped the surface of the Moon in more detail that the Earth's ocean floor. We need good seafloor maps for a number of reasons including navigation, laying undersea cables and pipelines, and fisheries management and conservation. A well-illustrated BBC article reports that one-fifth of our planet's ocean floor is now mapped. This is largely the result of the Nippon Foundation GEBCO Seabed 2030 Project that started in 2017. Back then only 6% of the ocean floor had been surveyed at modern standards and spatial resolutions. The striking image of the deepest oceanic point on Earth in the Marianas Trench in the western Pacific Ocean is a good illustration of the ongoing surveying work.

We love our rocks! They come second only in our lives to our loved ones (for normal geoscientists) and they deserve to be treated well. Planavsky et al. provide a well-written comment in *Nature* explaining why geological samples are important and why they should be archived and shared for research. With regards to the latter, the importance of the reproducibility of results to ensure scientific integrity cannot be overstated.

What do Kuruman Kop in the Northern Cape Province and a pool in the Mexican desert 1 000 km north of Mexico City have in common? The answer can be found in this fascinating article in *Science*: stromatolites! Part of South Africa's wonderful geological heritage are the outcrops of Transvaalian dolomites that contain these ancient signs of life on Earth that are Paleoproterozoic in age. We know that modern stromatolites are being formed in very rare environments such as Shark Bay in Western Australia. Another locality is the mineral-rich pools of water that form the oases in the Mexican desert. Ongoing studies will contribute more to our understanding of how life on earth began and propagated.

Which leads us to the subject of caves. We all know that caves are developed predominantly in carbonate rocks—limestones and dolomites. But did you know that they can also form in silica-rich rocks such as quartzites? A talk by Francesco Sauro, as part of the TED (Technology, Entertainment, Design) series, gives an eye-opening account of a truly lost world in the Roraima Mountains in Venezuela and Brazil. The amazing cave structures in the Paleoproterozoic quartzites have formed over tens of millions of years, a much longer timespan than for caves that form in carbonate rocks. Suaro is a geologist and a speleologist, and he and his team's research really emphasises how wonderful our natural world is. In the talk he jokingly mentions the possibility of running into a dinosaur.

Which brings us to ask: What killed the dinosaurs at the end of the Cretaceous? This is another topic

*Mega-domal stromatolites at Kuruman Kop in the Northern Cape. Note geological hammer for scale.*

that tends to get geologists and palaeontologists hot under the collar when they gather at conferences to present their latest findings in support of their pet theories, not to mention in the scientific literature. The two leading contenders are an asteroid impact, or massive volcanism giving rise to a large igneous province (LIP), namely the Deccan Traps in India. A recent *PNAS* article by Chiarenza et al. has the definitive title "Asteroid impact, not volcanism, caused the end-Cretaceous dinosaur extinction". The authors combined climate and ecological modelling tools to demonstrate that the Chicxulub asteroid impact was not good for dinosaur survival. Furthermore, they speculate that the Deccan volcanism could have, in fact, *ameliorated* the effects of the asteroid disaster. Now we expect the LIP proponents to come back fighting!

Another tourist site worth visiting because of its historical significance and mystery about its origins

*View of Mounts Kukenan (left) and Roraima (source: M Campello, Wikipedia Commons).*

*Stonehenge (source: Gareth Wiscombe, Wikipedia Commons).*

is Stonehenge in England. You would think that by now, after years of study, we would know everything there is to know about the place, but, surprise, surprise! Scientists have finally worked out where the huge silcrete boulders, termed sarcens, that are in the structure come from. The smaller "bluestones" in the middle come from a quarry in Wales, but the larger sarcens have now been traced to an area about 25 km north of Stonehenge. A gamut of geochemical fingerprinting techniques, including using a hand-held XRF, inductively coupled plasma–mass spectroscopy (ICP-MS) and ICP–atomic emission spectrometry (ICP-AES) was thrown at the problem, and a definitive answer is the result. Read all about it in this article in *Science*.

There are those who believe passionately that Stonehenge and the Pyramids, amongst other ancient structures, were built by aliens from outer space because primitive man could never have done it. Which leads to the fact that Unidentified Aerial Phenomena (UAP), better known as UFOs, have never been scientifically investigated at all. Now Kopparapu and Haqq, a planetary scientist and astrobiologist, respectively, put forward a strong case for why UAPs should be taken seriously and studied scientifically. This article in *Scientific American* caught my attention because, years ago, when I started out my career as an exploration geologist, I saw a strange light in the night sky near Sutherland in the Northern Cape that I've puzzled over ever since. A colleague and I were returning from a trip to Cape Town and it was dark by the time we drove up Verlatenkloof Pass on the final stretch to Sutherland. We saw a bright orange light ahead of us, about 30 degrees above the horizontal, that appeared to float in the sky. It did not move as we headed towards it, and "switched off' after a couple of minutes. Now Sutherland is in the desolate Karoo, and it's hard to explain what we saw. Perhaps a multi-disciplinary study of UAPs would give some clues and provide rational answers to such sightings. To top it, my colleagues saw an unexplained, moving green light the next evening when he was on his way back to Sutherland after a visit to Beaufort West! Maybe the aliens are after the uranium deposits in the area….

**George Henry**

MINSA

# Mineralogical Association of South Africa

MINSA organises a variety of events of interest to mineralogists, geochemists & petrologists. These events promote access to cutting-edge developments in the field through regular talks, symposia, workshops, field trips and our quarterly themed Geode newsletter.

Our line up of events is outlined below, join MINSA today to take part!

**14 SEPT**

## GEODE

September's theme: 'Samples, Sampling & Sample Preparation'

**20 - 21 OCT**

## SYMPOSIUM

* Novel, interesting, & under-utilised techniques in process mineralogy

* Samples, Sampling & Preparation

**16 SEPT**

## AGM

Held virtually through a video conference platform

## Join Minsa today

minsa@gssa.org.za

Design by Sara Turnbull

# new generation

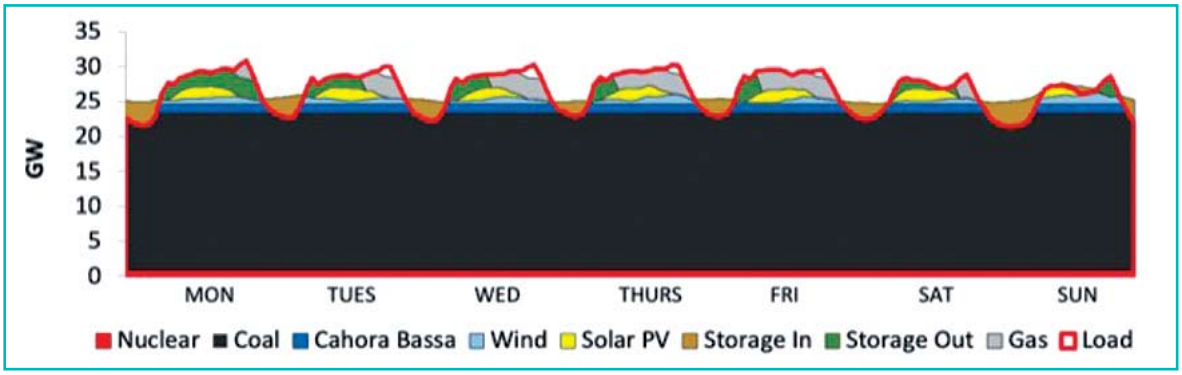
**Dancing to the new generation**

The world will migrate to a virtually all-electric energy system by 2050. No more fossil fuel propelled vehicles, trains, busses, trucks, boats, and eventually aeroplanes. The same goes for many industrial processes, which will be electrified or make use of "green" hydrogen as a feedstock.

In the South African context, my calculations show that we will require about four times our current quantum of electricity by 2050. According to the most recent integrated resource plan (IRP2019), we will consume about 1.4 times our current amount by 2050; but the IRP2019 only factors in demand growth from our current user base, not for the switch from fossil fuels to electricity in transportation and industry.

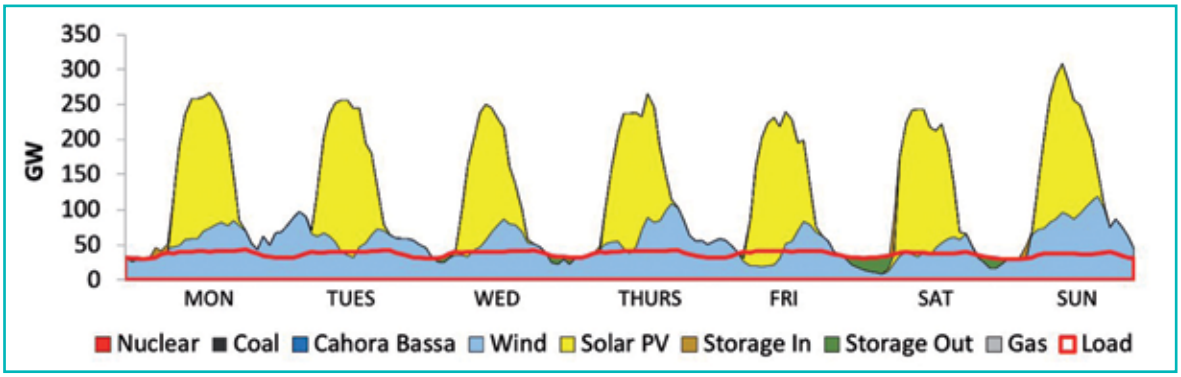
At present, our electricity demand profile calls the tune, and we must juggle our generation assets to dance to that tune. In the future, the generation profile will call the tune, and the new electricity demand sectors will adapt their patterns and user habits to fit in with the generation profile. The whole electricity supply industry will quite literally be turned on its head.

*South Africa's existing supply and demand curve.*

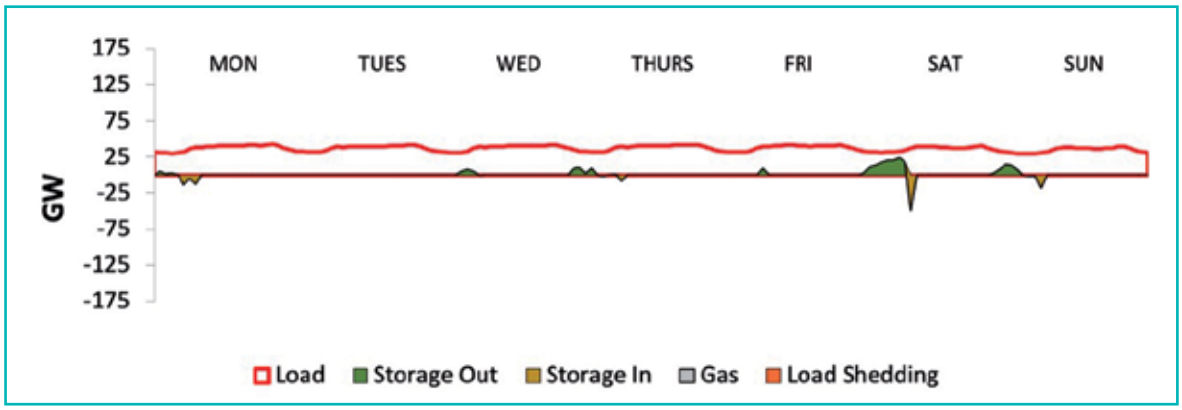



The chart above shows South Africa's current electricity supply/demand curve and balance. Nuclear and coal supply meet "baseload" and some of the mid-merit requirements, and Cahora Bassa (hydroelectric), wind, solar, pumped storage and diesel-fired open-cycle "gas" turbines (OCGTs) supply the rest, including the peaks.

*Predicted supply demand curve from renewables and storage in 2050.*



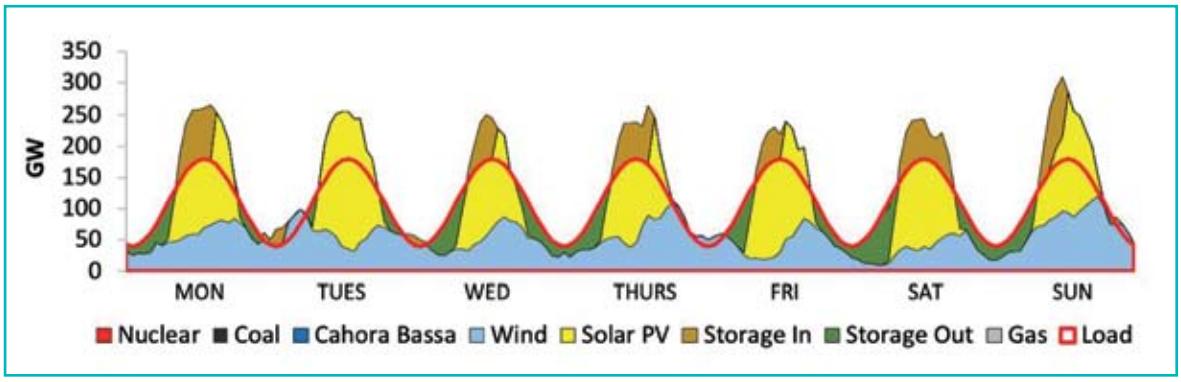

The chart above shows what a typical week in March 2050 will look like from a fleet dominated by solar PV, wind and storage (240GW PV, 150GW wind, and 90GW/360GWh storage, including hydrogen storage). It shows an increased electricity demand profile (by 40%), to reflect the IRP2019 demand estimates for 2050. Notice that the "conventional" demand profile is easily met, even on days with much less wind and solar, by drawing on storage. There is no nuclear, no coal, and no gas. This then represents the new generation profile that will call the tune in 2050.



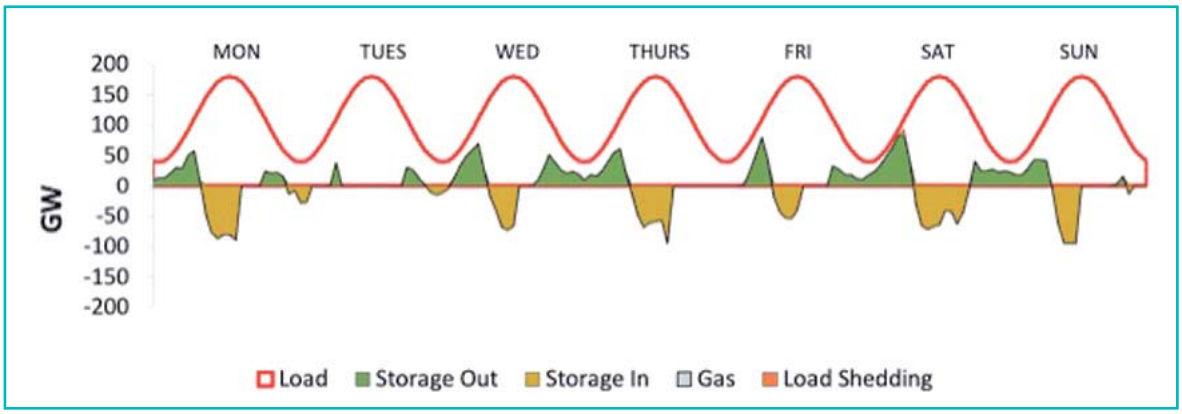

*Predicted residual demand curve by 2050.*

The chart above shows the 2050 residual demand curve, and highlights when surplus electricity is stored (brown), or when shortfalls are met by storage (green).

The newly electrified sectors will now adapt and dovetail with the new generation profile, which would call the tune, and thus the actual demand curve for all of the electrified sectors will look as shown in the chart below.




*Predicted 2050 demand curve for all electrified sectors.*




*Predicted day/night supply and demand in 2050.*

The chart above highlights the charging and discharging of the storage systems. It is important to note that due to the scale of wind, solar and storage assets, there would never be a time when the existing (as in 2020) demand, scaled up by 40%, could not be met by the system.

So, in the end, in my opinion, South Africa does not require any more nuclear, coal, or natural gas for electricity production. By 2050, we will all be dancing to the tune of the new generation.

**Clyde Mallinson** is a geologist who supports the use of renewable resources for energy production, in preference to those that deplete.

This article was first published at https://www.energize.co.za/dancing-to-the-new-generation/ and is republished with their permission.

# mining after covid-19

**Covid-19—What will the SA mining industry look like after the pandemic?**

It is fair to say that although the South African mining industry represents 8% of our GDP and employs approximately 450 000 people, by 2019 figures, it is SA's sweetheart industry. The mining industry was one of the first industries to be permitted to resume activities during the lockdown (and in some instances did not even fully shut down at all).

Mining is a sunset industry. Minerals are finite. Their extraction becomes more challenging every year as mines have to go bigger and deeper to access minerals. At some point we will run out of mineable resources, but for now it is projected that there are still approximately $2.5 trillion of mineral resources in the country. No picture of SA's future is complete without taking into account what mining can contribute.

Any prediction of the industry's future must inevitably consider the impact of the Covid-19 pandemic globally, but must also consider what transpired over the past quarter of a century since the dawn of our democracy.

In the mid to late 1990s, mining was controlled by approximately seven large mining groups. They operated like mini-governments and had large service departments, including research and development budgets. The re-entry of South Africa's mining industry into the global economy has contributed to the fundamental restructuring of the old "mining house" system as doors opened to international investment and movement of currencies relaxed. Over the past 25 years, we have seen:

- A new mineral law dispensation where the old Roman-Dutch law of mineral ownership was replaced with governmental custodianship. This was radical, but was needed to wrestle the economic power away from the mining houses and enable junior minors to enter the industry. This has also brought regulatory oversight as to who can own mining rights and under what circumstances a transfer of those rights can occur.
- Mining operations have been deconcentrated through various spin-offs to smaller operators. This, coupled with the opening up of new mining right applications post the deconcentrating of mineral rights, has brought many entrants into the mining industry. Although the bulk of mining is still in the hands of majors, there are now in excess of 58 mining companies who are members of the Minerals Council (previously the Chamber of Mines).
- The development of a social and labour responsibility mindset where mines acknowledge their licence to operate within host communities and focus on leaving a sustainable legacy once the life of mine comes to an end.

The Covid-19 pandemic may prove to be the ultimate disruptor or accelerator of change to the industry where the normal strategies of risk mitigation such as weathering currency and commodity fluctuations may prove ineffective.

Looking forward, there are three themes that will drive the metamorphosis of the industry:

- **Technological research and development:** To remain competitive, the industry will have to spend more on technological research and development than it used to under the mining house system. We will need new technologies to unlock the country's remaining mineral wealth and this may include artificial intelligence and deep-level remote mining employing skilled operators, rather than sending workers underground. This is an emotional issue, as the argument is often made that technology will replace employment and in a country where we are teetering on an unemployment rate of 30.1%, this

is not an insignificant consideration. Although one has great empathy with such a concern, it is not a question of choosing or rejecting technological advancement. Without it, some mineral resources cannot be mined at all and for the rest, it is important that mines remain competitive. Technology is the only answer to delaying the inevitable death of the industry once our mineral wealth runs out.

- **Economies of scale:** Small mining operators remain more vulnerable to internal and external threats. Larger companies are able to spread the risk among their operations, capitalise on economies of scale, attract better investment and unlock funding.
- **Infrastructure challenges:** The stability and cost of electricity supply remains the primary infrastructure challenge to the industry. Small mining operations cannot solve their electricity demands themselves. It is encouraging that Government is developing strategies to permit and encourage private electricity generation, but the capital costs thereof puts this beyond the reach of small and medium mining operations.

The future may very well look a little like the past. We should anticipate the consolidation of mining interests and operations over the next few years into the next decade. In the post-pandemic jungle, the evolution of the mining industry will ensure that only the fittest survive. To be able to capitalise on these opportunities, mining companies will need to be bigger and stronger.

But these trends were there before Covid-19 anyway—all that will happen now is that the financial stresses on small and medium mining operations will accelerate the process where financially distressed mining operations are the low-hanging fruit to the astute mining investor.

**Wessel Badenhorst**
Partner, Hogan Lovells Johannesburg

# geological travels

**Geological travels and adventures in the Indian Subcontinent during the ill-fated 36th IGC, early 2020, at the start of the COVID-19 pandemic.**

**Part 1: India**

In February 2020, I went to India in order to participate in the 36th International Geological Congress (IGC), and in its pre- and post-Congress field excursions. I was a voting member of the South African National Committee for the International Union of Geological Sciences/IGC (the body that organises the IGC).

On my way to India, I stopped over in Mahé, the Seychelles, for a few hours, just as Alex du Toit did (see my recent article "A few hours with Alex du Toit in the Seychelles in 1938", S. Afr. J. Sci., 2020). The only notable things to see at night in Mahé Airport are several large voluptuously shaped Coco-de-Mer fruits, resembling female torsos, on display (and not for sale). This much-prized fruit, the largest wild fruit in the world (weighing up to 42 kg), comes from a rare palm tree, *Lodoicea maldivicus*, which is endemic to two islands in this archipelago, Praslin and Curieuse (although it is now grown in several other places). The specific name of this fruit, *maldivicus*, comes from the fact that for centuries it used to be found floating in the Maldives archipelago, and many legends arose about its origins, before the source trees were finally discovered in the Seychelles by French explorer Marc-Joseph Marion du Fresne in 1768. Du Fresne is better known as the discoverer of South Africa's sub-Antarctic Prince Edward Islands (Marion Island is named after him), and the Crozet Islands. He was also the first European to land in Tasmania. Then he and 26 of his men met with a sticky end in the Bay of Islands, New Zealand, in 1772, when they were killed *and eaten* by Maori warriors.

*Chhatrapati Shivaji Museum (formerly Prince of Wales Museum), Mumbai—epitome of the Indo-Saracenic architectural style.*

*Entrance to the ruined 17th Century Portuguese Fort at Bassein, north of Mumbai, showing the Portuguese royal coat of arms.*

In the vast, bustling, noisy and heavily polluted megalopolis of Mumbai I visited the Chhatrapati Shivaji Museum, an oasis of serenity, with its great collections of Indian art, including sculpture, and beautiful gardens. The foyer of this 19th Century building, an epitome of the "Indo-Saracenic" architectural style, contains pillars decorated with the famous green "marble" made of serpentinite (altered mantle peridotite), from the Aravalli Belt in Rajasthan. As part of a geo-archaeological project involving the study of ballast from the 17th Century Portuguese shipwreck "Sacramento", which is located at Schoenmakerskop south of Port Elizabeth, I visited the ruined Portuguese fort at Bassein, North of Mumbai, where the "Sacramento" was originally built. The fort is constructed entirely of dressed blocks of Deccan Trap basalts, and some laterite.

I then flew to Ahmedabad, where I had been invited to give a talk at the Physical Research Laboratory (PRL), India's foremost geochemical laboratory involved in meteoritics and space science research. Because of tightened security due to the impending visit of one Donald Trump to Ahmedabad, I was unable to gain access to the PRL. So I had discussions with my embarrassed hosts in a coffee shop instead! The discussion was in connection with my discovery of the c. 3 Ga, >45 km-wide Simlipal Impact Structure in 2019 in Odisha, eastern India, which was to be presented at the IGC in Delhi.

An obligatory sight for any visitor to Ahmedabad is Mahatma Gandhi's Ashram on the banks of the Sabarmati River. At this famous shrine of non-violence and Satyagraha (a philosophy that Gandhi developed and first practiced in Johannesburg), I was greeted by the incongruous sight of heavily armed soldiers guarding its entrance (thanks, again, to the said Trump, who was going to visit in a few days). This ashram was the point of departure for Gandhi's famous Salt March, when he set out, on 12th March 1930, accompanied by 79 Satyagrahis, to protest against a British prohibition on gathering of salt, and the unjust imposition of a tax on it. When they reached the sea at Dandi, on the 5th of April, their numbers had swelled into thousands. Gandhi publicly and deliberately bent down and scooped up salt and provoked the British to arrest him. Never has the act of collecting a mineral been of such great political import! Gandhi, through this non-violent act of civil disobedience, was, in his own words, "undermining the very foundation of British imperialism". This scene is illustrated in a diorama at the Sabarmati Ashram.

*Diorama at the Sabarmati Ashram, Ahmedabad, showing Gandhi scooping up a handful of sea salt at the culmination of the Dandi Salt March, on 5 April 1930, in protest against British laws.*

*The famous "Jali" or window screen, carved out of solid Rajasthani marble, at the Sidi Saiyyid Mosque, Ahmedabad.*

Another famous Ahmedabad sight is the 16th Century Sidi Saiyyid mosque, at Lal Darwaza or Red Portals, with its World Heritage-listed intricately carved Rajasthani marble latticework windows, or "jalis", depicting intertwined trees and foliage. The mosque was built in 1573 by an Abyssinian (Ethiopian) called Shaykh Sayyid al-Habshi Sultani, or Sidi Sayyid, who was part of a little-known African diaspora on the Indian subcontinent.

From Ahmedabad I flew to Varanasi (Benares) on the Ganga (Ganges) River, which was to have been the start of a pre-conference Field Excursion of the IGC. However, because of the Coronavirus epidemic in China, the Indian government at that stage banned Chinese delegates from entering the country. The Chinese contingent was to have been the largest foreign delegation to the IGC (the Secretariat of the IUGS, which organises the IGC, is based in Beijing), and as a result, the original excursion was rendered unviable and was cancelled. My plane ticket could not be changed or refunded, however, so I went to Varanasi anyway.

Varanasi is situated on the north bank of the Ganga, opposite a very large sand bar. The temples and the steps leading down to the river are made of red rippled flaggy Vindhyan sandstones. The Ganga is one of the main river systems traversing the large foreland basin of the Himalayan orogeny, the Indo-Gangetic plain, and is nourished by numerous tributaries. It carries a

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*View from the rooftops of Varanasi of the braided Ganga River, with a large shifting sand bar on the far shore.*

huge volume of sediment towards the Bay of Bengal, where it is joined by the Brahmaputra. The joint sediment output of these two gigantic rivers has produced the largest submarine fan system on Earth—extending all the way down the Bay of Bengal to the latitude of the tip of Peninsular India, a north–south distance of about 1300 km.

I hired a small boat to show me the famous Ghats of Varanasi, where Hindus had their bodies cremated, or their ashes brought in from faraway places, and scattered in the sacred Ganga Mata (Mother Ganga), as the river is known here. The sight of up to eight funeral pyres with burning bodies simultaneously being engulfed in fierce flames, while family members, priests and attendants milled about nonchalantly, with unconcerned omnipresent cows and goats feeding obliviously on tufts of grass or discarded flower garlands among shrouded corpses lined up on the riverbank, and somber-faced tourists in boats, like myself, trying to make sense of this bewildering spectacle, is not easily forgotten. I was deeply distressed by these sobering sights, which brought up in sharp, undeniable, palpable and breathable reality the fragility of our existence on this earth, and which jarringly shattered the illusory sense of immortality that sustains our daily existence, by reminding us that we will all end up as a heap of ashes. At sunset I observed the daily theatrical enactment of the Ganga-Pooja on the steps overlooking the river—a quixotic mixture of synchronised acrobatics, fire juggling, and deep, chanting, bell-ringing religiosity, accompanied by loud beating drums and brightly lit white smoke from the ritual fires, in which the gathered throngs of worshippers and onlookers from a huddle of surrounding boats were deeply absorbed. I resolved to leave this depressing open-air crematorium as soon as I could, and arranged for a porter at 3 AM to help me carry my luggage, past slumbering beggars wrapped in their shawls, sleeping dogs sprawled in the narrow alleyways, and monkeys resting in the rooftops, wending our way carefully in the darkness for a kilometre or so through the roadworks where traffic was forbidden, to where I could catch a three-wheeler tuk-tuk for the train station, in time for the 4 AM train.

I had been offered a place on one of the few remaining IGC excursions that were still going ahead because the participants had already entered India, but it was going to start several days later, some 500 km away! So I first travelled by train from Varanasi to Lucknow, where I was a guest of the Birbal Sahni Institute for Palaeosciences. Having taken the earliest train, I arrived in Lucknow, five


*At the Birbal Sahni Institute of Palaeosciences, Lucknow. Prof. Nicholas Christie-Blick in the centre, Prof. Mukund Sharma, second from right; Sharad Master on the far left, Advind Singh second from left. On the wall is a portrait of the founder of the Institute, Prof. Birbal Sahni (1891–1949).*

hours later, in time to attend two prestigious lectures given by the Indian National Science Academy's award-winning special guest lecturer, Prof. Nicholas Christie-Blick of Columbia University (whom I had known from a previous memorable field trip in Namibia in 1999, when we shared a Land Rover driven by Dr Roy Miller). I participated in a field excursion, with Nick Christie-Blick, to see sedimentary deposits in uplifted terraces of the Indo-Gangetic Plain, a few thousand years old, along the Loni River, some 20 km SE of Lucknow. Here we saw well-developed palaeosols, silcretes, and salt efflorescences precipitated by evaporating groundwater discharges. Thereafter we were shown the sights of Lucknow, including the Bara Imambara and Asaf ud Daula Mosque Complex, and the City Gates (Rumi Darwaza), both built in 1784, and the ruins of the British Residency (destroyed during the Indian Rebellion of 1857).

Professor Birbal Sahni was the first Indian palaeobotanist, and the Institute he founded is the foremost Indian palaeontological research institute. Having been a Fellow of the Royal Society, he occupied a position among the pantheon of Indian scientists. Sahni died in 1949, a week after the official opening of his institute by then Prime Minister Jawaharlal

*Uplifted clayey siltstones in a terrace of the Loni River, south of Lucknow, showing palaeosols with rootlets, and white salt efflorescences. The lower part of this sequence has been dated at around 75 kyr, whereas the uppermost layers are around 26 to 7 kyr in age. These beds are part of the Indo-Gangetic plain, the main foreland basin of the Himalaya Orogen, and indicate continued uplift and incision in this tectonically active region.*

*Polydeformed granitic gneiss on the platform of Lucknow Railway Station.*

Nehru, and he was cremated on a plinth in the central courtyard, which today is a memorial to him. Hence it was to a very appreciative audience that I gave one of my intended IGC lectures, on "Correspondence concerning Gondwana palaeobotany and geology between South African geologist A.L. du Toit and Indian geoscientists Birbal Sahni, D.N. Wadia and M.S. Krishnan (1927–1947)". I spent a few days at their Laboratory for Precambrian Palaeobiology, which is under the directorship of Prof. Mukund Sharma. While in Lucknow, I received news that the entire International Geological Congress, including all post-congress field excursions, had been postponed because of the growing COVID-19 pandemic.

I was kindly escorted to the Lucknow Railway Station, whose platforms are paved with the most interesting polydeformed granitic gneisses, which could keep a geologist entertained for hours! I then made a not-to-be-repeated, supremely uncomfortable, 18-hour train journey (2nd Class A.C., top bunk) to Nagpur, which was the start of my replacement field excursion (one of only four pre-conference excursions that actually ran). This 5-day excursion was across the Satpura Gondwana

*RIGHT IMAGE:*

*The Talchir Conglomerate with a leucogneiss pebble derived from basement rocks. This glacial tillite at the base of the Gondwana Beds in India is an equivalent of the Dwyka tillite in the Karoo basins of Southern Africa.*

Basin of Central India, in Madhya Pradesh. It took in the entire stratigraphy of this Karoo-aged basin, starting with the Talchir glacial conglomerates (equivalent of our Dwyka beds), through coal-bearing strata with *Glossopteris* flora (cf. our Ecca), and into thick fluvial sandstones and conglomerates of the Pachmarhi Formation (cf. our Beaufort and Stormberg beds). In this latter formation I discovered several horizons of palaeoseismites, not previously recognised as such. The Pachmarhi Formation crops out as a resistant tableland, forming a castellated plateau with the highest elevations in Madhya Pradesh. We climbed Roopgarh,

*New Sethia Coal mine, situated in the Baraker Formation, Satpura Basin. The Baraker Formation is the time-equivalent of the Ecca Group of the Karoo Supergroup.*

*Fluvial cross-bedded conglomerates of the Pachmarhi Formation, Satpura Gondwana Basin, equivalent of the Beaufort Group of the Karoo Basin in Southern Africa.*

*View of the Satpura Ranges from the top of Roopgarh (1352 m ASL), the highest point in Madhya Pradesh.*

highest point in the Satpura Ranges, at 1352 m above sea level, for a spectacular sunset view of the rugged landscape. The Indian Gondwanas do not have thick Jurassic lava flows (equivalent to our Drakensberg), but have Cretaceous redbeds. They are capped with thick outpourings of flood basalts of latest Cretaceous-early Palaeogene (K–Pg) age—the famous Deccan Traps.

The Satpura basin is the home of members of the Gond tribe, who are world famous because they gave their name to the Gondwana biotic realm (recognised by late 19th Century Austrian geologist Eduard Suess), and later the Gondwana Supercontinent. Whereas Roderick Impey Murchison had named the "Ordovician" and "Silurian" systems after extinct Welsh tribes, Gondwana had been named after a Central Indian tribe that was still extant. Incidentally, Gondwana means "the land or abode of the Gonds", hence the term "Gondwanaland" is a tautology, and the supercontinent should be referred to as "Gondwana", and not as "Gondwanaland". The Mahuwa tree (*Madhuca longifolia*) is plentiful in this district, and from its fleshy flowers, the Gonds (like many other local tribes of India) distil a potent alcoholic spirit called "mahua", which we had a chance to sample. The excursion was expertly led by Ranjit Khangar and Merajuddin Khan, of the Nagpur office of the Geological Survey of India. On the last day of this excursion, an important find was made of the first unequivocal Ediacaran (terminal Neoproterozoic) fossils from India. This major palaeontological discovery has been written up by some of the participants, including myself, and is currently under review. The excursion ended with a visit to the famous Buddhist Stupa of Sanchi, which is built on red rippled Mesoproterozoic Vindhyan sandstones.

At the end of the excursion, I flew from Bhopal to New Delhi, where I spent the week of the cancelled IGC as a guest of the Indian National Science Academy, staying at their guesthouse located along a major road, Bahadur Shah Zafar Marg, named after the last Moghul Emperor of India. I spent the first couple of days obtaining a visa from the Nepalese Embassy, after which I did research at the Nehru Memorial Library (located at Teen Murti, Nehru's official residence, now a museum), working on the Birbal Sahni papers. These papers had been donated to the library in 1972 by Sahni's widow Mrs Savitri Sahni, who had been a friend of Nehru's daughter, Indira Gandhi, who was also Prime Minister of India at that time). After going through the unbelievably Byzantine bureaucratic procedures for which India is famous (one of the most infuriatingly persistent legacies of the British Raj), and paying a ridiculously high fee as a foreigner in order to use the library, I was disappointed to find only one letter from Alex du Toit in the folder about his correspondence, even though he and Sahni had communicated for more than 20 years. I kept on searching, and my persistence finally paid off when I found the letters misfiled in a folder entitled "Irrigation Department" (which is where du Toit had worked, in Pretoria, before he joined De Beers). In there I found the bulk of the correspondence. I already had most of this correspondence from du Toit's archive in Cape Town, but also found many missing letters that I had not seen before. Because I was not allowed to take photographs or make photocopies, I spent two days directly transcribing and typing out these letters onto my laptop. At the Academy dining room, an acquaintance told me that I had just missed the nephew of Birbal Sahni, Prof. Ashok Sahni (also a palaeontologist), and his wife. After lunch I enquired at the reception desk if Prof. Sahni was still around, and serendipitously, at that very instant, he walked in through the entrance doors. The receptionist pointed him out and I introduced myself to him and his wife, who was by his side. This was a mind-bogglingly improbable encounter: in a country of 1.3 billion people, what are the chances that I would accidentally meet the one living person in the whole country who had met Birbal Sahni, who had died 71 years ago, and whose papers I was researching at that very moment?

Having seen the main sights of Delhi on two previous visits, I confined my sight-seeing to the National Archaeological Museum, which was well worth revisiting, especially the section on the Indus Valley or Harappan Civilisation, which houses some of the major

finds from Harappa and Mohenjo-Daro (excavated from what is now Pakistan before the Partition of Greater India in 1947), as well as from Indian sites such as Lothal and Dholavir in Gujarat.

Towards the end of my stay at the guesthouse of the Indian National Science Academy, I had dinner with Prof. Dhiraj Banerjee (professor emeritus from the University of Delhi), who had been my host there. We had met previously at meetings in Johannesburg, Brisbane and Cape Town. Professor Banerjee had been one of the main movers behind the Indian bid to host the IGC. When I told him about my plan to go on an excursion through the Himalaya in Central Nepal along the Kali Gandaki River, he told me he had done this trip as a young geologist in about 1972, when his party came right up to the Tibetan frontier, and actually penetrated a few km into Tibet, to document a geological contact that was exposed there, and rushed back before they could be discovered by Chinese border guards! I remember a similar story told me by Dr Ian Stanistreet, formerly at Wits University, of how, while he was with a party mapping in eastern Iran (during the time of the Shah in the 1970s), they ducked into Afghanistan in order to check out some rock formation. One could write a book about what geologists would and wouldn't do in order to follow their passions—rocks!

On Sunday 8th March, I flew from Delhi to Kathmandu, Nepal, flying close to the India–Nepal border for much of the way, and getting an excellent view of the snow covered peaks of the High Himalaya on the horizon, and of the rivers draining southwards in the Indo-Gangetic Plain. I was at last on my way to fulfilling a long-held ambition—to see the Himalaya!

*[To be continued—Part 2: Nepal]*

**Sharad Master**

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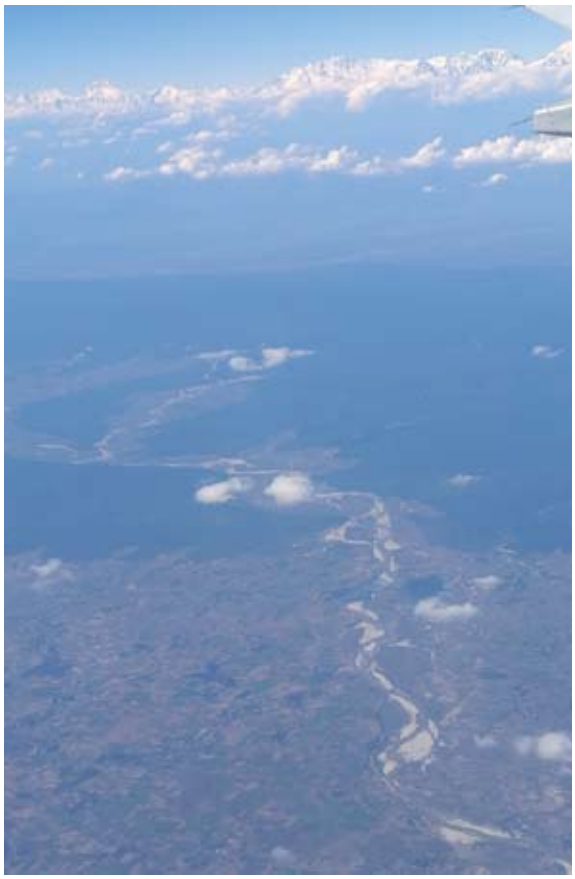
*Professor Dhiraj Banerjee of the Indian National Science Academy (left) with Sharad Master (New Delhi, 6 March 2020).*



*The High Himalaya on the Nepal–Tibet border along the horizon, with braided rivers draining the Himalaya flowing south into the Indo-Gangetic foreland basin of northern India in the foreground. Taken from the New Delhi–Kathmandu flight, 8 March 2020.*

# Meet the Bridge the Gap team!

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BridgeTheGap
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# Call for Industry Participation

BridgeTheGap
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**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".**

Geoheritage

# heritage month

September is Heritage Month in South Africa, so the GSSA Geoheritage Division is arranging a series of talks on South Africa's rich Geoheritage.

The foundation of South Africa's extraordinary Geoheritage is the Kaapvaal Craton and its deep diamondiferous roots. The evolution of the craton by kimberlites bringing the diamonds to surface is one of the aspects to which Irina Artemieva has turned her attention in her ground-breaking studies of the Kaapvaal and other cratons. We are grateful to Irina for bringing her fresh insights to us across the nine-hour difference in time zones between the USA west coast and South Africa.

Also presenting from a distance, but in the same time zone, Christoph Heubeck will present new insights from the Barberton Greenstone Belt. The most recent development from this World Heritage Site is the evidence that life had colonised land by 3.2 Ga, much earlier than previously believed.

Skipping almost 3 billion years forward brings us to the end-Ordovician mass extinction, the first of five major Phanerozoic extinction events. The palaeoenvironment prevailing at that time is the special interest of Claire Browning, curator of the palaeontological collection at the Iziko South African Museum in Cape Town. The next major mass extinction, in the late Devonian, saw the emergence of four-legged creatures, as Rob Gess of the Albany Museum will reveal. The catastrophic Permian–Triassic extinction interval witnessed major changes in the evolution of animals and plants. Bruce Rubidge will outline his vision for putting the transition from reptiles to mammals on display in the Graaff-Reinet museum. Rose Prevec of the Albany Museum will describe some of the major transitions in plant evolution during this interval.

In addition to their invaluable palaeontological collections, museums are also the repositories of the best specimens of the mineral wealth of southern Africa. Bruce Cairncross will present some of his superb images from these collections in his overview of the mineral collections in South African museums. Bringing biological and mineralogical evolution to the general public requires well-trained museum staff. Wendy Taylor will describe how technology can assist in creating an online museum training academy.

In a new experiment in the GSSA online talks, Lyn Wadley's recent discovery of 200,000-year-old bedding in Border Cave will be shown in the evening from a pre-recorded presentation. Depending on internet connections to the remote site where she is currently excavating, Lyn will field questions afterward. Should load-shedding or other mishaps prevent connection, Lyn has agreed to review some of the other innovations preserved in KZN rock shelters later this year, and will be able to answer questions then.

Few have played a greater role in bringing the attention of the world to South Africa's geoheritage than the late Maarten de Wit. Two presentations will highlight the Maarten de Wit legacy. Bastien Linol, a co-author of Maarten's last paper, will present the evidence for uplift of southern Africa after the eruption of the Karoo basalts, 183 million years ago. John Anderson, who together with Maarten created the concept of Gondwana Alive Corridors, will present the current status of the Gondwana Alive and Africa Alive Corridors. Ways to take the Corridor concept forward will be discussed throughout the month, with a review of the proposals at month end.

A preliminary programme, subject to change, is shown on the next page:

**Chris Hatton**
GSSA Geoheritage Division

| PRESENTER | AFFILIATION | TITLE | DAY, TIME |
|---|---|---|---|
| Irina Artemieva | Stanford University | The Kaapvaal Craton—deep roots of Geoheritage in southern Africa | 2nd, 4 pm (7 am PDT) |
| John Anderson | ESI, Wits | The Maarten de Wit Legacy—Gondwana and Africa Alive Corridors | 3rd, 1 pm |
| Bruce Rubidge | ESI, Wits | The importance of Karoo fossils, our distant ancestors, and their potential for heritage tourism in Graaff-Reinet. | 7th, 1 pm |
| Rose Prevec | Albany Museum | Karoo plant fossils in the Albany Museum | 9th, 1 pm |
| Morris & Richard Viljoen | Bushveld Minerals | Geoheritage destinations in South Africa | 10th, 1 pm |
| Christoph Heubeck | University of Jena | New Insights from the Barberton Greenstone Belt, including evidence for early life on land | 11th, 3 pm (3 pm CEST) |
| Hartwig Frimmel | University of Würzburg; UCT | Our golden heritage: biogenic origins of Witwatersrand gold | 14th, 1 pm |
| Lyn Wadley | ESI, Wits | Fire and grass bedding construction 200 000 years ago at Border Cave | 16th, 7 pm |
| Claire Browning | Iziko South African Museum | The Boonstra Diorama Digital Preservation Project | 18th, 1 pm |
| Rob Gess | Albany Museum | First four-legged beasts in Africa and their environment—insight from the late Devonian Witpoort Formation | 21st, 3 pm |
| Wendy Taylor | Arizona State University; UCT | MTECH—an online museum training academy | 23rd, 1 pm |
| Bruce Cairncross | University of Johannesburg | Pros and Cons of Preserving South Africa's Portable Geoheritage | 25th, 3 pm |
| Bastien Linol | AEON, NMU | The Maarten de Wit legacy—the rise of southern Africa after Karoo magmatism | 28th, 1 pm |
| Chris Hatton | GSSA | End of Heritage Month—So long and thanks for all the fish | 30th, 1 pm |

# mineral scene

## Cuprite

Since starting this column about four years ago, minerals of Namibia have yet to be featured. This is somewhat of an oversight considering the wealth of economic deposits found in the country, plus the world-famous specimen-producing localities such as Tsumeb, Erongo and Okoruso, to name only a few. Choosing a mineral to represent one of the myriad of these deposits is not easy but considering that copper is found in many places, this Mineral Scene column features cuprite from a small but iconic deposit known globally to mineral curators and collectors alike.

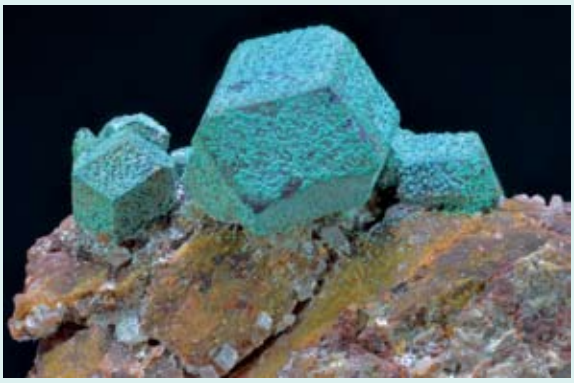
Cuprite ($Cu_2O$) is a copper oxide and usually forms from the oxidation of primary copper sulphides.[1] Crystals of cuprite are typically octahedral, cubic or dodecahedral. A variety of cuprite, called chalcotrichite, consists of fibrous hair-like crystals that usually form bright red, tight, interlocking mats. It can also be found as earthy, granular masses. The red colour of cuprite is striking and distinctive, with crystals displaying vibrant blood-red to purple-red colours. One of the physical shortcomings of cuprite is that if exposed to sunlight for extended periods it loses its red colour and becomes metallic black. Being a copper species, cuprite occurs in base metal deposits containing other copper-bearing minerals and associated species can include azurite, chalcopyrite, chalcocite, bornite, malachite, chrysocolla, and native copper.

Mindat.org lists 37 Namibian localities that contain cuprite, but the premier cuprite locality is the old Onganja mine in the Khomas Region, approximately 80 km northeast of Windhoek.[2] No other Namibian

*A cluster of large cuprite crystals with a thin outer coating of malachite, characteristic for the cuprite from Onganja mine. The specimen measures 10.8 x 9 cm. (Photo: Bruce Cairncross; specimen: Desmond Sacco collection.)*

deposit can rival the size and quality of cuprites from this tiny deposit. The country rocks hosting the mineralisation consist mainly of Kuiseb Formation quartz–garnet–biotite schists, phyllitic schists, epidote-bearing quartzites, and graphitic schists.[3] The Onganja ore deposit is associated with a broad anticline with a west–northwest axis that plunges to the west. The copper mineralisation occurs in fracture-filled veins that appear to be tensional features associated with an anticlinal fold.[4]

During 1973, a sensational discovery was made in the underground workings, which yielded an estimated 2,000 perfect cuprite crystals, the largest measuring 14 cm in diameter (!) and weighing 2.1 kg.[5,6] The crystals have an octahedral to dodecahedral habit, or combinations thereof. Common forms include dodecahedra and octahedra modified by cubic faces and rare trapezohedron faces. The crystals are typically sharp edged and very well formed. A characteristic feature of the cuprite crystals is the outer surficial coating of a thin film of malachite. However, some crystals were found that are 'clean' and not possessing the malachite coating. Another feature of many of the cuprite specimens is their gemminess, making them highly desirable among collectors of unusual coloured stones, such as the one shown here. Some large masses of flawless, completely transparent cuprite weighing up to 2 kg, and stones up to 300 carats, have been cut.[7] The Smithsonian Institution has a round-cut cuprite weighing 182 carats. Most of the larger cuprites that were recovered are loose



*Sharp, well-formed cuprite with the outer surfaces partially altered to malachite, associated with tiny colourless rhombohedral calcite. Matrix specimens of cuprite are rare from Onganja. Field of view is 1.9 cm. (Specimen and photo: Bruce Cairncross.)*

*Calcite crystals enclosing orange-red cuprite variety chalcotrichite, associated with native copper, from Onganja mine (3 cm). (Specimen and photo: Bruce Cairncross.)*

crystals or groups of crystals. Acicular cuprite is also present in the deposit, usually as fine crystals enclosed in calcite.

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*An outstanding 149.36 carat (3.22 cm) faceted cuprite, cut from gem-quality rough Onganja cuprite. (Photo: Mark Mauthner; specimen: Warren Taylor Rainbow of Africa collection. Used with permission.)*

# obituary



## Roger David Dixon †

**Roger David Dixon**

**25 October 1959 to 6 June 2020**

At the beginning of June this year, my good friend Roger succumbed to a particularly aggressive strain of cancer after a courageous battle. He passed away in his sleep in the early hours of the 6th of June at his home in Pretoria North, which is nestled against the dip-slope of the Daspoort Formation quartzite. The night of his passing was marked by a penumbral lunar eclipse. Meanwhile, humankind the world over was locked down and wracked in the throes of the rising viral pandemic, whilst cities rocked in civil unrest.

I was introduced to Roger in the mid-1990s by a mutual friend who told me there was someone I should meet that I would find very interesting. Thus began a long friendship with an endless amount of good discussions and interactions over numerous bottles of red wine and the occasional bottle of malt whiskey. We had a multitude of common scientific, mechanical and natural philosophical interests and we introduced each other to more. He was open-minded through curiosity and thus prepared to allow himself into situations beyond what one would expect would fall within his comfort zone. He read extensively from scientific texts through to classic literature (he told me he had read 'War and Peace' at a very early age) and had a particular liking for science fiction. He relished play of words in the English language with a dry wit and he was unashamedly eccentric.

I knew Roger as a keen birder who was very active in the Southern African Bird Atlasing Project. We both attended a memorable birding trip to the Highveld to identify different cisticolas by song and flight pattern. It was here I learned that his father had known the famous bird-book author, Austin Roberts.

I for one experienced Roger's unbounded generosity, both materially and with his time, willingly searching for information and taking considerable effort to

*Roger enjoying inclement weather during International travels.*

explain difficult concepts. He became an accomplished genealogist and delighted in offering to research the family history of his friends and acquaintances for nothing other than out of interest. This short tribute to my friend highlights some of his journey and his achievements.

Roger was born in Mbabane, Swaziland, in 1959. His father, David (who sadly passed away two years ago), was a veterinary surgeon and his mother, Anne, is a physiotherapist. The family loved Africa and spent their recreational time mostly in the veld, with its wildlife and campfires at night under starlit skies. Roger was the eldest of four siblings, Dianne, Chris and Kate. Chris's childhood memories of Roger include the two of them running freely across the grassy hills in Swaziland and having daring adventures, such as Roger teaching Chris to jump off the garage roof using an umbrella as a parachute. Chris's fond memories of his elder brother even include a time when Roger suggested to Chris that the way onto a donkey's back is by climbing up its tail, resulting in temporary remodelling of Chris's face from the inevitable kick.

The family moved to Cape Town in 1971, where Roger matriculated from the South African College High School

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in Newlands, in 1976. He graduated from the University of Cape Town in 1980, where he obtained a BSc in Geology and Chemistry with Honours in Geology. His Honours thesis was entitled "The Granites of the Du Toit's Kloof Tunnel". He then joined the Geological Survey (now Council for Geoscience) in Pretoria in 1981, where he was responsible for the X-Ray Diffraction laboratory, using this and other instrumentation to analyse and identify rocks and minerals for mapping, research and industry. This extended to verification of gemstones and identification of reaction products and materials in the building and other industries. He conducted research into clay mineralogy and the analysis of plant material for geochemical exploration, as well as taking part in the regional geochemistry program between 1983 and 1985, involving a number of months of fieldwork. During this time, he completed his MSc on the unusual metamorphic minerals of Wessels Manganese Mine in the Northern Cape, from which he discovered a number of new minerals. His findings are published in international publications.

In 1988, Roger took on the curatorship of the Geological Survey museum, part of the State Museum in Pretoria. He catalogued the whole collection into a digital database and was responsible for the acquisition of new collections, tours and displays as diverse as a collection of Ching dynasty jade carvings from the National Museum of Taiwan. He was involved with the design and construction of additions to the museum. He co-ordinated and wrote chapters in the book commemorating the 100-year anniversary of the establishment of the Pretoria Museums complex. He was the official gemstone evaluator, providing export documentation, and he also examined forensic material for the police and made court appearances as an expert witness. While here, he qualified with a post-graduate Diploma in Museum Science (Natural History), with his thesis entitled "The Museum of the Geological Survey: A historical perspective 1892–1966". It was during this period that he met and married Elmi, a colleague at the Geological Survey. Together they had a son and daughter, David and Catherine, of whom he was immensely proud. They moved northwards out of the city onto a plot with enough room for Roger to build up an extensive collection of plants and trees; "I live in a forest that I planted myself" is a quote that has been attributed to him.

Roger then changed vocation to become Principal Forensic Analyst for the South African Police Service in 1994, achieving rank of Colonel. Here, he conducted analytical investigations using a variety of techniques on soils, geological materials and inorganic chemistry exhibits in murder cases and crime scene investigations, especially relating to the mining industry and precious metals and diamonds. Where materials relate to trace evidence, including explosive and gunshot residues and environmental crimes, his specialist knowledge was invaluable in optimal sampling and identification. His pioneering use of image analysis techniques and court appearances as expert witness resulted in successes in the High Court in a number of high-profile cases.

Over the years he equipped the Forensic Science Laboratory with an impressive array of analytical and optical instrumentation (prompting a comment by a former colleague that it looked like NASA Mission Control) and he established forensic geology as a discipline in South Africa for the first time.

Precious metals had become a large part of his portfolio and he developed a trace-element profiling technology for fingerprinting gold and other materials that took him all over the world for the establishment of international ties with forensic and other organisations to develop protocols to combat illegal cross-border trade in various stolen products.

By this time, he had a staff complement of 32 and took on increasing management functions. He had an enormous range of multidisciplinary knowledge and would urge his staff to research extensively until they understood every aspect of what they were working on.

In 2013, he left the South African Police Service Forensic laboratory to focus on research and explore new challenges in the academic environment, joining the University of Pretoria as Chief Analyst and Manager of the university's Stoneman Laboratory. He retained some of his public role as a forensic analyst in cases such as the Oscar Pistorius case. Here his carefully deliberate pronouncements to non-scientists perhaps

came across to some as halting and uncertain, but were perfectly scientifically valid, unbiased interpretations that fell within his vast range of forensic experience and exhibited his integrity.

For the Stoneman Laboratory, Roger motivated for and organised the acquisition of the cutting-edge Selfrag machine, the first in Africa, and he was heavily involved in the recent rebuild of the facility with his characteristically meticulous attention to detail. In 2015, he finalised his PhD entitled "Provenance of Illicit Gold with Emphasis on the Witwatersrand Basin". He returned to live in Pretoria shortly after this, closer to the university. With his broad and extensive knowledge, he was always ready to talk and help out, devoting a lot of time to dealing with postgraduate projects in a wide range of fields; always ready to advise and encourage.

Roger was a great listener and would hear someone out until he made his objective, analytical response whether his comments were what the recipient wanted to hear or not; he was quick to compliment but did not suffer fools gladly!

Roger's knowledge footprint extended far beyond the disciplines of geoscience. He was an expert in succulents and clivias and spent over 30 years as editor for the succulent society's Aloe magazine and he often judged clivia competitions. He discovered *Conophytum phoenecium* in the Richtersveld on one

*Roger at a conference in Colombia.*

of his many expeditions. He published extensively, authoring, co-authoring and editing around 60 papers, articles and books on subjects as diverse as geology, mineralogy, botany and natural history. He is co-author of the definitive tome "Minerals of Southern Africa".

My last trip with Roger was to the 50th anniversary conference of the Geological Society of Namibia at the beginning of September 2019. We drove the Trans-Kalahari Highway, arriving in Kang early enough to do a spot of birding before spending the night there, after Botswanan beef steaks and, of course, red wine. After the three-day conference in Windhoek, we headed off

*Roger birding in the Northern Cape.*

*Roger with the Selfrag Instrument.*

west to try and sample the Matchless Belt for one of Roger's colleagues. We then spent the night in the veld on my mother-in-law's farm, sleeping under the stars either side of the fire, after braaied lamb chops and red wine, using the car bonnet as a table.

The last time I saw Roger, he was very weak and frail but still maintained his strong presence. I suspected it was the last time I would see him. It was. Roger's passing creates a great chasm in the lives of all those who knew him. He will be greatly missed but always remembered as an honest friend, proud father and loving son.

**Stuart Clague**

(with valuable assistance from **Jaco Delport, James Roberts** and **David, Catherine** and **Chris Dixon**)

# obituary

## Thomas Gordon Molyneux †

**Thomas Gordon Molyneux**

**25 March 1936 to 17 April 2020**

*'One of Life's Characters'*, a.k.a.:

- *'The Geologist who Recognised and Named the Four Groups Comprising 26 Titanomagnetitite Layers, and the Principal A–B–C Subdivisions of the Main Zone of the Rustenburg Layered Suite in the Bushveld Complex'*—as acknowledged by his peers;
- *'The Man Who Wrote Letters'* —Tom Molyneux's own choice of epitaph.

Tom Molyneux, originally from Dunlavin and Bray in County Wicklow, Ireland, spent most of his working career based in South Africa, then returned to Bray before he passed away peacefully at the age of 84. He was admitted to hospital in Loughlinstown after a fall, where ironically he contracted Covid-19 during the pandemic currently sweeping the globe. He was in good health and spirit while on holiday early in 2018 when he last met with his former colleague, Roy Corrans, in the Garden Route of the Western Cape, South Africa. Tom is survived by his wife Wendy and daughter Katherine in Ireland, as well as by his two sons from his first marriage in Canada, Hugh and Stefan.

Tom grew up in rural Ireland where he obtained his first degree in geology from Trinity College, Dublin. He then embarked upon a life-long career in geology and mineral exploration focused mainly in Africa with the Anglo American Group of companies, but he also worked and travelled on three other continents. The main love of Tom's working life was geological mapping and research 'at the sharp end' of the Bushveld Complex in South Africa, which gave him great satisfaction and

which he considered to be the highlight of his career. His publications, maps and knowledge, particularly of the eastern and the northern Bushveld limbs, brought him well-deserved recognition from his peers. Tom also took a keen interest in the application of geochemistry and geobotany to mineral exploration, as well as in the natural history and ancient mining activities of southern Africa.

Tom Molyneux, a kindly, modest and devout family-minded man with strongly developed Protestant spiritual values, descended from an Anglo-Norman family. His paternal ancestor, Robert De Moulin, arrived in England with 'William the Conqueror' nearly 1000 years ago. 'Sir Thomas Molyneux', a later descendent, was sent to Ireland in 1576 as Chancellor of the Exchequer. This man was the direct ancestor of the Irish Molyneux family, who contributed towards the foundation of Trinity College, Dublin, in 1592. Molyneux descendants in successive generations over the next three centuries included prominent academics, politicians, business people and distinguished landowners, including several early *'Thomas Molyneux'* namesakes of our recent colleague Tom.

Tom had a happy childhood, growing up in the countryside at *'The Decoy' (Windyridge)* farm south of Dunlavin. This farm, overlooking the Wicklow mountains, was acquired by the Molyneux ancestors in 1752 and had been home to six generations of Tom's direct family until his father's death in 1956, when the farm was sold. Young Tom attended the nearby Gloucester House Preparatory School as a boarder from 1946 to 1948. He then attended Portora Royal, the senior Protestant school also in Dunlavin, which is situated in the countryside bordering Lough Erne. While at Portora, he earned pocket money using his pet ferret to catch rabbits on *'The Decoy'* farm. He sold these to the school masters. Besides playing rugby and cricket at school, he enjoyed rowing on Lough Erne. Tom excelled at this water sport and became captain of the Senior Eight team that won the Belfast Head of the River, the Metropolitan Regatta Senior Eights, the Ulster Schools' Cup, and went on to beat University College School at Henley on Thames in England in

*Thomas Gordon ('Tom') Molyneux in 1962, standing next to the Main Magnetite Layer (V-bearing 'Seam') of the Bushveld Igneous Complex at Magnet Heights in Sekhukhuneland.*

1954. Tom considered this to be one of the highlights of his life and his first experience of "The Big Time".

Tom studied natural sciences, majoring in geology and physics at Trinity College, Dublin from 1954 to 1958, where his direct ancestor, Sir Thomas Molyneux (1650–1698), had been Professor of Medicine nearly three hundred years earlier, and where a portrait of the Professor's brother William Molyneux hangs to this day in the Examination Hall. The modern-day Tom also enjoyed rowing for his university. He was in the senior rowing VIII that came second, half a length behind Queen's College, Cambridge, the eventual winner of the Ladies Plate at Henley Royal Regatta in 1955.

Tom accepted a job offer from Anglo American and departed from Southampton in January 1959 on a mail ship belonging to the Union Castle line. After Tom's arrival in Cape Town he boarded a train destined for the Transvaal (Gauteng), and 36 hours later found himself at Anglo American's head offices situated at 44 and 45 Main Street in Johannesburg. Here he was introduced to Arnold Waters, who was in charge of a new exploration programme in Tanganyika (Tanzania). Three days later Tom was on board an old Dakota (DC3) aircraft on a bumpy flight from Johannesburg to the former Williamson's Diamond Mine at Mwadui, where he started work on an assignment with De Beers as a field geologist based at the mine. He and Sam Terry, an Australian, were the first geologists to be sent to Mwadui in north-west Tanganyika by De Beers after the acquisition of Williamson's. They were assigned to exploring for kimberlite pipes in the unspoiled surrounding wilderness adjoining the Serengeti plains. Tom and Sam were initially supervised by Williamson's field geologist Mousseau Tremblay, followed by Louis Murray, Mwadui's mine geologist. The field geologists

went on 80–100 km sorties of about four days each, driving in Landrovers or walking along water courses and collecting sediment sample concentrates at regular intervals, "fly-camping" in the bush away from their base. Where stream sediment samples could not be collected because the terrain was too flat, soil samples were collected along 13 km-long lines cut through the bush, perpendicular to base lines, and reconnaissance-scale geological mapping was undertaken. Their working areas included Loliondo near Lake Natron in the Rift Valley, the region of Seronera Lodge in the Serengeti Park; the Simiyu and Grumeti rivers that drain from the Serengeti Plains into the Speke Gulf of Lake Victoria; and the Olduvai Gorge, where Mary Leakey first found Australopithecus remains in 1959. Wild animals, including lions and black rhino, were frequently encountered. Thus began Tom's 32-year career with the Anglo American group of companies!

At the end of Tom's assignment in Tanzania in August 1961, he accompanied several friends on a trip to India (Bombay, Delhi, Calcutta, Mysore State), Malaya and Hong Kong, before returning to Mwadui to fly back to Johannesburg. He had the good fortune to re-join the Anglo exploration group supervised by Hans Nel, working in the eastern Bushveld Complex at Roossenekal in the upper reaches of the Steelpoort River Valley. Their task was to evaluate the open-cast reserves of the vanadiferous Main Magnetite Seam by plane-table mapping, pitting and sampling of the pits and outcrops, diamond drilling to explore the down-dip extensions, accompanied by assaying of the vanadium, titanium and iron content of the Main Seam.

Tom Molyneux's first deployment in South Africa was at Magnet Heights in Sekhukhuneland, which has the best exposure to study the rocks of the Upper Zone. He used a bicycle for transport and undertook a topographic survey using a plane-table and alidade for mapping. This assignment ignited Tom's enthusiasm and led to further academic achievements. He enrolled at Pretoria University in 1963 for an MSc (supervised by Prof. Johannes Willemse), which Tom obtained cum laude, on the geology of the Magnet Heights area and surrounds. He was then awarded an Oppenheimer Grant, and was given unpaid leave from Anglo American, as well as logistical support from the Geological Survey of South Africa, to carry out field work towards a PhD over a study area of 1 400 km$^2$ in the eastern Bushveld Complex. A four-year hiatus followed, during which he continued exploration-mapping and prospecting for tin with an Anglo team led by Louis Coetzee in Bushveld felsites near Nylstroom in the Pietersburg (Polokwane) area, before he completed his PhD in 1970.

Tom's interest in the Bushveld Complex continued until the time of his death in 2020. He was granted several additional contract mapping assignments with logistical support occasionally provided by Anglo American, the Council for Geosciences and other parties over about 15 years after his retirement in 1994. Tom had mapped about one-fifth of the outcrop of the Eastern Compartment of the Bushveld Complex by the time of his death.

Tom Molyneux's lasting contributions include his significant input to the geological understanding of the Upper Zone of the Bushveld Igneous Complex. The two articles published by the Geological Society of South Africa (Molyneux, 1970; Molyneux, 1973) are classic contributions and remain the fundamental reference on the geology of the titanomagnetitite layers. The articles are constructed around detailed field mapping that he undertook specifically in the area of Sekhukhuneland, in the 1960s and 1970s. They provide original and fundamental descriptions of the titanomagnetitite layers and their associated gabbroic rocks. The numbering scheme developed by Molyneux of recognising four groups of titanomagnetitite layers (labelled as Lower Layers 1–4; the Main Magnetite Layer; and Upper Layers 1–21), i.e. 26 layers in total, is still applicable and remains the most widely used classification scheme.

Molyneux also contributed to an understanding of the Main Zone, as he initiated the first subdivisions and naming of the A–B–C Sub-Zones that are of fundamental significance and are still widely used. The contributions and field mapping by Molyneux, together with his colleagues working under Professor Willemse

at the University of Pretoria, formed the basis of a large part of the chapter on layered igneous intrusions in the classic book of that title by Wager and Brown (published in 1968). It is unfortunate that Molyneux's input in this regard was not more fully acknowledged.

Tom considered that perhaps his single biggest discovery in the field was the existence of the Sekhukhune Fault, which has a throw of up to 1 800 m near the Schoonoord Administration Centre. This discovery led to a reduction of the Main Zone in the Rooisenekal area of approximately 1000 m. Later in his life, Tom was involved with Mike Scott in developing a large Platinum Group Element project east of the Phosiri Dome, in the vicinity of the farm Spelonk 478 KS, in the mid-to-late 1990s.

In recent years, Tom Molyneux collaborated with Roger Scoon on a number of occasions to discuss publications on the Bushveld Igneous Complex; even in his retirement he retained a keen interest particularly in the Upper Zone, and followed as many of the new contributions as possible.

Tom's career and contributions to South African geological knowledge were focused mainly on the Bushveld Complex and its related mineralisation. This has already been addressed above; accordingly his work experiences in other regions are listed without further detail or discussion:

- 1966–1968: Tom Molyneux was transferred to Charter Consolidated Limited in London, UK, to work with the exploration arm of Anglo American International on various projects, including a compilation of all mineral occurrences and metalliferous mines in the Iberian Peninsula (with Manuel D'Oliveira); he took over from Chris Pedersen in exploration mapping at the Akjoujt oxide copper deposit in Mauritania; he worked on various lead–zinc deposits in Wales; and he undertook mapping for the location of a shaft for the Yorkshire Potash Project.
- 1969: Tom returned to the University of Pretoria, South Africa, to complete his PhD study on the oxide minerals of the Bushveld Complex in Sekhukhuneland and the Steelpoort Valley.
- 1970–1974: Tom worked in the Tati area of Bechuanaland (Botswana) mapping the historic gold mines (1970); in the Witwatersrand Basin (1971–1972); and the Namib Desert on uranium exploration at Husab and Tubas in South West Africa (Namibia) (1972–1974).
- 1974–1977: Tom was involved with other Anglo geologists in the identification of "Bushveld Satellites"—small intrusions with potential for nickel and platinum group metals around the periphery of the main Bushveld Complex. This work resulted from Louis Coetzee's re-discovery, from a literature review, of such a mineralised intrusion on the farms Uitkomst 541 JT and Slaaihoek on the Eastern Transvaal (Mpumalanga) Escarpment near Badplaas. The discovery was originally described by P.A. Wagner in 'The Platinum Deposits and Mines of South Africa', published in 1929.
- 1977–1980: Tom worked in the Barberton Mountainland and in the Central/Western Transvaal Basins. During this period he fortuitously came across the remains of the ore dump left behind after the mining out in the 1920s of a small high-grade pod of more than 20 different nickel–iron-bearing oxide ('trevorite') and silicate minerals on the farm 'Bon Accord' near Barberton. Tom purchased these ore dump remains comprising about two tonnes of what some consider to be a metamorphosed Archaean "meteorite fragment", and transported these to a small-holding in Midrand, Gauteng, to sell specimens to world-wide collectors and to share with his friends.
- 1984–1985: Tom took unpaid leave from Anglo American and was attached for two semesters as 'Acting Associate Professor for Economic Geology' at the University of Washington, Seattle, USA, in an exchange arrangement with the university's Professor Eric Cheney, who in return received an assignment with a South African institution.

- 1985–1989: Tom worked for Anglo American Gold Division in a geological training role based at Welkom in the Free State and Carletonville in Gauteng. During 1988 he accompanied friends on a hiking trip in the Himalayas, and ascended to 300 m above the Everest base camp.
- 1989–1991: Tom worked on various aspects of the economic geology of the Bushveld Complex on behalf of the New Mining Business Division of Anglo American.
- 1991–1993: Tom worked at the Council for Geoscience in Pretoria compiling aspects of the magnesite and kieselguhr mineralisation of South Africa. During this period he also compiled a report on the economic geology of 1:250 000 scale Geological Sheets 2428 and 2528 (mostly Bushveld Complex).
- 1994–2010: Tom and his family moved to Bray in Ireland, from where he consulted on behalf of clients and made various geological trips to Algeria, Iran, Morocco and Syria. He returned to the eastern Bushveld Complex in South Africa a number of times to undertake geological mapping around Clapham 118 KT north of Steelpoort, with the logistical support of Anglo American's New Mining Business Division.

Interspersed between Tom's technical contributions over the years were a number of light-hearted letters (often copied to a wide group of his friends) on topical subjects addressed to high-profile people of the day. A good example was his letter to the British Prime Minister Margaret Thatcher at the time of the Falklands War; the letter was illustrated with a map that made a case for the Falkland Islands belonging to South Africa and neither to Argentina nor the United Kingdom. Tom used geological logic based on the islands' origin as a sliver of the southern African continent, which slid westwards under the forces of continental drift during faulting and the break-up of Gondwana some 180 million years ago, to the Falklands' present location in the southern Atlantic Ocean. Another memorable example was Tom's submission to the late President Robert Mugabe of Zimbabwe in the 1990s, of all the verses of a bawdy ballad often attributed to Noel Coward, which describes the lurid exploits of a lady from the Frozen North and her Mexican accomplice, to which Tom received a polite reply from the President's secretary: *'Thank you for the poetry'*.

Tom Molyneux re-visited his old school Portora Royal in Ireland in about 1995, and was introduced to the headmaster who responded: *'Oh, you are the man who writes letters!'* Tom was pleased by this description, and informed family members and friends some 20 years later that a fitting, humorous epitaph for his gravestone would be *'Here lies the man who wrote letters'*.

The sale of *The Decoy* and its two adjoining farms while Tom was at Trinity College, Dublin where a number of his ancestors had studied, and shortly before he started out on his geological career, was a significant event in Tom's life. Tom's mother moved to join his sister in Bray, County Wicklow, after his father died; this is where Tom, with his wife Wendy and daughter Katherine finally settled in mid-1994, close to his birthplace in Dunlavin. Tom held the view that *"having grown up in a small country like Ireland, it was necessary to go abroad and meet world-class people and strive to meet their standards of competence, in order to grow in experience, confidence and other ways"*.

Tom also states in an unpublished Addendum to his Memoirs (March 2018): "My main underlying motivation has been to forward the objectives of my family. My objective has mostly been to restore the fortunes of my family from being losing landowners to becoming winning educated people with top qualifications".

**Roy Corrans** and **Roger Scoon**

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7. 'MEMOIRS', T. G. (Tom) MOLYNEUX 1936 – 2020, completed in January 2020, is an interesting account of his family history and his own extensive travel/career experiences in four continents. Refer to the link maintained by Tom Molyneux's nephew Robin Hanan: https://www.robinhanan.ie/wp-content/uploads/2020/04/Memoirs-Tom-Molyneux.pdf



# obituary

## John Ferguson †

**John Ferguson**

**16 February 1933 to 8 July 2020**

On the 8th of July 2020, John Ferguson passed away peacefully at the age of 87 in his home at Whiskers Hill, Carwoola, New South Wales.

John is survived by his family in Australia, including his first wife Gillian Ferguson and their sons and daughter, Luke, Miles and Sarah, and by Marcus, his son by a second marriage, now living in Denmark.

John Ferguson was born on 16 February 1933 in South Africa, was educated at King Edward's School and graduated with a BSc at the University of the Witwatersrand (Wits), Johannesburg, in 1955. John then went on to complete an MSc at McGill University in Canada. His 1958 thesis was on metamorphic rocks from near Fort Chimo, Northern Quebec.

From 1958 to 1962, John worked in the fledgling Greenland Geological Survey. The Survey worked out of Denmark, with the geologists in the field in Greenland in summer. Unfortunately on one of his first trips he was involved in a helicopter crash and spent nearly two years in hospital and rehabilitation in Denmark.

From 1962 to 1974, John was back at Wits on the staff of the Geology Department. Much of his PhD, awarded in 1967, was on the Ilimaussaq Complex,

*John Ferguson (left) and John Rowntree conducting exploration in south-east Greenland in 1995.*

Greenland. When he resigned, he was a Reader/ Associate Professor. In 1975, Wits awarded him a DSc for his outstanding and sustained research.

John left South Africa in 1974 to join the Bureau of Mineral Resources, Geology & Geophysics (BMR) in Canberra, Australia, as a senior geologist. Following the major re-organisation of BMR in 1980, he was appointed as Head of the Research Division of Petrology and Geochemistry. BMR is now Geoscience Australia (GA).

In 1979, John was on the Organising Committee for the International Symposium on the Pine Creek Geosyncline, Northern Territory, Australia.

After 1985, John became involved in the mineral exploration industry. Over time he was a Director or Executive Officer of nine public companies in Australia and Canada, including Hunter Resources Ltd, MacArthur Minerals Ltd., Hudson Resources Inc. and Platina Resources Ltd.

His exploration work was principally in Australia, Canada and Greenland, although he also worked in Chile, Mongolia and Namibia. He spent time in Greenland every year for 30 consecutive years. He found the regulatory environment of his native South Africa unhelpful, one in which it would be difficult to operate.

John Ferguson played an essential role in a number of world-class mineral discoveries, including in Australia, the Munni Munni Platinum Project and the Jellingbah East Coal Project; and in Greenland, the Sarfartoq Rare Earth Element Project, the White Mountain Aluminium Deposit, the Isortoq Titanium/Vanadium/Magnetite Project and the Maniitsoq Ni/Co/PGE Project.

*John Ferguson (right) with Mimi Cabri in Ottawa, Canada in 2008.*

John wrote over 90 papers in international journals; these included studies of U, Ag and PGEs in quartz-pebble conglomerates; diamonds in kimberlites; and PGEs in layered mafic/ultramafic complexes in Australia. There were others on V, Ti, and on regional tectonics and, would you believe, on rock specimens from the Moon!

There were publications, too, reflecting a long-term interest in circular structures, working first with (the late) Louis Nicolaysen of the Bernard Price Institute for Geophysics at Wits on examples in South Africa and Namibia, and continuing on his own in Australia and Canada. The main conclusion reached was that many such structures with characteristic shock metamorphic features were endogenic, caused by violent outbursts of fluid-laden material from the mantle and not—as often posited—the result of meteorite impact (i.e., exogenic). That these features were not randomly distributed, as meteorite impacts should be, provided supporting evidence. He saw the Sudbury Basin as endogenic.

John Ferguson had unique skills and extensive knowledge in mineral exploration. He was a lateral thinker: for example, he understood that the magnetite beach sands at Isortoq in Greenland indicated a mafic/ultramafic complex source, which exploratory drilling confirmed, resulting in the discovery of the titanium/vanadium/magnetite project.

John was a Fellow of the Australian Institute of Mining and Metallurgy and a Fellow of the Geological Society of South Africa.

John's love for science included a fascination with ornithology: he recorded 164 species of birds on his rural property at Whiskers Hill. It was here that he entertained colleagues, friends and family, enjoying many a spirited discussion on the wide-ranging subjects dear to his heart.

Throughout his very successful career, John approached exploration with the same determination, enthusiasm and energy that characterised his whole life.

**John Rowntree** and **John Truswell**

# obituary



**Anthony James Naldrett**

**23 June 1933 to 21 June 2020**

## Anthony James Naldrett †

Anthony James 'Tony' Naldrett was one of the world's best-known geologists through his work on magmatic sulphide deposits. He passed away at home in Chichester UK, on 21 June 2020 after a six-month battle with cancer, two days before his 87th birthday.

Tony was born and schooled in London, UK. After two years of military service in the RAF where he learnt to fly Meteor jets, he went to Trinity Hall, Cambridge in 1953. Because of his rowing prowess he was selected for the 1st VIII, which meant spending afternoons on the river. He only studied geology with chemistry and physics because it fitted his schedule with classes in the morning, but he loved the subject and a geologist he became.

In 1957 he immigrated to Canada, and spent two years as a mine geologist in Sudbury. Two years later, wanting to find out more about ore geology, he enrolled for an MSc thesis at Queen's University in Kingston, Ontario. This was followed by a PhD thesis in 1964 on 'Ultrabasic rocks of the Porcupine and related nickel deposits'. Between 1964 and 1967, Tony spent three years as a postdoctoral fellow at the Geophysical Laboratory in Washington learning experimentation on metallic sulphides at high temperatures and applying this new knowledge to real ore systems. The approach combining the theoretical with the practical was to define the direction of his future career.

In 1966, during a social visit to the University of Toronto, Tony was offered an Assistant Professor position—something that would be unheard of these days without formal interviews. He became a full professor in 1972 and remained at the university for 31 years until his retirement in 1998. His graduate students and postdoctoral fellows are in academia around the world, or are captains in industry, and in government. Tony's work on komatiites in Canada led to a sabbatical year working on a nickel deposit in Western Australia. An invitation to spend six months at the Bushveld Research Institute at Pretoria in 1979–1980 was a pivotal point in his career and he retained his interest in the Bushveld Complex for the rest of his career. A visit to Moscow led to a visit to Noril'sk—perhaps one of the first westerners to do so—and his work on this deposit formed the basis of a book published in Russian, Chinese and English.

In 1998 he retired from the University of Toronto. In his retirement he was invited to join the Bushveld Research Group of Judith Kinnaird at the University of the Witwatersrand in Johannesburg and he visited South Africa twice each year from 2004 until 2012 funded largely by Anglo Platinum. During his time at Wits he gave invited lectures and courses in London, UK; Finland; Moscow; Quebec; Dublin; Newfoundland;

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Wuhan, China; Hong Kong; Bhubaneshwar, India and of course across South Africa. He also published nine papers and four book chapters. He co-supervised 11 Honours projects at Wits and the University of Venda and three MSc projects.

In 2008, Tony was elected the De Beers Du Toit lecturer of the GSSA. His lecture was entitled 'From the mantle to the bank: The life of some Ni sulfide deposits'. The lecture was first given at the SEG-GSSA conference at Misty Hills, Johannesburg, and then repeated at the Universities of Cape Town/Stellenbosch, KwaZulu Natal, Free State, Fort Hare, Rhodes, Venda, and Witwatersrand, to GSSA branches in Barberton, Polokwane, Rustenburg and Pretoria, and to the Geological Societies of Botswana and Namibia. In 2010, he undertook a three-week lecture tour of China and subsequently spent six weeks per year in Guiyang in 2010–2012. His last visit to South Africa in 2018 was to attend the 13th International Platinum Symposium, where many will have met up with him for the last time.

Over an outstanding academic career, he carried out seminal research on the origins of many of the world's major magmatic Ni–Cu–PGE deposits and much of our understanding of such deposits is directly attributable to Tony's publications on chemical processes related to magmatic sulphides. His research culminated in the authoritative book 'Magmatic Sulfide Deposits: Geology, Geochemistry, and Exploration' (2013).

In addition to his research, he consulted for 43 companies worldwide, held directorships of several companies, and published more than 200 scientific papers, 62 books or chapters in books and 50 unpublished professional reports. He served on the editorial board of major journals, chaired several international panels, international advisory boards and was a chief scientific advisor to the Canadian delegation to UNESCO. He was President of the Mineralogical Association of Canada (1982–1983), the International Mineralogical Association (1998–2002), the Society of Economic Geologists (1991–1992) and the Geological Society of America (2001–2002).

He won numerous medals and accolades across the world. He was awarded a DSc from Laurentian University in 2000, and from the University of Pretoria in 2001. He was a visiting professor at the universities of Pretoria (1979–1980), Toronto (1984–1988), Florida (2001–2003), Witwatersrand (2005–2018) and Royal Holloway, London (2005–2008). He also won awards in Canada, the EU, the US, the UK, South Africa and Australia. He was an Honorary Research Fellow at the Natural History Museum, London (2009–2012), Fellow of the Geological Society of London, and in 2006, the Finniston Distinguished Lecturer. In 2004, the IMA Commission on New Mineral Names accepted *naldrettite* ($Pd_2Sb$) as a new mineral, named in Tony's honour. The mineral was discovered in drill core at a Ni–Cu–Co–PGE deposit in far northern Quebec.

In March this year, when asked what he regarded as his best work, Tony cited his research on Norilsk and on the Bushveld. Certainly he enjoyed his time in South Africa enormously, free from academic administration with time to discuss ideas, focus on research and enjoy a glass of wine at the end of the day with students or colleagues. He was always ready for an evening out, and could party happily into the small hours. He was always very approachable, ready to give freely of his time and tributes from around the world all recalled him as a 'true gentleman'. He had a huge energy and lived life to the full, enjoying travel, food and wine. He was a great raconteur, always ready with a story. He leaves a great legacy that will live on in the work of his associates and students. He is survived by his sister Frances, his three daughters Penny, Anne and Jennifer and two granddaughters.

**Judith Kinnaird**

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

regret to announce:


# EVENT POSTPONED

Dear Southern African Earth Sciences community,

As many of you by now well know, the current global Covid-19 pandemic, which grips the world in its virulent claws, has led the Geocongress Local Organising Committee (LOC) to make the difficult (but we believe correct) decision to postpone the 2020 Geocongress. The committee continues to monitor the local and international situations, and has as yet not made a definite decision regarding the exact dates over which the postponed Geocongress will be held. Our preliminary feeling is that the event will run in June/July 2021 and that it will comprise a significant component of online or remote-access functionality.

The LOC would like to apologise for any inconveniences that this postponement may have caused, and would like to thank each and every one of the session chairs for their efforts thus far. At this point, the theme and proposed sessions will carry over to next year, the website will remain live, and the abstract submission portal will continue to accept abstracts. The event website (http://allevents.co.za/geocongress/), the Geobulletin, and the GSSA mailing list will remain the primary vehicles for communication of updates related to the postponed Geocongress. As always, we will look forward to welcoming everyone to Stellenbosch once it is safe to do so.


# THE GEOTRAVELLER

By Roger N Scoon[1]

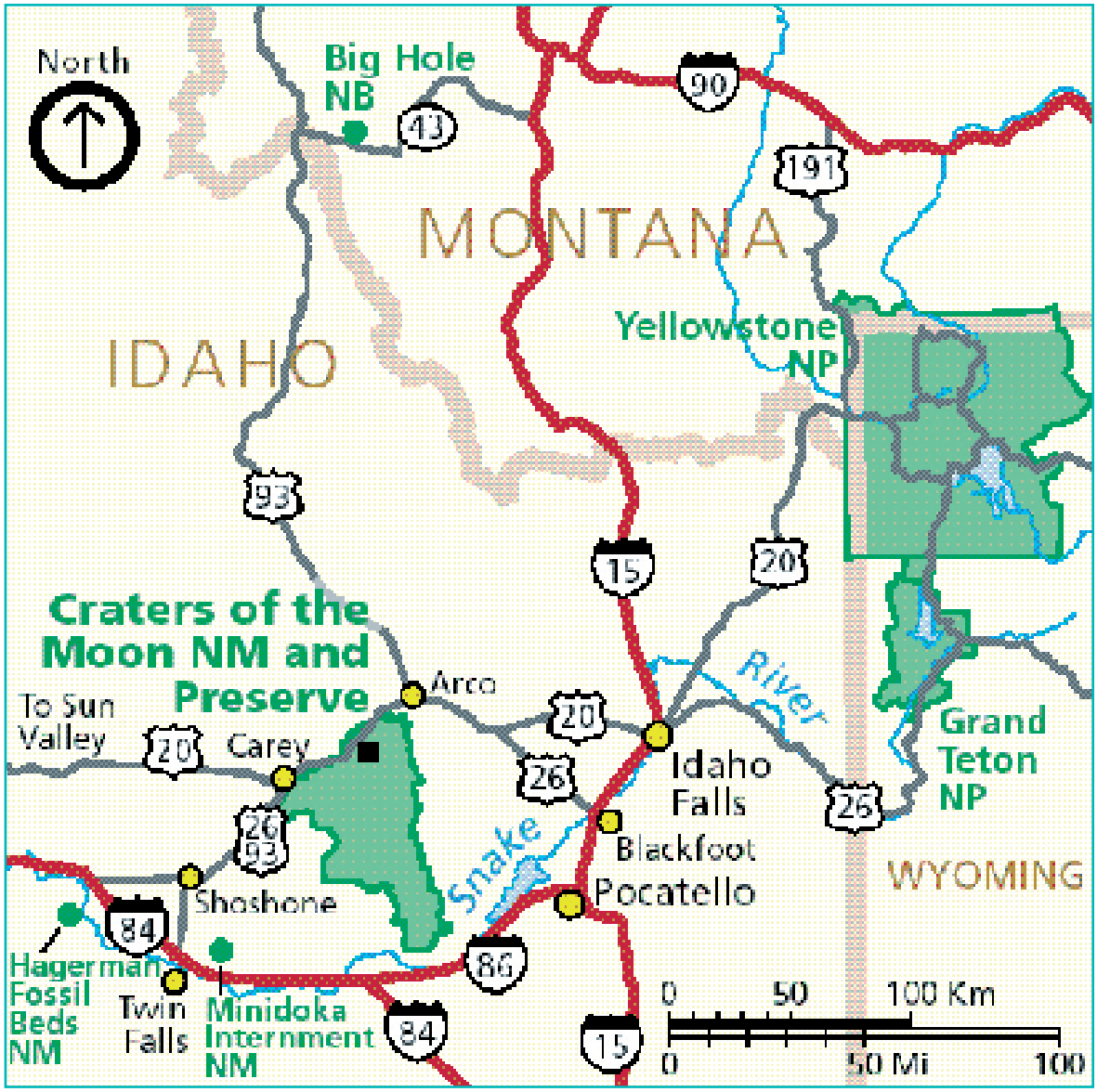
## Craters of the Moon, Idaho:
## *Holocene Lava Fields and Cinder Cones*

*The Craters of the Moon lava field is characterised by large spatter or cinder cones and extensive unvegetated lava flows.*

*The Craters of the Moon National Monument and Preserve is situated in the state of Idaho, northwest USA. The protected area is part of the Snake River Plateau, a semi-arid area west of the Rocky Mountains. The monument was established in 1924 to protect an area of approximately 3,000 km² dominated by poorly vegetated, mostly Holocene, lava flows. In recent years there has been discussion of upgrading to national park status. The lava fields constitute areas of rocky outcrop that include cinder cones and explosion craters. A notable feature of the lava fields is the occurrence of deep fissures, the largest of which has a depth of 240 m. Small caves or cavities have been left in the lava by trees incinerated by the advancing flows.*

*The Craters of the Moon can be reached on the combined highway I-20 and I-84, which links the regional town of Pocatello to the Idaho state capital of Boise and the west entrance of the Yellowstone National Park (Wyoming). The monument is located between the small towns of Arco and Carey and is bordered to the northwest by the Pioneer Mountains. The Snake River Plateau has an average elevation of 1,800 m and is part of the sagebrush steppe grasslands, an extensive botanical region west of the Rocky Mountains. The plateau in Idaho is dissected by the westward-flowing Snake River. The Pioneer Mountains located to the northwest of the Craters of the Moon Monument may be snow-covered even in late spring. The mountains consist of a core of ancient gneiss, together with complexly folded Palaeozoic sediments, and are overlain by flat-lying Eocene-age volcanic and sedimentary strata.*

*The Snake River Plateau is part of one of the world's largest flood basalt provinces and the thick sequences of basalts and rhyolites, erupted during the Late Cenozoic, are readily observed. Some surficial features in Idaho are, however, related to catastrophic floods that occurred in the latter part of the Late Pleistocene Ice Ages.[1] The lava fields in the Craters of the Moon Monument started to form towards the end of the Pleistocene epoch. The flows have been radiometrically*



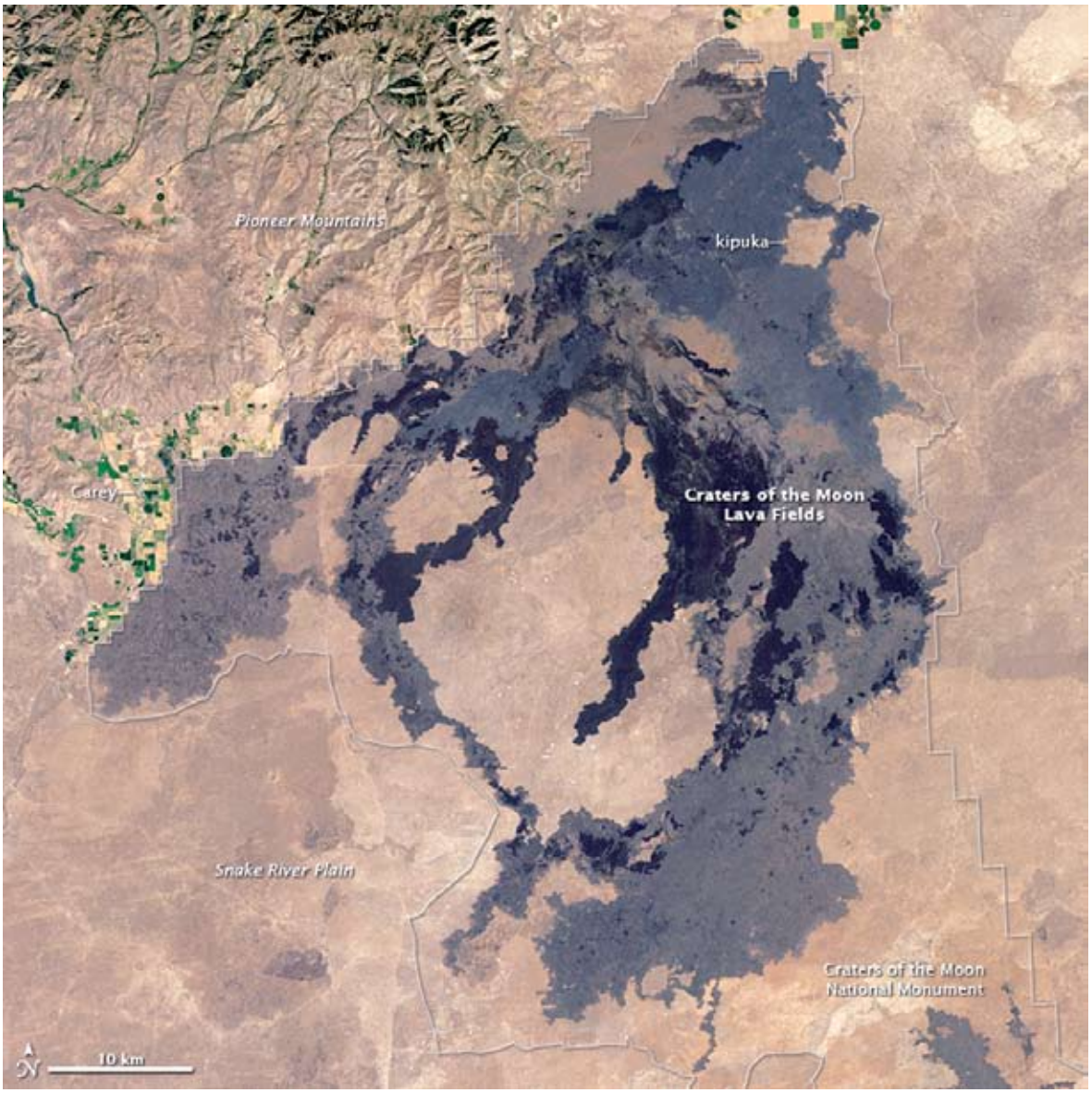

*Location map of the Craters of the Moon National Monument and Preserve in eastern Idaho.*

*dated at 15,000–2,100 BP.[2,3] The Pleistocene activity was investigated using the $^{40}Ar/^{39}Ar$ method, with the Holocene volcanism based on radiocarbon ages. The volcanic activity may have been concurrent with some of the catastrophic flood events but occurred after the deposition of loess soils, which demarcated the termination of the Last Glacial Maximum (approximately 20,000 BP). Three separate lava fields are recognised in the monument: Craters of the Moon, Kings Bowl and Wapi, which collectively contain 60 lava flows. Lava flows have an average thickness of approximately 20 m. More than 25 large spatter and cinder cones have been identified. The lava fields in the monument cover an area of 1,600 km² and contain about 30 km³ of basaltic lava. An additional five lava fields occur in the Snake River Plateau, outside of the monument boundary. The Late Pleistocene and Holocene activity in the Snake River Plateau is basaltic.*

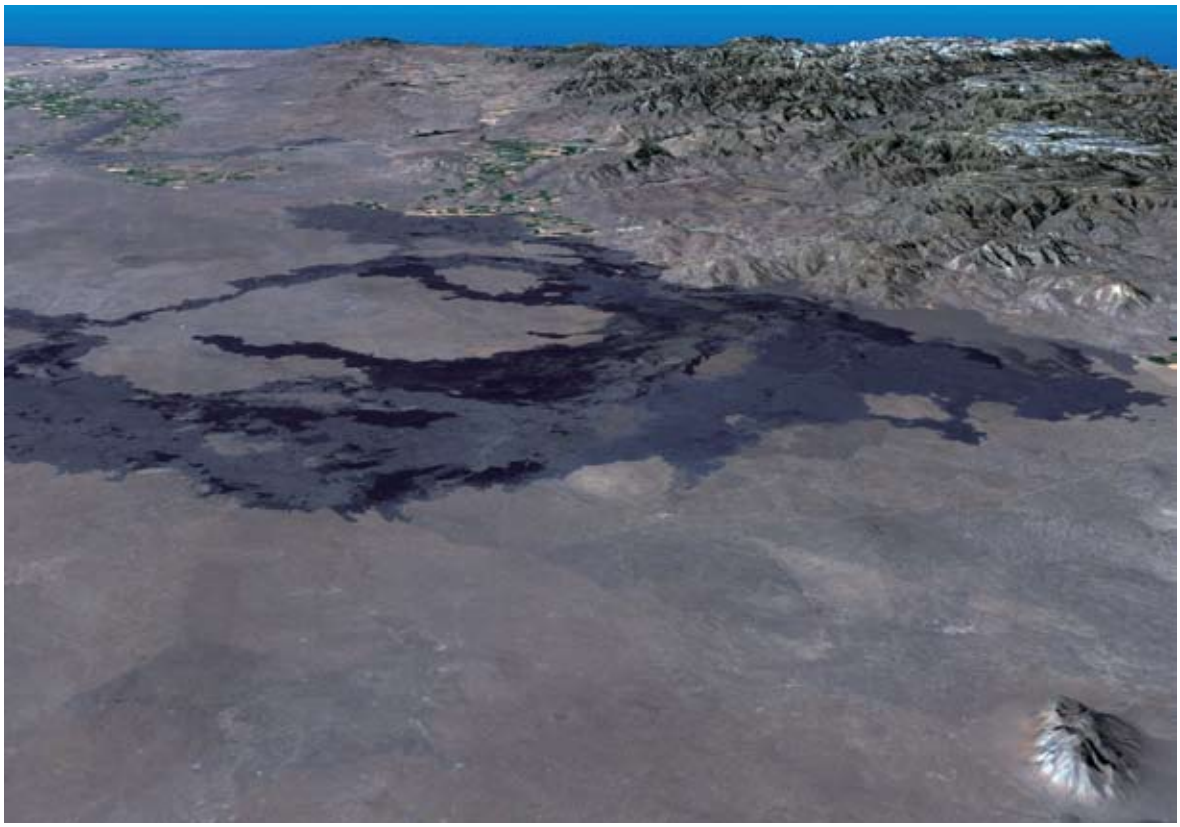
*There is little evidence of the Craters of the Moon Monument having been permanently inhabited by the indigenous peoples of North America, although the Shoshone people are reported to have witnessed some of the more recent eruptions. One of the ancient wagon train routes used by pioneers heading west intersected part of the monument and in 1879 two farmers from Arco were among the first to explore the lava fields. The first geologist to visit the area was Israel Russel (in 1901 and 1903), while undertaking surveys for the USGS. The name "Craters of the Moon" was promoted by geologist Harold Stearns, in 1923. The name is somewhat unfortunate as the craters on the surface of the Moon are mostly ascribed to meteorite impact, not volcanic activity. Some of the earliest NASA astronauts did, however, undertake training exercises in the monument, including collecting rock samples. The barren nature of the poorly vegetated, and therefore dark or black, lava fields is apparent in satellite images.*

*The recent nature of the lava flows in the Craters of the Moon Monument is revealed by the paucity of vegetation.*

*Eruption of huge volumes of basalt and rhyolite from fissures associated with the Columbia River/Snake River flood basalts is related to a hot spot located deep in the lithosphere.[4] The same, deep-seated hot spot is probably responsible for the volcanism at Yellowstone. The apparent eastward migration of the hot spot is ascribed to the westward drift of the North American Plate. The rate of drift is estimated at several cm/year. The combined Columbia River/Snake River and Yellowstone volcanic region can be linked to a single Large Igneous*

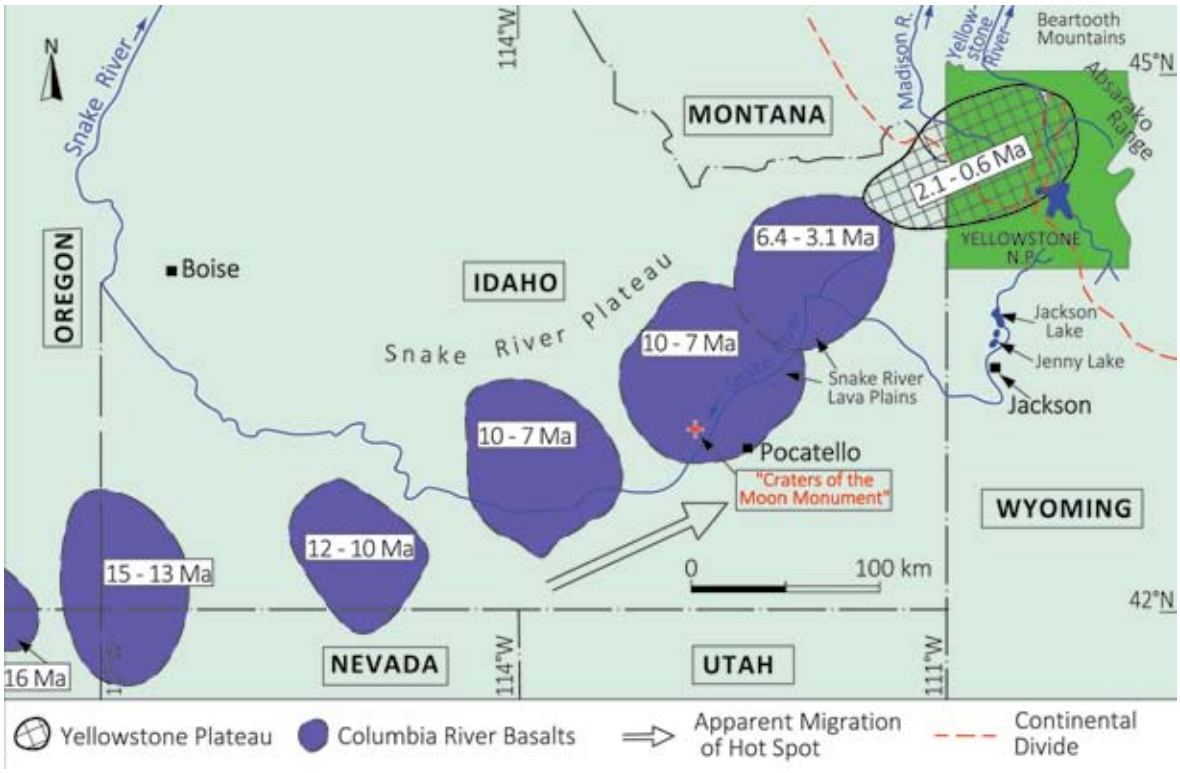



*A natural colour image of the Craters of the Moon acquired by the Enhanced Thematic Mapper Plus (ETM+), Landsat 7 satellite (August 1, 2001). The recent lava flows are black–dark brown–dark blue; forested Pioneer Mountains and irrigated fields on the Snake River Plain are green; scrub vegetation typical of the Snake River Plateau is brown (source: National Park Service).*



*A three-dimensional view of the Craters of the Moon lava field with the Pioneer Mountains in the background. USGS Global Visualization Viewer, Landsat 7 (source: National Park Service).*

*Province.[4,5,6] The Yellowstone volcanism produced an isolated plateau that formed from multiple, highly catastrophic, Plinian-style eruptions. Each of the caldera events generated huge volumes of rhyolitic ashes and pyroclastics, erupted from a central conduit. The flood basalts and rhyolites located west of the Rockies are, however, related to multiple fissures. The Snake River lavas are one of the most well-developed examples of bimodal (basalt–rhyolite) volcanism.[5] The ENE–WSW alignment of the Snake River Plateau is indicative of extension parallel to the elongation of the hot spot trend in the eastern part of the volcanic province.*




*The volcanism of the Columbia River flood basalts and the Yellowstone Volcano is related to a single deep-seated hot spot that appears to have "migrated" eastward due to the westward drift of the North Atlantic Plate.*

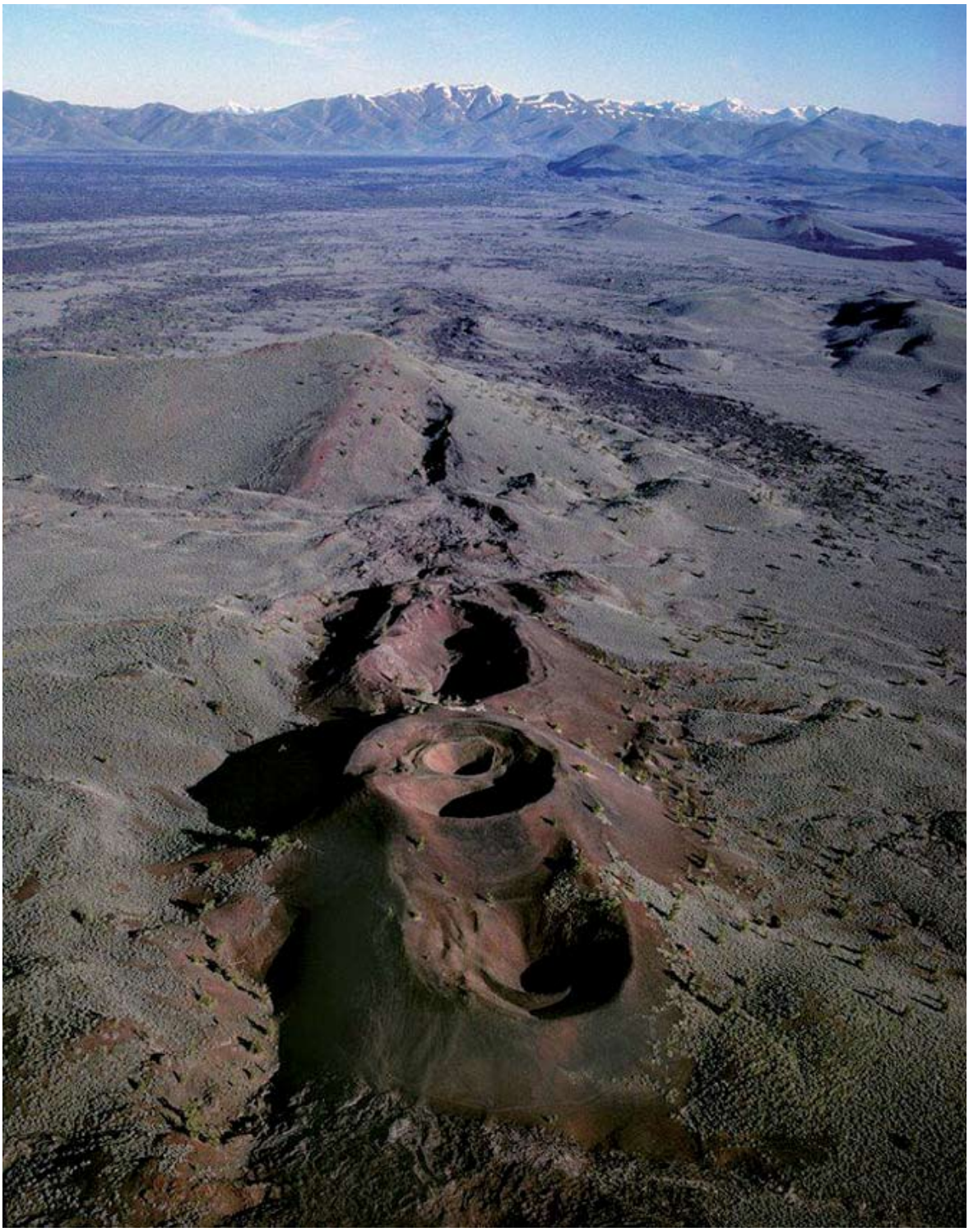
*The Columbia River/Snake River flood basalts and rhyolites formed after the peak of the Laramide Orogeny. The oldest centres occur in eastern Oregon and western Idaho (16–13 Ma). The younger centres are associated with the Snake River Plateau in eastern Idaho (12–3.1 Ma). Multiple eruptions of relatively fluid basaltic lava "flooded" the pediment over large areas.[7] The lava smoothed out the older topography to form stepped plateaus. The stacked lava flows attain thicknesses of more than 1,800 m.[8] More than 300 individual lava flows have been recognised in the Snake River Plateau, representing a combined volume of 500–600 km³ of basaltic magma.[9] The rhyolites are ascribed to eruption of "dry" magmas at temperatures >850 °C.[6] Basaltic magmatism is invoked as the impetus for large-scale crustal anatexis to produce the rhyolites, although effusion of basaltic lavas largely post-dates silicic activity.[10]*

*The flood basalts and rhyolites in the vicinity of Pocatello are of Miocene age (7–10 Ma), whereas the lava fields in the Craters of the Moon Monument are far younger and do not fit this generalised pattern. The lava fields are attributed to heat remaining from the hot spot (despite the hot spot having migrated eastward towards Yellowstone) that was trapped in some sections of the crust. The magma derived from localised melting of the lithosphere was liberated by rifting.[3,11,12] The Snake River Plateau is part of the Basin and Range terrain, which formed in part due to block faulting and rifting in the region west of the Rocky Mountains after the Laramide Orogeny. The lava fields at the Crater of the Moon Monument are aligned with the "Great Rift"—declared a National Natural Landmark in 1968—a series of NNW-trending fissures that extends for approximately 85 km³. The Great Rift connects the three separate lava fields in the monument. The fissures are generally considered to be dormant (not extinct), with new eruptions predicted to occur during the next hundred years. The trend of fissures can in part be mapped by documenting the deep fissures that are such an unusual characteristic of the lava fields.*

*The Craters of the Moon is the largest of the three lava fields, and the Kings Bowl and Wapi fields, which occur in the southern part of the monument, are distinctly subordinate.[3,11,12] The Kings Bowl lava field is restricted to a single fissure eruption dated at approximately 2,250 BP. The eruption is estimated to have lasted only a few hours. This feature includes a phreatic explosion crater: the "Kings Bowl". The explosion crater measures 90 m by 30 m and has a depth of 30 m. The steam explosion was probably triggered by interaction between the lava and groundwater. The Wapi lava field, which is far larger than the Kings Bowl field, may initially have been contemporaneous, but the activity lasted considerably longer. The Wapi lava field includes small shield volcanoes.*

*Eight major eruptive periods are recognised in the Craters of the Moon lava field.[3,11,12] The oldest activity occurred at 15,000 BP, with each period lasting approximately 1,000 years. The basaltic volcanism was separated by periods of quiescence lasting 500–3,000 years. Individual flows attained lengths of 50 km, the "Blue Dragon Flow" being the longest such feature. Eruptions typically commenced with lava curtains of heights of up to 300 m spread along the fissures for distances of as much as 1.6 km. This early-stage activity is associated with relatively fluid basaltic lava. As the eruption progressed, the lava became increasingly silicic and correspondingly less fluid. The lava curtain thus became increasingly disjointed, with discrete eruptive centres, or vents, developing. Vents are associated with gas-rich lava, which produced cinder cones, with large blebs of lava forming spatter cones. The final stage of eruptions produced lava streams that flowed out of the side or base of cinder cones. Some lava flows caused disintegration of cinder cones, which were transported some distance from the vents. Some of the*

*The Snake River winds through stacked sequences of flat-lying basalt and rhyolitic lava flows in eastern Idaho.*



*View of the Kings Bowl, a phreatic explosion pit located in the southern part of the Monument, looking north over the Craters of the Moon lava field towards the Pioneer Mountains (source: onlyinyourstate.com).*

*most extensive flows were fed by lava tubes beneath the solidified crust. This feature can be seen in the "Cave Area". A 24 km-long cave system associated with a single lava tube connects the Crater of the Moon and Wapi lava fields. The lava tubes may include lava drips on the roof and features on the side-walls indicative of the high stands.*

*The volcanic rocks in the lava fields of the Craters of the Moon Monument have been analysed for major and trace elements.[3] Several subdivisions are identified, including basalt, hawaiite and latite. The basalt and hawaiite flows have glassy crusts that are dark blue or olive green, whereas the latite flows are capped by glassy crusts that are black. The colour distinctions were used in the designation of individual lava flows mapped by Kuntz et al.[3]. The pre-Holocene flows, however, tend to be uniformly dark as the crusts have been eroded from the flow surfaces. Many of the lava flows show well-developed pahoehoe textures indicative of relatively fluid*

*The Craters of the Moon lava field includes buttes consisting of sections of cinder cones transported by lava flows, as seen in the "Cave Area".*

*lavas. It was also noted that the cinder cones and fissure deposits tend to be oxidised and intensely weathered and are highly variable in terms of colour.*

*The Craters of the Moon Monument includes a visitor centre with displays and an orientation video. The 11 km-long Loop Drive is a popular road from which many of the principal volcanic features can be examined, including fissure vents, cinder and spatter cones, and individual lava flows.[13,14] The 400 m-long paved trail at the "North Crater Flow" exposes one of the youngest lava flows, with an age of 2,200 BP. The flow contains tiny pieces of purplish-black obsidian. Moreover, the flow includes ropey-texture pahoehoe and blocky aa lava. A trail connects the "Big Craters" and "Spatter Cones", the latter including a 91 m-high cinder cone. The "Devil's Orchard" is a cluster of cinder cone fragments transported as rafts by a lava flow. The "Inferno Cinder Cone" can be ascended by a short, steep path. The view from the summit includes many of the spatter cones that characterise the Craters of the Moon lava field. The view includes "Big Cinder Butte", which with a height of over 200 m is the highest of the cones.*

*An intriguing feature of the Craters of the Moon lava field is the occurrence of incinerated trees where the lava has overrun part of an ancient forest. Some of the trees have left casts in the lava, which can be ascribed to release*

*Lava tubes are associated with ropy-textured or pahoehoe flows indicative of relatively fluid lava.*

*of water. The "Tree Moulds" area can be reached from a 1.6 km wilderness trail. This trail includes views of the extensive Blue Dragon lava flow. The "Cave Area" incorporates a sequence of lava tubes that can be viewed from a short trail. The lava tubes are open to visitors (without guides), although a free permit is required. Several longer trails can be undertaken that follow the approximate alignment of the Great Rift.*

*All photographs unless otherwise referenced are by Ian Scoon and the author.*

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*Paved trail at the Craters of the Moon Monument with views of cinder cones and breadcrust-textured lava flows (source: trip101.com).*


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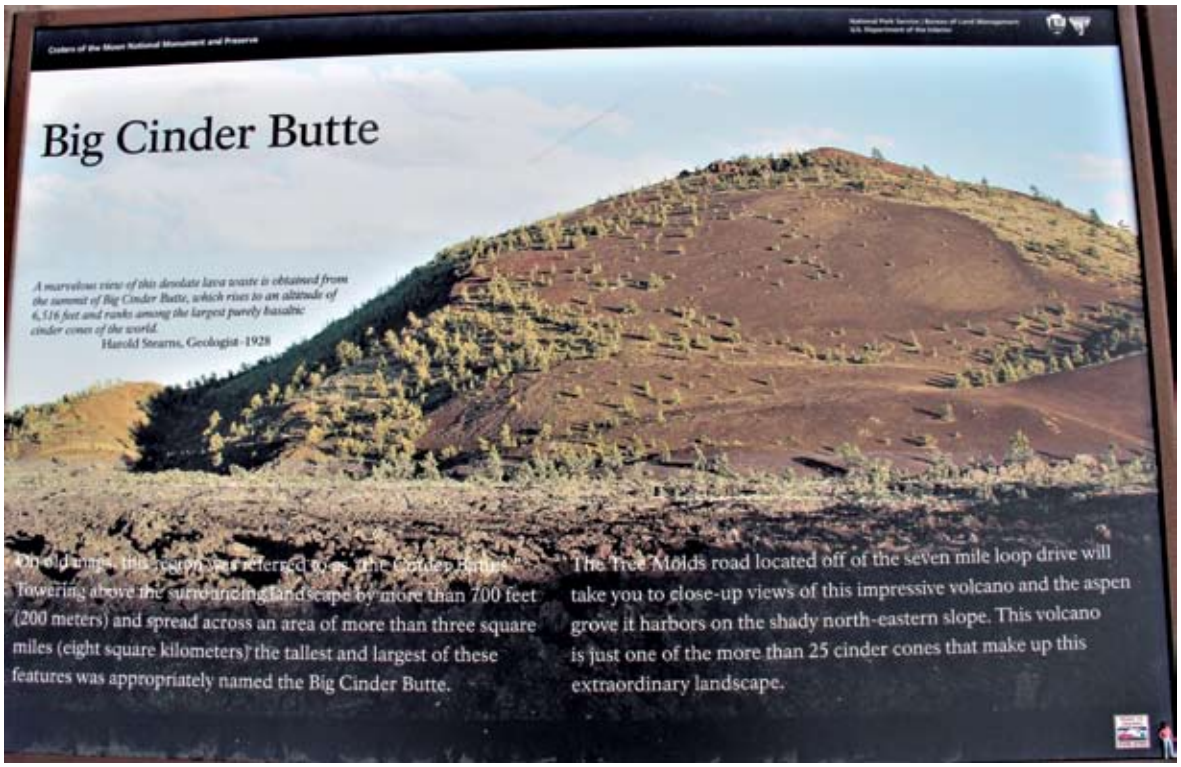


*Information board at Big Cinder Butte, a large cinder cone in the Craters of the Moon lava field.*


*Information board in the Craters of the Moon lava field showing details of lava flows.*

*Tree moulds in the Craters of the Moon lava flows include impressions of bark (photograph: James Tolbert).*


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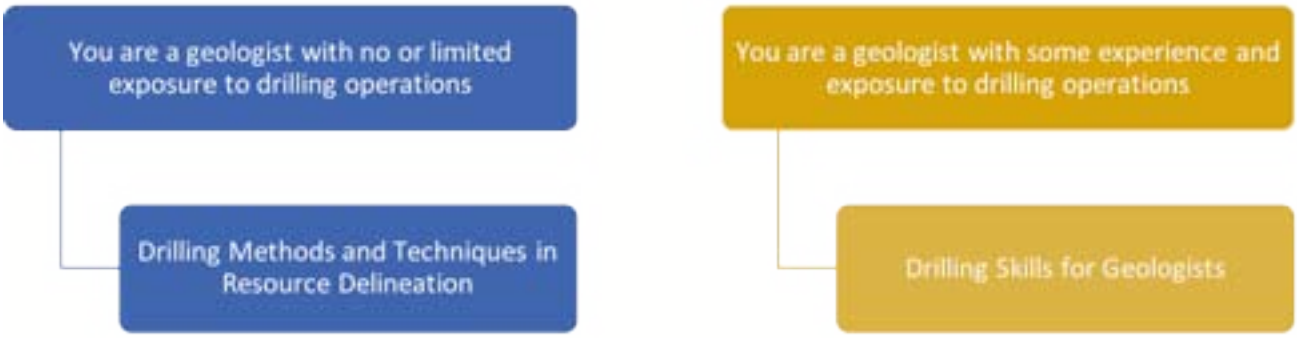
14. *National Park Service (1991). Craters of the Moon: National Park Handbook No. 139. ISBN 978-0-912627-44-1.*

# Online drilling training for geologists

Frequently, geologists (both newly qualified and experienced) are placed on drilling projects with very little understanding of the drilling operation. In order to understand the operation and be able to move towards managing it effectively, geologists need at least a fundamental understanding of the processes involved in drilling. The GSSA has two online course offerings for geologists at different stages in their careers:

1. Drilling Methods & Techniques in Resource Delineation—this is for newly qualified geologists looking for a fundamental understanding of drilling operations;
2. Drilling Skills for Geologists—this is for more experienced geologists looking for a deeper understanding of drilling concepts in order to better manage drilling projects.




## Drilling Methods and Techniques in Resource Delineation I 16 GSSA 2 SACNASP CPD points

In order to effectively contribute to managing the project, geologists require at least a basic level of understanding of drilling principles and the drilling operation as a whole. This course will provide newly qualified geologists that have had little or no exposure to drilling operations with a fundamental understanding of selected aspects of a drilling operation.

Who should attend?

Newly qualified geologists, geologists with little or no exposure to drilling operations, anyone involved in a drilling project that wants to improve their understanding of the fundamental principles of a drilling operation.

What will you learn?

The course is presented in three modules:

1. The principles of drilling: Principles and fundamentals concepts of different methods of drilling boreholes into the earth.
2. Drilling circulation systems: Flushing and circulation systems and some fundamental calculations that every geologist must be able to do.
3. Cost aspects of drilling: Directional survey concepts and some economic aspects of a drilling operation.

## When does the course take place?

The course will be delivered over a four-week period from 15 September to 6 October 2020. Delegates will be required to do a fair amount of online, self-directed learning in their own time that will be supported by four virtual contact sessions over the course of four weeks.

For more details and registration, download the Drilling Methods & Techniques Course flyer.

## Drilling Skills for Geologists I 40 GSSA 5 SACNASP CPD points

The objective of every exploration project is to obtain representative samples of as high a quality as possible, safely and efficiently. The key concepts here are quality, safety and efficiency and this program is designed to provide candidates with the necessary knowledge and skills to improve their effectiveness in identifying the source of problems and managing these three key aspects of a drilling project. This program is made up of nine courses that cover the technical, economic and safety aspects of a drilling operation. There is a strong focus on the safety and legal aspects of exploration drilling, which sets this program apart from the Drilling Methods and Techniques course.

### Who should register?

This certificate program is designed for geologists, geological technicians, safety personnel, project managers and engineers who need an in-depth understanding of the drilling aspects of an exploration project.

What will you learn?

This program is made up of nine courses that build upon each other:

1. Drilling Fundamentals
2. Introduction to Drilling Methods
3. Common Drilling Calculations
4. The Use of Drilling Fluids and Foams in Exploration Drilling
5. Fundamentals of Borehole Surveying
6. Economic Aspects of Exploration Drilling
7. Fundamentals of Hazard Identification
8. Fundamentals of Risk Assessment
9. Legal Aspects of Exploration Drilling (SA Law)

### Duration

Although our online learning programs allow candidates to work at their own pace, the program generally takes 6 to 10 months to complete, but no longer than 12 months.

For more details and registration, visit www.colinriceexploration.co.za/drilling-skills-for-geologists.

Colin Rice
EXPLORATION DRILLING ADVISORY


# 12 IKC POSTPONED TO 2022

**The 12th International Kimberlite Conference is postponed to**

## 15 - 19 August 2022

The postponement reflects the COVID-19 situation and resulting difficult times for the diamond industry together with the goal of maintaining the symbiotic mix of industry and academia that makes International Kimberlite Conferences unique. This change has the full support of the International Kimberlite Conference Advisory Committee

The intention is to host the 12IKC at the same venues in Yellowknife, with the same scientific programme, field trips, short courses and social events, but delayed by one year.

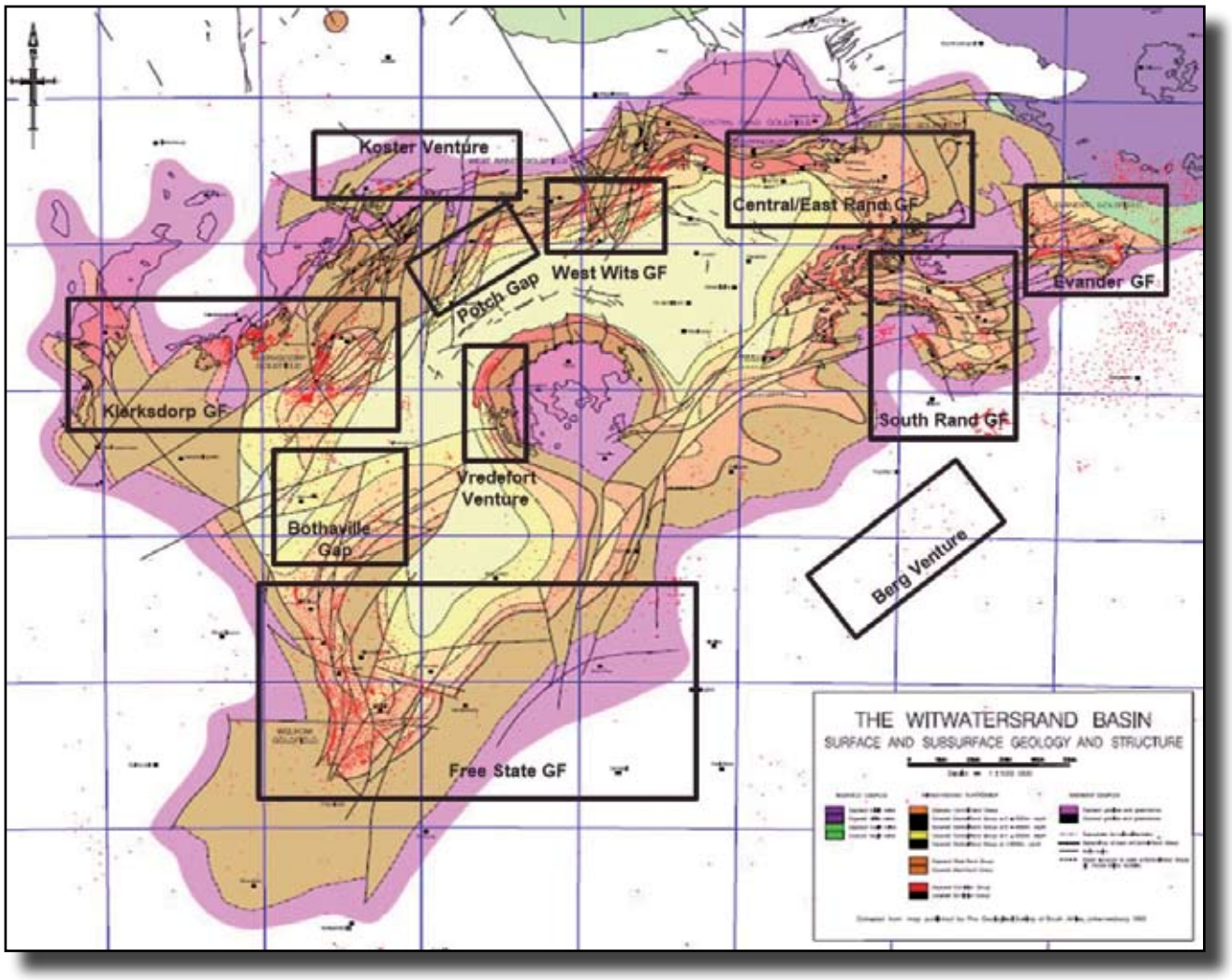
Further updates will be available on the 12 IKC Bulletin Board as well as via the 12 IKC mailing list.

We look forward to welcoming you to Yellowknife in 2022!

NOTICE

# AngloGold Ashanti opens up 80 years of exploration information

AngloGold Ashanti is in the process of closing off the sale of its remaining operations in South Africa. Exploration core and records, however, have not been sold. Over 500 000 m of core with associated borehole logs and assay results have been retained. About 5 000 detailed reports on work done in Southern Africa over the past 80 years have also been retained. The data cover many areas of the region and all known and a few unknown goldfields. AngloGold Ashanti remains listed in South Africa and would like to return value to the country that witnessed the creation and growth of the company. To this end, the company would like to make core and data records available to academic institutions in an effort to preserve the geological heritage, and to enable research that would not otherwise be possible. An example of this would be the development of an entirely new Transvaal Basin in the northern Free State where drilling has shown that the sedimentary rocks are like those of the Ghaap and Postmasberg Groups of the Kalahari Basin.




In addition to making the data and core available for research, AngloGold Ashanti is prepared to sell core, drill results and reports to any interested exploration and mining companies. This is to support exploration and mining development in South Africa and is in line with the exploration initiatives of the DMR and the Mineral Council of South Africa. The information will be sold at a fraction of the cost that would be incurred to re-acquire the data today.

Interested parties are welcome to contact Vaughan Chamberlain at vchamberlain@anglogoldashanti.com to discuss, and to check if there are records for specific projects or areas of interest, be it for research or exploration purposes.

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# rates card 2020

excl VAT & commission

## 1. 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.

**Black & White**

| Size | Casual 1-3 insertions | 4+ Insertions |
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| Full Page | R11 270.00 | R10 405.00 |
| Half Page | R 7 490.00 | R 6 735.00 |
| Quarter Page | R 4 960.00 | R 4 255.00 |

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Material to be supplied on CD as a FH MX/InDesign CS2 or PDF file. Accompanying images should be high resolution in CMYK format (NO RGB or Pantone colours). Any full page material to be trimmed to 297 x 210 mm must include a bleed of 5 mm all round. A COLOUR HARDCOPY MUST ACCOMPANY MATERIAL. Any modifications to incorrectly supplied material will be charged to the advertiser at R300.00 per hour.

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| | |
|---|---|
| March issue: | 15 February 2020 |
| June issue: | 15 May 2020 |
| September issue: | 14 August 2020 |
| December issue: | 15 November 2020 |

## 6. CANCELLATIONS

At least 4 weeks prior to deadline

## 7. CIRCULATION

Geobulletin is issued in digital format to all members of the GSSA and its local and overseas exchange partners. A printed option is also available for those who opt for it, and the electronic version is available as an open access download on the GSSA website. **Circulation exceeds 3150 recipients plus website visitors, and reaches decision makers in the geoscience community including industry, academia, and government.**

## 8. ADVERTISING BOOKINGS AND SUBMISSION

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