

Geological Society of Africa

Newsletter

Volume 10 - Issue 4
(December, 2020)



Edited by
Tamer Abu-Alam
Editor of the GSAf Newsletter

<http://gsafr.org/newsletter/>

Welcome to Fez, Morocco

The 28th Colloquium of African Geology
(CAG 28)

9th-17th October, 2021

Abstract deadline June 20th, 2021

Join the largest geological event in Africa

<http://www.fsdmfes.ac.ma/CAG28/>

In the issue

GSAF MATTERS

| | |
|---|----|
| <u>GEPARK INITIATIVE CALL OUT TO GSAF</u> | 1 |
| <u>IN MEMORIAM: PROFESSOR DR. DIETRICH DANKWART KLEMM</u> | 4 |
| <u>UNESCO LECTURE SERIES</u> | 7 |
| <u>KNOW AFRICA (COVER STORY)</u> | 11 |
| <u>GEOLOGY COMIC</u> | 12 |
| <u>CALL FOR ABSTRACTS AND SPECIAL ISSUE</u> | 13 |
| <u>GEOLOGICAL EXPRESSIONS</u> | 15 |
| CONTRIBUTIONS FROM GEOSCIENTISTS | |
| <u>THE VALUE OF REVIVING ABANDONED PROJECTS VITAL FOR SUSTAINING A MODERN WORLD</u> | 16 |
| <u>INVESTIGATION OF GROUND CRACKS IN NAMIBIA</u> | 18 |
| <u>NAMIBIA, MECCA OF MINERALS AND FOSSILS</u> | 19 |
| <u>CONTACT THE COUNCIL</u> | 25 |



Geological Society of Africa – Newsletter
Volume 10 – Issue 4
December 2020

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<http://gsafr.org>

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GSAf MATTERS

Geopark Initiative Call Out to GSAf

By Wladyslaw Altermann (Vice-President of the GSAf), University of Johannesburg

Dear Colleagues, Friends, Geopark Enthusiasts and Members of the GSAf

In the recent years a GEOPARK INITIATIVE FOR AFRICA has been launched by UNESCO and developed successfully along the lines of the Global Geopark Network of the International Association on Geoparks and the International Geoscience and Geoparks Programme (IGGP). Many initiatives for Geoparks in African countries were developed and two UNESCO Global Geoparks, Ngorongoro-Lengai in Tanzania and M'Goun in Morocco were established. They operate successfully next to many Aspiring UNESCO Geoparks and even more national Geoparks and Geopark initiatives and geological World Heritage Sites across the African continent.

UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, and education. They combine nature conservation with sustainable development and tourism, involving local communities and their cultural and economic background. More information on Geoparks, their establishment procedures, requirements, goals and advantages in sustainable protection of geo and cultural heritage, tourism, education and economy in general for the operating countries, can be found on UNESCO webpages (see below). Some of you are already involved in such initiatives and are active and/or managing a Geopark or a Geopark initiative, others may be in an initial stage of planning.

Many international initiatives aim to partner with Geopark initiatives in Africa as a contribution to sustainable development of the continent. Among such initiatives, German Geoparks but particularly the six existing UNESCO Global Geoparks in Germany, seek for partners that are willing to participate in exchange of experience, educational seminars on Geopark organization and management, and on application to UNESCO for a Geopark or Aspiring Geopark status and related questions. This programme will run for several years and profit both sides in a sustainable development of relevant infrastructure and administration. The Global Geopark Network and the International Association of Geoparks are involved in this initiative. Geoparks or Aspiring Geoparks and other such initiatives in Africa will be invited to the projects and seminars and participate in mutual team visits and training programmes. Further steps will be undertaken by the African partners and German UNESCO Commission to develop strong partnerships and cooperation.

The project was supposed to start and run already in 2020 but it could not lift-off due to the Covid pandemic and all is shifted to 2021 and following years. The curriculum for the cooperation between African countries and Germany is being currently developed, whereby Germany will help in funding of educational courses and seminars for African participants, which will involve visits to German and African Geoparks, training of guides and exchange of experience on various levels.

Africa is in the declared centre of interest of UNESCO activities. The Geological Society of Africa (GSAf, affiliated with UNESCO; <http://gsafr.org/>), as the only geoscientific organization reaching across Africa, should be involved in this project and actively support Geopark initiatives and cooperation between African and other Geoparks.

If you are interested in such cooperation and are a part of an existing African Geopark or Geopark initiative, please contact me and UNESCO GLocal geoparks with some information on your organization and its activities until the end of February 2021. I will pass this information including your addresses and web pages to the German Global Geoparks. Please address your writing with the subject "African Geoparks" to my email w.altermann@outlook.com.

Websites informing of UNESCO and African Geoparks:

- <http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/>
- <https://en.unesco.org/news/new-unesco-global-geoparks-network-support-africas-rich-geological-heritage>

- <http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/tanzania/ngorongoro-lengai/>
- <http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/morocco/mgoun/>
- <http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/list-of-unesco-global-geoparks/>

Examples of the richness of African geo heritage:



Ngorongoro crater in Tanzania; entrance to the Geopark and the inner crater wall.



The Barberton Mountain Land, South Africa, a World Heritage Site (WHS) of 3.5 billion year old rocks.



The Okavango Delta wet lands in Botswana; a unique inland delta in the world, with seasonal flood plains, active fluvial and lacustrine sedimentation saline ponds in the centre of the islands, dried out by evapo-transpiration through vegetation; a unique geo-bio cultural diversity.



Thy pyramids of Egypt are the heritage of the geology and geological knowledge of the ancient Egyptians.



Columnar basalt of the Lebombo Mountains in Mozambique.

GSAf MATTERS: In Memoriam: Professor Dr. Dietrich Dankwart Klemm

Ludwig-Maximilians-Universität München (LMU), Germany

Obituary by:

Wladyslaw Altermann (Vice-President of GSAf, South, University of Johannesburg, South Africa)

Prof. Dr Dietrich Dankwart Klemm (Dietrich or “DD” as some of us knew him), was a well-known connoisseur of African geology and mineral deposits and of the ancient Egypt. He spent most of his academic life in Munich, being Professor at the Ludwig Maximilians University. DD Klemm was born on 29th January, 1933. Already his grandfather Carl Albert Gustav Klemm was a well-known geologist and director of the “Grand-Ducal Hessian State Geological Institute”. He worked and published on the Spessart and the Odenwald regions, between ca. 1910 to 1930ies. Dietrich’s father, Dr Ing. Richard Klemm was a chemical engineer. Although he never spoke much about his childhood, Dietrich was proud of his scientific heritage, which certainly led him to become geochemist, mineralogist and archeometrist, and he followed the footsteps of his grandfather as a young lecturer and Ass. Prof. working in the Odenwald and for the Geological Survey of Hessa.

Dietrich Klemm studied at the Universities of Frankfurt (BSc geology) and Heidelberg (mineralogy), where he received the doctorate in 1959 with a thesis on Anatolian Fe-deposit of Divrik, under Prof. Paul Ramdohr. He worked at the University

of Heidelberg and moved to the Ludwig-Maximilians University of Munich, in 1961. In 1964 he received the habilitation (DSc) and continued as a lecturer and Ass. Prof. until he became full professor of geochemistry and economic geology, in 1973. Until his retirement in 1998 Prof. Klemm was a highly respected teacher at the LMU and became a very successful scientist, well-funded by the German Research Foundation - DFG (over 50 project applications), the Volkswagen Foundation and other sources, by securing over 10 million Euro for research. His colleagues and students profited tremendously from this funding and participated in exciting research and field expeditions, mainly to northern and southern Africa.

Together with his wife Rosemarie Klemm, a well-respected archaeologist and Egyptologist, Dietrich led several projects with students investigating the cultural heritage of ancient Egypt and Nubia and how it was based on the rock and mineral wealth of the north African region. This co-operation with Egyptian Organisation of Antiquities on ancient monuments led also to the development (together with Prof Rolf Snethlage) of a scientific laboratory for restoration and conservation of building materials and a fruitful teamwork with the Bavarian Office for Conservation of Monuments. Prof Klemm's interest in archaeometry and conservation of monuments resulted in new investigation methods and helped many of his students and colleagues to become specialists in these disciplines. After his retirement, Prof. Klemm was still active for several years in conservation and archaeometry, with one of his daughters.

Dietrich's other passion were the mineral deposits of southern Africa. He worked on Precambrian sedimentary deposits and the BIF- related iron and manganese ores of South Africa, on the Bushveld Igneous Complex (BIC), or the Great Dyke mineralization in Zimbabwe. He was fascinated by gold deposits and was also active in mineral deposits of Nigeria and of southern (alpine) Europe.

I first met Prof. Klemm during his sabbatical at the University of Stellenbosch, where I was a post-doctoral researcher, in 1990. Actually, it was my wife (then a PhD student in biology) that met him first and brought him for a dinner. He was a gentleman and charmer. On excursions he used to pick flowers in the outcrop and give them to female students before giving field explanations, and he often wore a bow tie during mine visits (even in the heat of the Bushveld). He was always interested in a cultivated conversation on almost any subject in the world. But he was selective in his conversation partners and offered the German "Du" (you) only after he knew people very well, otherwise rather using the respectful but distancing plural form of addressing ("Sie"). It was an honour to have him as promoter and a friend. We have had many very good conversations in the beer gardens of Munich, during excursions and visits to the field in Griqualand West, where we inspected Neoproterozoic to Paleoproterozoic outcrops and mineral deposits. Later, I worked under him at the LMU for many years until his retirement and my habilitation dissertation. At the same time also Prof. Pat Eriksson of the University of Pretoria, did his habilitation degree under the auspices of Prof. Klemm. The many student excursions organized together were highlights of the LMU geology curriculum. Most famous across Germany's geology departments were the 2-3 weeks long excursions organized by Prof. Dietrich Klemm every two to three years. They took about 20 German students across the mines of South Africa, visiting daily one or even two underground and open cast operations, and on weekends spectacular world heritage outcrops, including the obligatory one-day drive through the Kruger National Park. Many of

those students remained in or later returned to Africa and became important personalities in the geological fraternity.

Dietrich Klemm has initiated and supervised over 100 Master and 40 PhD dissertations. For the colloquium in celebration of his 65th birthday, organized by Dr Esther von Plehwe-Leisen and myself (1998), we have counted 16 students of Dietrich which became professors, working and living between Asia, Africa, Europe and South America, among them Esther's husband, Prof Hans Leisen.

Prof Klemm's important publications include:

- A book edited with H.-J. Schneider "Time- and strata-bound ore deposits" (Springer, Berlin 1977; 1984; ISBN 3-540-08502-5 and ISBN 0-387-08502-5), which was a "must-read" when I was a student in Berlin, where H.-J. Schneider was my economic geology professor.

Books with Dietrich's wife Rosemarie Klemm (Klemm, DD and Klemm, R) include:

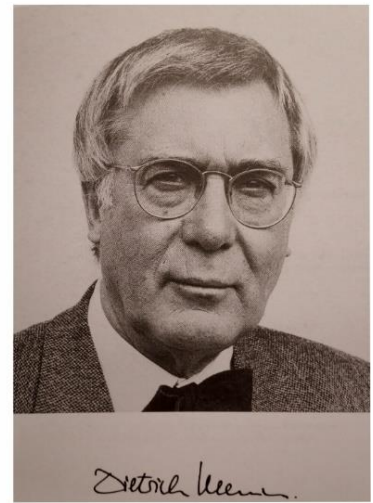
- 1981: "Die Steine der Pharaonen. Herkunftsbestimmung altägyptischen Steinmaterials", published at the Staatliche Sammlung Ägyptischer Kunst München, 1981.
- 1993: "Steine und Steinbrüche im Alten Ägypten". Springer, 1993 ISBN 3-540-54685, 465 p.
- 2008: "Stones and Quarries in Ancient Egypt. - British Museum Press, London, 354 p.
- 2010: "The Stones of the Pyramids. Provenance of the Building Stones of the Old Kingdom Pyramids of Egypt"; de Gruyter, Berlin 2010 ISBN 978-3-11-022123-7
- 2013: "Gold and Gold Mining in Ancient Egypt and Nubia/Sudan" Springer, 2013, 649 p.

These books became standard work in Egyptology. I remember visitors from Egypt but also, for example, from the British Museum, coming to the LMU to learn from Dietrich and Rosemarie.

Next to the above widely recognized merits, professor Klemm was also the Editor of the Springer journal "Mineralium Deposita", affiliated to the Society of Geology Applied to Mineral Deposits. Dietrich Klemm was a long-time member of the Geological Society of South Africa and has also published in the Journal of African Earth Sciences of the GSAf:

- DD Klemm, 2000; The formation of Palaeoproterozoic banded iron formations and their associated Fe and Mn deposits, with reference to the Griqualand West deposits, South Africa; J. of African Earth Sciences, Vol. 30, No, 1, pp. 1-24.
- DD Klemm, R Klemm and A Murr, 2001; Gold of the Pharaohs – 6000 years of gold mining in Egypt and Nubia; J. African Earth Sciences 33, 643–659.
- DD Klemm and R Klemm, 2001; The building stones of ancient Egypt – a gift of its geology; J. African Earth Sciences 33, 631–642.

Prof Dr Dietrich Dankwart Klemm passed away peacefully on the 2nd October 2020 in his house in Diessen, close to Munich. We commiserate with his family, wife, three daughters and grandchildren and great grandchildren, his students and colleagues and all those that knew and miss Dietrich.



Upper left: Prof Dietrich Klemm in 2016. Upper right: Egypt in ca. 1994, unpacking his desert tent. Low left: With German students in the Bushveld, South Africa (ca. 1996) and on the right, in 1998 at the 65th birthday colloquium.

GSAf MATTERS: UNESCO Lecture Series

Earth Materials for a Sustainable and Thriving Society
PROGRAMME

Earth Materials for a Sustainable and Thriving Society

Organised in collaboration with IUGS and iCRAG

PROGRAMME

Minerals and other Earth materials are a key component in the development of a sustainable global society, providing essential raw materials for technologies and economic growth while respecting the natural world. This programme of lectures, designed for a global audience, will provide diverse perspectives on Earth materials and their role in society. Leading natural scientists, social scientists, and educators will look at how Earth materials are critical to a sustainable future and how the minerals sector, adhering to best practices, can contribute to society in a socially and environmentally positive way.

The lectures will be delivered in webinar format by recognized global experts who will frame their presentations in the context of the United Nations Sustainable Development Goals. The Series will boost knowledge of Earth materials and contribute to better informed local, regional, and international discussions. The lectures will be freely accessible and will be archived for later online access.

The Lecture Series is sponsored by UNESCO, the only United Nations organization with a mandate to support research and capacity building in the Earth Sciences. The Series supports the vision of UNESCO's International Geoscience Programme for efficient, safe, sustainable and renewable natural resources exploration and extraction.

- **UNESCO** is the only United Nations organization with a mandate to support research and capacity building in the Earth Sciences.
- The UNESCO **International Geoscience Programme (IGCP)** serves as a knowledge hub of UNESCO to facilitate international scientific cooperation in the geosciences.
- The **International Union of Geological Sciences (IUGS)** encourages international co-operation and participation in the Earth Sciences in relation to human welfare.
- **iCRAG**, the Science Foundation Ireland Research Centre for Applied Geosciences, is a team of researchers creating solutions for a sustainable society.

The lecture series will commence 26 January 2021.

To register, visit: <https://bit.ly/UNESCOlectures>

For more information, please email: unescolectures@icrag-centre.org

All sessions will be conducted in English with live captioning in French, Spanish, Portuguese, Arabic, Swahili, and Hindi. The presentations will be made available online for later viewing.



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1. EARTH MATERIALS: THE FOUNDATION FOR DEVELOPMENT

26 January 2021

05.00 (Vancouver) * 08.00 (Toronto, Lima) * 13.00 (London) * 14.00 (Paris, Lagos) * 15.00 (Johannesburg) * 16.00 (Nairobi) * 18.30 (Mumbai) * 19.00 (Dhaka) * 21.00 (Beijing) * 22.00 (Tokyo) * 00.00+1 (Sydney)

- Introductory remarks from **Dr. Shamila Nair-Bedouelle**, Assistant Director-General for Natural Sciences, UNESCO, and **Dr. John Ludden CBE**, Bicentennial Research Professor, Environmental Governance and Diplomacy, Heriot-Watt University, UK

Review of historical and present-day mineral demand and its connections to the economy, technology, and society

- Historical context globally — why Earth materials are important
- Technological evolution and climate neutrality are creating demand for new mineral portfolios
- Mineral wealth and the SDGs, including wealth and social justice

Dr. Larry Meinert, Meinert Consulting LLC, Delaware, USA.
and

Dr. Nellie Mutemeri, Mining Practice Lead, Mutemeri Consulting and Associate Professor, University of Witwatersrand, South Africa.

2. CLIMATE NEUTRALITY, THE CIRCULAR ECONOMY, AND EARTH MATERIALS

2 February 2021

07.00 (Vancouver) * 10.00 (Toronto, Lima) * 15.00 (London) * 16.00 (Paris, Lagos) * 17.00 (Johannesburg) * 18.00 (Nairobi) * 20.30 (Mumbai) * 21.00 (Dhaka) * 23.00 (Beijing) * 00.00+1 (Tokyo) * 02.00+1 (Sydney)

Reimagining metal supply to meet demand and societal expectations

- Current and emerging demand drivers
- Circular economy — importance and challenges
- Moving to efficient and responsible primary extraction
- Joining up the value chain

Prof. John Thompson, Consultant, Vancouver, Canada.
and

Prof. Frances Wall, Professor of Applied Mineralogy, University of Exeter, UK.

3. SUPPLIERS, CONSUMERS, AND THE GLOBAL MINERALS SUPPLY CHAIN

Technical, environmental, business, and social aspects of different scales of mining operations; links between consumers and source

- How supply chains work from source to use
- Differentiating large-scale, high-tech small-scale, and artisanal mining sectors
- Processing, refining, manufacturing sectors
- Stakeholders, responsible sourcing programmes, and their impacts

Dr. Kathryn Moore, Senior Lecturer in Critical and Green Technology Metals, University of Exeter, UK.
and

Dr. Judy Muthuri, Associate Professor of Corporate Social Responsibility, Nottingham University Business School, UK, and Project Lead, Sustainable Artisanal and Small-scale Mining Project (Kenya).



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4. MINERAL EXTRACTION AND COMMUNITIES

Regulation of the mining sector; mining and local communities in the context of Latin America and Africa

- Social justice and sustainability: the challenge of social acceptance and license
- The importance of governance: Regulation and oversight of mining operations
- Case studies and best practices

Dr. Rajiv Maher, Research Professor, EGADE Business School del Tecnológico de Monterrey, Mexico.

and

Dr. Melba Kapesa Wasunna, External Affairs Manager, Base Titanium Ltd., Kenya.

5. THE NEGLECTED MINERALS AND MATERIALS OF DEVELOPMENT

Materials produced and consumed locally (in both developing and developed countries)

- Bulk materials, generally for nearby use
- Role in construction, infrastructure, agriculture, water treatment, etc.
- Environmental, social, and economic dimensions

Prof. Daniel Franks, Program Leader, Sustainable Minerals Institute, University of Queensland, Australia.

6. EARTH MATERIALS AND A SUSTAINABLE FUTURE

A reliable, affordable, and just supply of earth materials can be the foundation for a sustainable future and young professionals are the key to that future.

- Earth materials and the UN Sustainable Development Goals
- Technical, workforce, and social challenges must be addressed at all scales in both developing and developed countries
- A vision for the future

Prof. Murray Hitzman, Director of iCRAG and Science Foundation Ireland Research Professor, University College Dublin, Ireland.

and

Ms. Halleluya Naantu Ekandjo, research student, iCRAG, Dublin, studying the Rosh Pinah zinc-lead deposit, Namibia.

- Closing remarks by **UNESCO representative**

Images top to bottom: Page 1: Shutterstock/MrNovel; Shutterstock/Sunshine Seeds; Shutterstock/Talukdar David. Page 2: Shutterstock/Abdelrahman Hassanein; Getty Images/iStockphoto; Natanael Melchor on Unsplash. Page 3: Shutterstock/egd; Shutterstock/yurakrasil; Rawpixel.com - stock.adobe.com.

KNOW AFRICA (COVER STORY)

Ethiopia

Shaded relief map. Surrounding territory greyed out. Colored according to vegetation. Includes clip path for the state area.
Projection: Mercator Extents: 31/49.7/1.5/17 Data source: NASA

(Modified from <https://www.123rf.com>)



Welcome to Fez, Morocco

The 28th Colloquium of African Geology
(CAG 28)

9th-17th October, 2021

Third circular

English version: <http://www.fsdmfes.ac.ma/CAG28/MDocs/files/CAG%2028%20Fez%20Third%20announcement%20I.pdf>

French version: <http://www.fsdmfes.ac.ma/CAG28/MDocs/files/CAG%2028%20Fez%20Troisieme%20Circulaire%20Fr.pdf>

GEOLOGY COMIC



Call for abstracts

You are invited to submit your abstract for oral or poster presentation at the Conference Centre of Fez University. Dates, modalities, procedures and guidelines are indicated in this announcement and in the conference website at:

<http://www.fsdmfes.ac.ma/CAG28/Abstracts/Submission>

Call for papers: Special Issue of the Journal of African Earth Sciences

A special issue of the Journal of African Earth Sciences (Elsevier) will be dedicated to the 28th Colloquium of African Geology. All the themes covered by the colloquium are concerned.

If you are interested in a special-issue JEAS publication, the submission deadline has been set for **October 30, 2021**, just after the CAG28. You will be able to send your manuscripts **from June 20, 2021**, the closing date for CAG 28 registration.

The provisional theme of the special issue is:

“The growth of African Continental Crust through geological times. African cratons and their margins.”

This Special issue title is not restrictive in terms of topics and themes.

In order to meet the requirements of the JEAS, **you are first asked to send us your intention of interest accompanied by the provisional title of your publication, the list of authors and their affiliation (s) and a short abstract (cag28fez@gmail.com).**

Please refer to the JEAS guidelines to prepare your manuscript from now at:

<https://www.elsevier.com/journals/journal-of-african-earth-sciences/1464-343x/guide-for-authors>

Appel à communications

Vous êtes invités à soumettre votre résumé pour une communication orale ou affichée au Centre de Conférence de l'Université de Fès. Les dates, les modalités et les procédures sont précisées dans cette circulaire et sur le site web du colloque à :

<http://www.fsdmfes.ac.ma/CAG28/Abstracts/Submission>

Appel à Publications: Numéro spécial du Journal of African Earth Sciences

Un numéro spécial du Journal of African Earth Sciences (Elsevier) sera dédié au 28ème colloque de Géologie Africaine. Tous les thèmes couverts par le congrès sont concernés.

Si vous êtes intéressés par une publication JEAS, la date de soumission a été fixée au **30 octobre 2021**, juste après le CAG28. Vous pourrez envoyer vos manuscrits finalisés à partir **du 20 juin 2021**, date de clôture des inscriptions au CAG28.

Cependant, vous êtes priés dans un premier temps, pour satisfaire aux exigences du JEAS, **de nous faire parvenir votre intention d'intérêt accompagnée du titre provisoire de votre publication, de la liste des auteurs et leur affiliation (s) et d'un court résumé à l'adresse e-mail du colloque cag28fez@gmail.com.**

Référez-vous aux instructions du journal à l'adresse suivante pour la préparation des manuscrits :

<https://www.elsevier.com/journals/journal-of-african-earth-sciences/1464-343x/guide-for-authors>

Le Journal of African Earth Sciences (JEAS) est le journal officiel de la Société Géologie d'Afrique (GSAf). Nous sommes associés par un protocole d'entente dument signé (MoU, convention) dont les objectifs sont l'encouragement et l'aide aux géoscientifiques africains pour publier et mettre en valeur leurs recherches dans un journal scientifique de haut niveau international. Par le passé, plusieurs numéros spéciaux ont pu être consacrés à différentes manifestations scientifiques, à titre indicatif, on peut citer : (CAG 17, El Jadida; CAG 24, Addis-Ababa; 3MA, Fez 2007 ; 3MA, Agadir 2015 ; AAWG3, 2009 ; ICG1, 2019...).

Nous retenons, pour le moment, comme thématique globale pour ce numéro, le titre suivant :

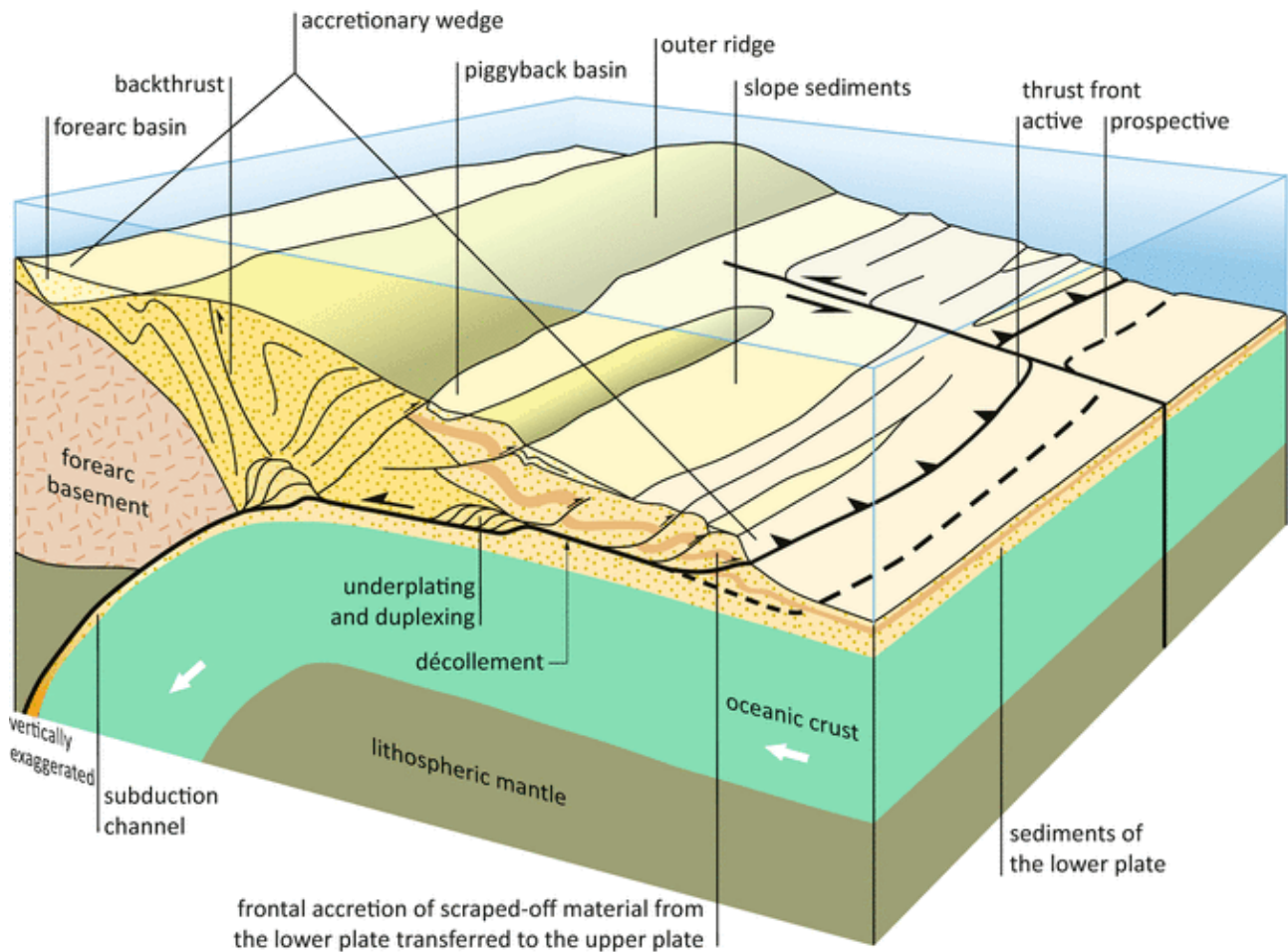
“The growth of African Continental Crust through geological times. African Cratons and their margins”.

Ce titre ne restreint pas les thèmes et les sujets à proposer dans les articles. Tous les thèmes du programme seront concernés.

GEOLOGICAL EXPRESSIONS

Accretionary Wedge

A mass of sea floor sediment that accumulates at the boundary between a converging oceanic plate and continental plate. This sediment is being scraped off the top of the oceanic plate as it is forced under the continental plate. It "accretes" at the point of plate collision, and that is where the name originates.



modified from <https://www.geo.umass.edu/news/geomechanics-lab-studies-energy-budgets-accretionary-wedges>

modified from <https://geology.com/dictionary/glossary-a.shtml>

Contributions from geoscientists

Acknowledgment

The editor thanks all the members of the GSAf who contributed to the "Contributions from geoscientists" section during 2020. An especial thank goes to members of the GSAf council who helped to get these articles. The council hopes to see more contributions from society's followers.

The value of reviving abandoned projects vital for sustaining a modern world

By: Dr. Nortin Titus

titus.nortin@gmail.com

The seismological network of Namibia, which was first implemented in 1998, reached a turning point in 2015. At that time the network was already more than 15 years old and the equipment started to show its age. Data from the stations became increasingly problematic as digitizers and sensors began to fail. To add to these problems, the central seismic server was showing a tendency to shut down sporadically, jeopardizing the uninterrupted flow of data recordings, with the looming threat of eventual complete collapse. In addition, very little documentation was available from previous work on the network, and little guidance regarding the practical purpose of a seismic network. To save the Namibian Seismology Program and preserve the investment of previous years, a long-term project, designed to provide a clear vision and pathway for the future, was developed.

However, motivating the replacement of aging seismometers clearly was going to be difficult in view of the country's many other competing national objectives. It was further impeded by the widespread idea that Namibia was seismically inactive - an unfounded assessment which, owing to the lack of available data, was based on belief rather than fact!

Still, the advantages of a functioning seismological network were numerous. In a country rich in natural resources, with many open-pit mining operations, such information is invaluable in mine planning, especially with regard to maximum slope angles of pits and tailings. Seismic data, therefore, are critical for safety assessments and hazard mitigation, which, however, are not restricted to operating mines, but extend to both large national infrastructure projects such as airports, dams, nuclear power stations, etc., and local construction schemes.

Accordingly, it was decided to go ahead with the program and to invest substantially in new equipment and training to ensure the long-term efficiency of the "revamped" seismological network. A formal plan for a five-year seismological network expansion project, which would improve the passive seismic monitoring surface area from 7% in 2018 to 44% in 2022, was formulated, embracing simple objectives:



Station A: Southern Namibia

Station A: Southern Namibia



Station B: Northern Namibia

Station B: Northern Namibia

- Availability - collect seismic data;
- Quality - lower network detection sensitivity;
- Reduction of maintenance costs - invest in machine learning techniques and automation for remote network management;
- Sharing and education - promote open data science.

Its three development phases were bracketed as:

- Planning and funding;
- Procurement and training;
- Deployment and system management.

A series of more or less heavy earth tremors, which occurred during 2015 and 2016 around the country - most notably in the vicinity of the capital Windhoek and in the Kunene Region of north-western Namibia - received a lot of attention in the media as well as at political level. Apart from proving the inaccuracy of statements that Namibia was seismically dormant, these events served to underline the importance of reliable seismological data and justify the heavy investment on new equipment and training.

Today, four years later, close to 50 new seismometers and digitizers for both permanent and rapid deployment applications, and a new data management system for data recording, management and archiving have been procured. In addition, three advanced seismology upskill training programs for staff members were conducted.

At present, we have just entered the third phase of the project, which involves the deployment of the new equipment in the field and the renovation of a seismology observatory operational centre. This stage is always the most exciting, because as new seismic stations come online, the detection threshold decreases, the operational centre becomes visually impressive, machine learning algorithms improve for system maintenance and servicing, and an improved crustal image of the Namibian subsurface emerges dispelling or confirming the current seismic profile of the country.

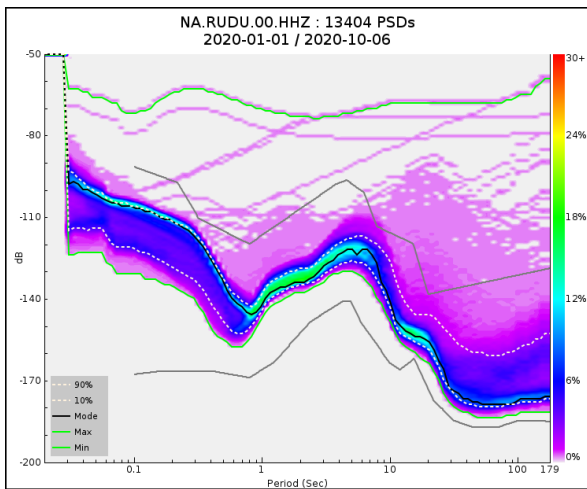
The network is currently managed by a chief geophysicist, a geotechnician and a post-graduate intern, with other staff of the Geophysics Division providing operational support when needed. Through many challenges and a rigorous learning process, all those who participated in the project gained valuable expertise in setting up and maintaining seismological stations, and a range of solutions was developed, which we are glad to share with others having the same road to go.



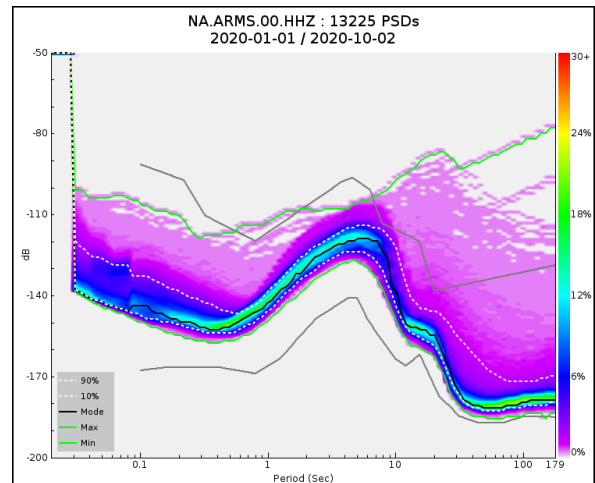
New Nanometrics QA120 Seismometer



New Nanometrics Centaur Digitizer



PSD plot of Station B noise profile 01.2020 - 10.2020



PSD plots of Station A noise profile 01.2020 - 10.2020

Investigation of ground cracks in Namibia

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On the 8th July 2019, residents of Farm Aandrus No. 5 in Omaheke Region reported an occurrence of ground cracks on their farm, which they described in a telephonic communication as deep cracks occurring in their field and neighboring farms, occasionally within homesteads and they feared that their livestock would fall in. On 21st October 2019, a similar incident was reported in two different villages in Omusati Region, with some cracks dating back to early 2019, however they became worrisome as they continued to widen. On a different occasion, another call was received from Waterberg in the Otjozondjupa Region in December 2019.

On all four occasions, the Geological Survey of Namibia (GSN) sent out a team of geoscientists to investigate. Consideration was given to environmental components such as the geology of the area, hydrogeology, climate, and land use activities. Two main theories were deduced. The cases in Omaheke Region and Waterberg were said to be due to possible subsidence. This concept was described by Leake (2004) as a downward movement or sinking of the Earth's surface caused by removal of underlying support. The Omaheke area is covered by thick Late Cretaceous to Recent sedimentary units of the Kalahari Group, while Waterberg has sedimentary units of the



Cracks occurring in cohesive and clay-rich soils. And yes, it is costing us!



Omingonde Formation. Ground movement might have been induced by continued pumping of groundwater or aquifer overdraft, worsened by prolonged droughts and lack of rainfall for aquifer replenishment. Abstraction of water from these aquifers and lowering of the groundwater table gradually removes the pressure supporting overlying material, which affects the internal structural integrity of the aquifer; thereby causing the ground to settle or subside.

In areas where the sedimentary units are clay-rich, the shrink and swell behavior of soils is seen as a possible cause of these cracks. This concept refers to the general loss of water from clay-rich soils, causing them to shrink. Owing to their mineralogical structure, clays are sensitive to fluctuations in moisture content. They undergo a volumetric change called heaving, such that when they are hydrated, they expand and when they dehydrate (i.e. lose water) they shrink. This general shrink-swell behavior can cause development of cracks as the clay-rich soils are continuously drying up.



What was different? A study by Shikangalah (2020) found that the rainfall during the 2019 drought was the lowest recorded in Windhoek since 1891 and the drought was the worst in the last 90 years in Namibia. This was mostly felt by the Agricultural Sector, with perishing livestock, most farmers left with no product and relying heavily on drought relief by the government. The famous concept of climate change is known to cause geohazards in polar regions, often manifested as melting of ice or glacier collapse. But did we ever wonder how it manifests in the arid and semi-arid regions? Is ground cracks one of the manifestations or is it simply a coincidence that there were suddenly more cases of ground cracks during the drought period? Well, I think not. We need to direct some research effort towards the concept of climate change and its influence on geohazards.

Namibia, Mecca of Minerals and Fossils

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This article is supported by external information from www.mindat.org

Namibia is a primarily arid to semi-arid country located in southern Africa along the western coast. It is bordered by Angola in the north, Zambia and Zimbabwe in the northeast, Botswana to the east, South Africa in the south, and the Atlantic Ocean to the west (www.fao.org). Namibia covers an area of 82 429 000 ha and gained its independence from South Africa on 21 March 1990.

Namibia is extremely rich in minerals and fossils. Since before the First World War, geologists and palaeontologists from around the World have studied Namibian minerals and fossils. However, only a few fossils have been repatriated to Namibia, while many of the best mineral specimens from Namibia have found their way into private collections and overseas museums and universities.

The specimens stored in the collections of the National Earth Science Museum of the Geological Survey of Namibia have been studied extensively. The ages of the fossils that have been discovered in Namibia thus far range from about 650 million years to the last 2-5 million years.

Namibia is also a favourite destination where minerals and rocks are concerned. As many as 337 minerals have been discovered at the historical Tsumeb Mine in northern Namibia's Otjikoto Region, of which 72 minerals are unique to the mine (see list below from www.mindat.org).

Type Minerals from Tsumeb Mine:

| | | | |
|--------------------|----------------------|-------------------|--------------------|
| Andyrobertsite | Arsenbrackebuschite | Arsendescloizite | Arsenohopeite |
| Arsentsumebite | Bartelkeite | Betpakdalite-CaMg | Biehlite |
| Brunogeierite | Calcioandyrobertsite | Calvertite | Chudobaite |
| Davidlloydite | Duftite | Ekatite | Erikapohlite |
| Eyselite | Fahleite | Feinglosite | Ferriotharmeyerite |
| Fleischerite | Gaitite | Gallite | Gallobaudantite |
| Galloplumbogummite | Gebhardtite | Gerdtrammelite | Germanite |
| Helmutwinklerite | Hermannroseite | Ianbruceite | Itoite |
| Jamesite | Johillerite | Kegelite | Keyite |
| Koritnigite | Krieselite | Leiteite | Ludlockite |
| Lukrahnite | Mathewrogersite | Minrecordite | Molybdoformacite |
| O'Danielite | Otavite | Otjissimeite | Ovamboite |
| Plumboselite | Plumbotsumite | Prosperite | Queiteite |
| Reinerite | Schaurteite | Schneiderhöhnite | Schultenite |
| Sewardite | Sidpietersite | Söhngeite | Stibioclaudetite |
| Stottite | Stranskiite | Thometzekite | Tsumcorite |
| Tsumebite | Tsumgallite | Vanackerite | Warikahnite |
| Wilhelmkleinite | Zincgartrellite | Zincrosasite | Zincroselite |

The country is well known for gemstones such as diamond, tourmaline, aquamarine, amethyst, jeremejevite, topaz, garnet, diopside, azurite, fluorite, pietersite and many more. Below are some of the localities and the minerals and gemstones they have yielded (www.namrocks.com).

- Berg Aukas Mine – Descloizite, Smithsonite, Willemite
- Brandberg – Amethyst, Topaz
- Erongo Mountains – Aquamarine, Beryl, Ilmenite, Jeremejevite, Feldspar, Fluorite, Schorl, Topaz
- Gamsberg Area – Amethyst, Epidote, Gwindel Quartz, Rutile, Scheelite, Titanite
- Goboboseb Mountains - Amethyst, Smoky Quartz, Scepter Quartz, Phantom Quartz
- Goanikontes – Boltwoodite
- Kaokoveld – Diopside, Malachite, Shattuckite, Spessartine
- Karibib & Usakos – Tourmaline & other pegmatite minerals
- Okorusu Mine – Fluorite
- Onganja (Emke) Mine – Cuprite, Malachite
- Orange River – Hematoid Quartz, Scepter Quartz
- Spitzkoppe Mountains – Beryl, Phenakite, Topaz
- Tsumeb Mine – Adamite, Azurite, Cerussite, Diopside, Mimetite, Smithsonite, Willemite, Wulfenite
- Tubussis – Demantoid





Native Copper from Tsumeb Mine



Amethyst from Sarusas Mine



Watermelon Tourmaline from Erongo



Yellow Fluorite from Okoruso Mine

In northern Namibia in the Otavi Mountainland abundant fossilized blue-green algae of Neoproterozoic age, also called stromatolites have been discovered and tell a story of the presence of a large ocean called the Adamaster in the distant past where now only mountains are seen.

Namibia is well known for fossils of the first multicellular animals on Earth, also known as the Ediacaran fossils. These fossils were first found and reported by German soldiers near a small settlement called Aus in southern Namibia, but from rock art, it is clear that the original inhabitants in this area knew about these fossils long before the soldiers arrived at the site. The Ediacaran fauna lived 635 million to 542 million years ago and were mostly grazers of algal mats and filter-feeders that lived in a shallow sea, called the Nama Sea which covered much of southern Namibia.



Ediacara species Pteridinium from near Aus

Fossils of small aquatic reptiles called Mesosaurus were found in southern Africa (South Africa and Namibia) and eastern South America. These small reptiles lived during the Early Permian time in Namibia (~275-278 million years ago) and were used by the geologist Alfred Wegener as evidence for the continental drift theory. They tell a story of melting ice glaciers forming a large lake spanning southern Africa into Brazil and Uruguay. A few years later, about 261-265 million years ago (upper Middle Permian), temnospondyl amphibians that were medium-to-large aquatic predators appear. Well-preserved fossils of these animals have been found in the Gai-As Formation in western Namibia, which once formed an elongated, inland lake extending over more than 1.5 million km² and which was located at a latitude of about 40° south.



Mesosaurus from Farm Spitskop

The ancestors of mammals, known as cynodonts which looked like small dogs and other animals, like large herbivores and carnivores related to dinosaurs and crocodiles were found in Triassic deposits near the Omatako and Mount Etjo mountains on the banks of the Omaruru River. The first palaeontological survey to the Omingonde Formation near the Etjo Mountains was undertaken in the 1970s by the South African Dr. André Keyser, who discovered the first fossils here. To date the formation has yielded a diverse vertebrate fossil fauna of amphibians, dicynodonts, archosaurs, therocephalians, and cynodonts.



Cynodont species *Etjoia dentitransitus* from Mount Etjo

The bone impressions of a primitive Triassic dinosaur called *Massospondylus*, were found by a group of students from Germany at the Waterberg National Park and many dinosaur tracks can be seen on the Waterberg plateau and on Farm Otjihaenamaperero near Kalkfeld. These have been studied by many researchers including palaeontologists from Italy. Tracks of small mammals have also been preserved in Jurassic to Cretaceous deposits like the Twyfelfontein Formation in western Namibia, where petroglyphs were made inside the rock by the first inhabitants of Namibia .

During the Eocene and Miocene, forty to twenty million years ago a great variety of animals lived in the former Sperrgebiet, now the Tsau //Kae National Park, such as elephants, various giant carnivores, crocodiles, and sheep-sized hyraxes to name but a few. The first fossils from this park were discovered right after the diamond rush in 1908 and many of these were brought to Germany for further studies.

One hundred years later, in 2008 many fossil discoveries were made in the Etosha National Park including one of the oldest mammoths, *Mammuthus subplanifrons*, the ancestor of the Oryx, lion, and two types of crocodiles to mention a few. These fossils are estimated to be 5 million years old.



Excavating a mammoth skeleton in the Etosha National Park

An important discovery was made at the Berg Aukas Vanadium mine, by a group of international scientists shortly after the country's independence. The discovery was that of the earliest ape south of the Equator, *Otavipithecus namibiensis*,

estimated to be 13 ± 1 million years old. Only a few bones and teeth were found, but from these it became evident that *Otavipithecus* probably liked eating wild fruits and was a good climber, suggesting that at this time the Otavi Mountainland area was more moist and vegetated.

In recent years field surveys to Namibia's north-western Erongo and Kunene Regions have focused on tufa deposits, many of which are Plio-Pleistocene in age. These surveys have resulted in the discovery of several fossil-rich tufa sites which preserve visible impressions and casts of floral structures and invertebrate remains such as snails, but have also yielded an unexpectedly rich fossil fauna, which includes frogs, lizards, chameleons, snakes, birds, and mammals (rodents, hares, shrews, macroscelidids, bats, bovids, equids, giraffids, papionines) after the treatment of breccia samples that had been collected from these sites. Many more fossils and new fossil-rich localities are continually being discovered.



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Tectonics, Magmatism and Structural Analyses of North African
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Cover Image

Ethiopia. Shaded relief map. Surrounding territory greyed out.
Colored according to vegetation. Includes clip path for the state area.
Projection: Mercator Extents: 31/49.7/1.5/17 Data source: NASA
Modified from <https://www.123rf.com>

