TANZANIA GEOLOGICAL SOCIETY (TGS)

2024 ANNUAL CONFERENCE

BOOK OF ABSTRACTS




TANGA

01st to 6th of December 2024

Front cover photos:

***Top Left**: Tanga Railway Station – one of the characteristic buildings of Tanga; **Top Right**: Tanga Port, an important harbor that will save the EACOP Hoima – Chongoleani Pipeline project; **Bottom left**: A section of Amboni Caves Complex (Middle Jurassic Limestone) in Tanga; and **Bottom right**: Swahili Monumental Tomb, one of the 15th century tombs in Tongoni, Tanga.*

Message to Participants of the TGS 2024 Conference

Our distinguished participants, colleagues, and guests, it is with great pleasure that we welcome each of you to the TGS 2024 Annual Conference, and we are happy to be your host in the Tanga region. Tanga is a historic coastal town located in north-eastern Tanzania, along the Indian Ocean. It has a rich history as a trading port, its origins dating back to the 14th century when it was part of the Swahili Coast's thriving trade networks. Tanga served as an important trade hub between Africa, the Arabian Peninsula, and India, particularly in goods like ivory, gold, and spices. During the late 19th century, the town became a key town for German colonial interests in East Africa, and it was the site of significant military action during World War I, particularly the Battle of Tanga in 1914. After World War I, Tanga remained under British control until Tanzania's independence in 1961. Today, it is an important regional economic hub, with its port playing a vital role in trade as well as its proximity to natural attractions such as Mount Usambara and the Tanga Marine Reserve.

As the gateway to the Swahili Coast, Tanga boasts a vibrant mix of natural attractions and historical sites. Visitors can explore the idyllic beaches of Pangani and the nearby Saadani National Park, where wildlife meets the Indian Ocean. Tanga is also home to historic landmarks like the German colonial-era buildings and the ancient Amboni Caves, offering a unique insight into the region’s past. For those seeking an off-the-beaten-path destination, Tanga provides an authentic Tanzanian experience, with less commercialization compared to other coastal cities like Dar es Salaam or Zanzibar.

We are thrilled to have you join us for what promises to be an inspiring and engaging event, bringing together thought leaders, innovators, and experts

from across diverse geosciences and extractive fields within Tanzania mainland, Zanzibar and abroad. During this conference, you will have opportunities to engage in fruitful discussions and connect with colleagues from different sectors.

The organising committee is excited to present a dynamic agenda filled with cutting-edge presentations, interactive panels, and collaborative discussions designed to challenge our thinking and drive progress in Tanzania's mineral wealth and its contribution to sustainable economic growth and smooth energy transition. This year's presentations and discussions will focus on Tanzania's strategic minerals, energy transition, water resources, geohazards, academic-industry partnership in enhancing the development of early career geoscientists, the contribution of the petroleum industry in national development and smooth energy transition, Madini vision 2030 in strategic mineral development, Geoparks, and environmental conservation. Our goal is to foster an environment of learning, sharing, and discovery, where everyone feels encouraged contributing and exploring new possibilities for the betterment of our nation.

It is our ardent hope that you will take full advantage of this event. Do not hesitate to reach out to our team for any assistance or inquiries throughout the conference. We are grateful to all Tanzania Geological Society members, our distinguished sponsors, and every volunteer whose efforts made this conference a success. Thank you for being a part of this experience, and we look forward to a successful and rewarding event together.

Conference Organising Committee

Tanzania Geological Society (TGS)

Conference Organising Committee

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Conference Organising Committee

Subcommittees	Members
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Mr. Ronald Machumu

Our Gold Sponsor

Barrick Gold Corporation

https://www.barrick.com

Barrick is a global sector-leading gold and copper producer, dedicated to building the world's most valued gold and copper company through owning the best assets, but importantly committed to delivering the best returns and benefits to all its stakeholders, especially its host countries and communities.

Operating in Tanzania through its partnership with the government, the Twiga partnership is already contributing 51% of the government's revenue from the extractive industry, as reported by the Tanzania Extractive Industry Transparency Initiative. Apart from this significant contribution, Barrick has also demonstrated its commitment to delivering benefits to its host communities through several initiatives. One such is "the Barrick-Twiga Future Forward Education Program", in which Barrick financed a $10 million infrastructure expansion at 64 schools, the first financing phase of a 3 phase initiative with a pledge of $30 million in partnership with the Tanzanian government, towards the expansion of education infrastructure in Tanzania. To continue, the Barrick Academy, which has already trained more than 1,000 foremen, supervisors, and superintendents from across the company's Africa and Middle East region on track to meet its target of training more than 2,000 people this year.

The Tanzania Geological Society especially recognizes Barrick as a key stakeholder committed unwaveringly to supporting TGS.

Our Silver Sponsor

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https://www.stamico.co.tz/

State Mining Corporation (STAMICO), a wholly owned Government enterprise, is under the Ministry of Minerals established by the Public Corporation Act cap 257 through State Mining Corporation Establishment Order No. 163 of 1972 as amended in 2014. STAMICO was re-established in 2015 through the Public Corporations (Establishment) (Amendment) Order, 2015 - to increase the contribution of the mineral sector to the national economy and create employment opportunities for Tanzanians.

STAMICO has been playing a vital part in supporting small-scale miners with field surveys and drilling services, enabling small-scale miners to achieve improved results, increased profits, and enhanced financial success in comparison to earlier years but more importantly, position them to access loans from local financiers.

Apart from significant strides in the extractives sector, STAMICO through its Rafiki Briquettes, an alternative energy source for domestic use, actively supports government efforts aimed at environmental preservation by reducing the use of charcoal effectively addressing deforestation.

The Tanzania Geological Society especially recognizes Barrick as a key stakeholder committed unwaveringly to supporting TGS.

Our Silver Sponsor

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http://www.geitamine.com/en.html

Geita Gold Mining Limited, one of AngloGold Ashanti's flagship mines, is located in NW Tanzania in the Lake Victoria goldfields in the Geita region.
As one of the country's largest and most compliant taxpayers, its footprint goes beyond its contribution to the nation's economy, to committing to initiatives that improve access to clean water, create jobs, and support education. GGML stands out in the mining sector as dedicated to local talent development, diversity, and inclusion, and having a comprehensive approach to talent management. Its continued investment in local talent development initiatives, from its internship program, which has benefited 258 graduates from various academic institutions with more than 50% of these retained, to its field student enrollment, and its female future Tanzania Initiative just to name a few.
Living up to its commitment to responsible mining, GGML has made a switch to a greener, more sustainable future by embracing power generated within Tanzania by the Tanzania Electric Supply Company (TANESCO).
The Tanzania Geological Society acknowledges and appreciates GGMLs distinguished contribution as a dependable stakeholder to TGS' activities.

Our Silver Sponsor

Tanzania Petroleum Development Corporation

https://tpdc.co.tz/

Tanzania Petroleum Development Corporation (TPDC) is the National Oil Company of Tanzania, wholly owned by the Government of Tanzania, with all its shares held by the Treasury Registrar. TPDC was established through the Government Notice No.140 of 30th May 1969 under the Public Corporations Act No.17 of 1969 as amended.

Having been mandated by the Petroleum Act, of 2015, to undertake Tanzania's commercial aspects of petroleum operations in the upstream, midstream, and downstream and participating interests of the Government in the petroleum and natural gas agreements, TPDC through subsidiary companies; Gas Supply Company Limited (GASCO), TANOIL Investments Limited, strives to meet its objectives. TPDC and its subsidiaries have a combined workforce of over 350 people. With an increased rise in the demand for Compressed Natural Gas, TPDC's commitment to meeting this demand cannot be overemphasized.

The Tanzania Geological Society greatly appreciates TPDC's invaluable contributions as one of its dependable and highly esteemed stakeholders.

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TEMBO NICKEL

TGS New Institutional Member

RSK Acoustics

https://rskacoustics.com/

RSK Acoustics, part of the RSK Group, comprises a team of specialised acousticians with diverse backgrounds, dedicated to offering clients worldwide an extensive array of design, regulatory, and diagnostic services. Our team of technical specialists can operate on the continent of Africa, with staff based in Tanzania and South Africa.

The team has substantial experience in managing and delivering projects ranging from architectural acoustic design, planning and environmental permitting to large-scale environmental impact assessments (EIA) and international environmental and social impact assessments (ESIA). The team works with domestic and international legislation and guidance, covering all sectors in the physical environment.

RSK Acoustics has a track record of providing clients with efficient and innovative ways of solving a host of noise and vibration problems throughout the life of a project. This covers services from early-stage feasibility studies and optioneering through to compliance testing and post-build investigation studies. The team works closely with architects, engineers, regulators and other technical disciplines to provide the most effective, efficient and practical design, whatever the sector.TGS welcomes RSK Acoustics to the geoscientific community.

Recognition of the Outstanding Tanzanian Geoscientist

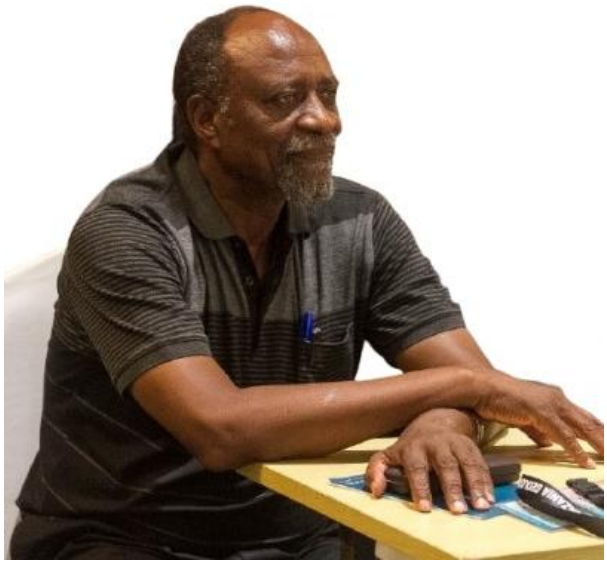
Erick Kalondwa

A token of appreciation is extended to our active senior TGS member Erick Kalondwa is a dutifully dedicated member of the association. Geo. Kalondwa's contribution spans outstanding representation of the geoscientific community's interests in the private sector to his consistency in participating and making contributions to issues crucial to the progress of the earth resources sector, and TGS.

He stands out for his commitment to participating in and making significant contributions through perspective-taking and a mindset focused on growth, whilst identifying areas for positive change. His goal has not just been to highlight challenges but also to contribute to developing strategies that enhance relationships, communication, and overall outcomes for the TGS's betterment.

Geo. Kalondwa currently is an exploration superintendent at Geita Gold Mine Limited, armed with over two decades of industry experience, and excellent success in gold discoveries which led to the naming project Kalondwa Hill.

Recognition of the Outstanding Tanzanian Geoscientist



Manyama Makweba

A token of appreciation is extended to our active senior TGS member, Manyama Matola Makweba. Geo. Makweba's dedication which goes beyond regular attendance at TGS events, to actively engaging and contributing pivotally in discussions vital to the earth resources industry truly sets him apart. His commitment is both exemplary and inspiring. The Tanzania Geological Society would like to sincerely thank Geo. Makweba for his commitment to the TGS. He inspires us with his unwavering commitment and the depth of his contributions. His active involvement truly makes a difference in our association.

Mr. Makweba is a consulting geologist and businessman focused on mineral exploration and quarry operations in Tanzania. He operates a limestone quarry at Yugo Hill, Tonga Village, and is also engaged in the exploration of critical minerals, including lithium at Koro Hill and East of Lake Eyasi, and Rare Earth Elements at Musensi and Nachezendwaye Carbonatite Hills in Tanzania.

Recognition of the Outstanding Tanzanian Geoscientist

Desmond Risso

A token of appreciation is extended to Desmond Risso, an active TGS member and impressive TGS representative in the Petroleum Upstream Regulatory Authority (PURA).

In representing TGS interests, Desmond's contributions are invaluable to our association and have been instrumental in helping us achieve our goals. Desmond who may be described as diligent has continued to ensure that TGS business is addressed in a timely and professional manner. Thank you for your exceptional commitment and teamwork.

Geo. Desmond Risso serves as a geologist in the Technical Department of PURA. He has extensive experience spanning 12 years in the academia, mining and petroleum industry, having worked with the University of Dodoma, Barrick Gold and Schlumberger (now SLB). Geo Risso holds BSc (Hons) Geology from the University of Dar es Salaam and MSc. Reservoir Evaluation and Management from Heriot-Watt University.

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TGS 2024 Conference Abstract Titles

Contents and Abstract Titles page

Conference Programme

DAY 1, 2 & 3 (01-12-2024 to 03-12-2024)

EXCURSION

Saturday 30.11.2024	
Time	**Place/ Activity**
06:00 - 00:00	Participants arriving in Tanga
Sunday 01.12.202	
Time	**Place/ Activity**
07:30 - 08:00	Participants gathering at the Mwembe Mawazo (Horohoro bus stand) to board mini-buses for excursion trip
08:00 - 09:30	Drive to Mbuta/Mwakijembe area for basement and Lower Karoo documentation
09:30 - 11:00	Discussion: Basement rocks and Lower Karoo-equivalent sediments through the Umba River. Tectonic influences
11:00 - 12:30	Drive to Kakindu (Middle Karoo-equivalent rocks) - Nairobi area, Gombero
12:30 - 13:30	Discussion at Kakindu: Lower Karoo-equivalent rocks - sedimentary structures, deposit types, petroleum prospectivity
13:30 - 14:30	Lunch Break
14:30 - 15:30	Drive to Sigi Bridi
15:30 - 17:00	Discussion at Sigi Bridge: Middle Karoo limestone, tectonic features, and continental-marine transition
17:00 - 17:30	Drive to Tanga town
17:30	Announcements
Monday 02.12.2024	
Time	**Place/ Activity**
07:30 - 08: 00	Participants gathering at Tanga Museum, Forodhani, Tanga
08:00 - 09:10	Visit Tanga Museum
09:00 - 10:30	Tanga Town History Tour
10:30 - 11:00	Drive to Amboni caves

11:00 - 12: 30	Tour at Amboni caves
12:30 - 13:00	Drive to Tanga town
13:00 - 14: 30	Lunch break
14: 30 - 16: 30	Drive to Magoroto forest reserve
16: 30 - 17: 30	Logistic at Magoroto
17: 30 - 19: 30	Evening activities at Magoroto
19: 30 - 21: 00	Dinner
21: 00 - 00:00	BBQ, Born fire, Music and Bar
00:00 -	End of the common program
Tuesday 03.12.2024	
Time	**Place/ Activity**
07:30 - 08: 30	Gathering and breakfast
08:30 - 12:30	Team building, sports, games and camp activities
12:30 - 13:30	Lunch break
13:30 - 14:30	Logistics
14:30 - 16: 30	Drive to Tanga town
16:30	Announcements and dispersing

DAY 4 (04-12-2024) ***OPENING CEREMONY & CONFERENCE***

Time	**Activity**	
07:30 - 08:30	Arrival & Registration	
08:30 - 09:30	Refreshments, Exhibition & Poster Session	
09:30 - 10:00	Tour with Guest of Honour	
10:00 - 10:15	TGS President: Speech and welcome Regional Commissioner	
10:15 - 10:45	Regional Commissioner: Speech and welcome the Guest of Honour	
10:45 - 11:45	Guest of Honour	
11:45 - 12:00	Photo session	
12:00 - 13:00	LUNCH BREAK	
Time	**Presenter**	**Title**
13:00 - 13:40	Prof. Nelson Boniface (DVC Research - UDSM)	Key-note Speech on Tanzania Strategic Mineral Deposits
13:40 - 14:00	Remigius Gama	Tanzania Geological Society and Its Services to the Society; Does It Matter?
PANEL DISCUSSION ON TANZANIA'S STRATEGIC MINERALS, ENERGY TRANSITION AND NET-ZERO CARBON EMISSION		
14:00 - 15:00 Convener: Albano Mahecha (Head Geosciences, TGDC)	Ms. Sundi Malomo (Mineral Trade Manager - Mining Commission)	
	Mr. Gerald Chuwa (Exploration Geologist and Active TGS member)	
	Geo. Manyama Makweba (Consulting Exploration Geologist, Senior and Active TGS member)	
	Prof. Nelson Boniface (DVC Research, University Dar es Salaam)	
	CPA Dr. Venance Mwasse (Managing Director, STAMICO)	
15:00 - 15:15	Q&A - All	
15:15 - 15:30	HEALTH BREAK	
15:30 - 15:45	Umoja Conservation Trust	Joint Sustainable Natural/Mineral Resources Utilisation: A Must If Africa Is To Develop
15:45 - 16:00	Lucas Tumbu	The Use of Audio Magnetotellurics (Amt) Techniques to Explore Tanzanian's Strategic Minerals
16:00 - 16:15	Edward J. Maarifa	Prospecting Potential Geothermal Resources through Mapping of Surface Hydrothermal Alteration Minerals and Geological Structures in the Songwe Region, SW Tanzania
16:15 - 16:30	Tukupala	Advanced Geological Mapping: High-Resolution UAV-

Time	Activity	
	Mwalyolo	Based Magnetic Survey for Mineral Exploration in Northern Tanzania
16:30 - 16:45	Basilius J. Ndimbo	Fast-tracking Tanzania Strategic Minerals: Identification, Development and Value Chain Optimization
16:45 - 17:00	Ernest Mulaya	The Helium Budget in the East African Rift System
17:00 - 17:15	All	Q&A
17:15 - 17:25	**Recap, Announcements & End of Session**	
19:00 - onwards	**Icebreaking Cocktail Party**	

DAY 5 (05-12-2024) ***CONFERENCE***

Time	Presenter	Title
08:00 - 08:40	Arrival, Registration & Poster Session	
08:40 - 08:55	Gabriel D. Mulibo	Damage distribution of the Mw5.9 September 10, 2016, Kagera Earthquake with Implications for Site Effect Amplification
08:55 - 09:10	Ernest Mulaya	Building Landslide Resilience in Tanzania: A Lesson Learnt from the Hanang Catastrophic Event
09:10 - 09:40	Daniel Clare & Antonio Sanchez	Environmental Hazards: Advanced Acoustic Monitoring and Analysis by RSK Acoustics & RSK East Africa
09:40 - 09:55	Mwadawa K. Gwebe	Deforestation and Changes in Land Use and Cover Caused by the Artisanal and Small-Scale Mining in the Biharamulo Forest Reserve, Tanzania
09:55 - 10:10	Befrina Igulu	Impact of Urbanising Watershed on Flood: Case Study of Msimbazi Catchment Dar es Salaam
10:10 - 10:25	Janeth J. Kimario	Factors Controlling the Rate of Movement of the Shifting Sand, Ngorongoro-Lengai Geopark, Tanzania
10:25 - 10:45	HEALTH BREAK	
PANEL DISCUSSION ON GEOPARKS, GEOHAZARDS AND ENVIRONMENTAL CONSERVATION		
10:45 - 12:35 Convener: Dr. Ernest Mulaya, UDSM	Daniel Clare MIOA, MIEnvSc, CEnv – Managing Director RSK Acoustics	
	Antonio Sanchez MIOA - Principal Acoustic Consultant RSK Acoustics	
	Mr Amogola Maurice - Trustee, Umoja Conservation Trust	
	Mr Amir Kiwanda - Chief Executive Officer, AfriGaurd Risk Solutions	
	Dr. Crispin Kinabo, Representative from the Department of Geosciences, UDSM	
	Dr. Befrina Igulu, National Environment Management Council (NEMC) - Tanzania	
12:35 - 13:35	LUNCH BREAK	
13:35 - 13:50	Mwakajumba Hobokela	Calcite Scaling Potential in the Songwe Geothermal Prospect, Southwest Tanzania
13:50 - 14:05	Mwita S. Maswi	Geochemical Mapping and Geo-Health- Concept, Principle and Application
14:05 - 14:20	Yedidia Mgema	Advances in Geocomputation and Geospatial Artificial Intelligence (Geo-Ai) for Mapping
14:20 - 14:35	Julius K. Dallu	Improving Community Livelihoods through Improved Availability of Water Resources in Semi-Arid Areas

PANEL DISCUSSION ON THE ROLE OF WATER IN LIVELIHOOD IMPROVEMENT		
14:35 - 15:35 Convener: Jumanne Mpemba (Basin Director, Ruvuma and Southern Coast Basin Water Board)	Geo. Emmanuel Kisendi (Lake Victoria Basin Water Board, Mwanza)	
	Geo. Amos S. Magige (Senior Hydrogeologist, GGM)	
	Dr. Renatus Shinhu (Lake Victoria Basin Water Board)	
15:35 - 15:50	Q&A	
15:50 - 16:10	HEALTH BREAK	
16:10 - 16:25	Elisante Mshiu	TGSMC: Reporting Code for Artisanal and Small-Scale Mining (ASM/SSM) in Tanzania
16:25 - 16:40	Gerald Chuwa	Lithomagnetic Domains and Metallogenic Zones in the Karagwe Ankolean Belt of Northwestern Tanzania: Insights from On-going Regional-scale Aeromagnetic and Gravity Data Interpretation
16:40 -16:55	Japhet Fungo	Application of Principal Component Analysis (PCA) in Remote Sensing for Mapping REE-Bearing Carbonatites: A Case Study of the Sangu-Ikola Carbonatites South-western Tanzania
16:55 - 17:10	Charles H. Kasanzu	Geochemical characterisation of the Cenomanian - Campanian Red Sandstone Group of SW Tanzania: Implications for Provenance, Climate and Paleo-ambient Redox Conditions
17:10 - 17:25	All	Q&A
17:25 - 17:35	**Recap, Announcements & End of Day 5**	

DAY 6 (06-12-2024) ***CONFERENCE & CLOSING CEREMONY***

Time	Presenter	Title
08:00 - 08:30	Arrival & Poster Session	
08:30 - 08:45	Hulda Mangachi	Overview of the Petroleum Industry in Tanzania
08:45 - 09:00	Venance E. Mboya	Geology of Eyasi Wembere Basin, NE Tanzania: Potential for Petroleum Exploration
09:00 - 09:15	Oras J. Mkinga	Petrophysical Identification and Characterization of Cenozoic Hydrocarbon Reservoir Zones At the R field, Northern Rovuma Basin, Tanzania
09:15 - 09:30	Paul Matumbi	Unlocking Energy Potential: Tanzania's Next Offshore Licensing Round
09:30 - 09:45	Wangese M. Misiwa	Hydrocarbon Potential for Mandawa Salt Basin
09:45 - 10:00	John Gama	Influence of Igneous Intrusions on Maturation of the Cretaceous-Eocene Source Rocks of the Offshore Tanzanian Basin
10:00 - 10:15	All	Q&A
10:15 - 10:45	HEALTH BREAK	
PANEL DISCUSSION ON CONTRIBUTION OF THE PETROLEUM INDUSTRY IN ENERGY TRANSITION		
10:45 - 11:45 Convener: Desmond Risso (Geologist, Technical Department - PURA)	Mr. Paschal Njiko (Director of Exploration, Development and Production - TPDC)	
	Geo. Abdulsatari Maulid Salim (Ministry of Water, Energy and Minerals - Zanzibar)	
	Dr. Oras Mkinga, Representative from the Department of Petroleum Science and Engineering, UDSM	
	Geo. Shigela Malosha (Director of Contracting and Licensing, PURA)	
11:45 - 12:00	Q&A	
CLOSING, TGS 2024 ANNUAL CONFERENCE		
12:10 - 12:15	TGS Vice President, TGS: Welcoming Remarks	
12:15 - 12:45	TGS President: Speech, and Welcome Guest of Honour	
12:45 - 13:45	Guest of Honour	
13:45 - 13:55	Photo Session	
13:55 - 14:50	LUNCH BREAK	

DAY 6 (06-12-2024) TGS ANNUAL MEETING

Time	Activity	Responsible
14:50 - 15:20	Opening	TGS President
15:20 - 17:50	Reporting on TGS 2023/2024 Activities, TGS Journal & Financial Report (Auditor's report)	TGS General Secretary, Treasurer and Editor
17:50 - 18:00	TGS Extractive Industry Solutions (TEIS)	TGS President
18:00 - 18:30	Closing	TGS Vice President
19:30 - onwards	**CONFERENCE DINNER**	

POSTER PRESENTATIONS

Presenter	Poster Title
Joyna L. Labohola	Sedimentary Facies and Depositional Environment of the Karoo-equivalent rocks of the Tanga Basin, Tanzania
Rachel A. Sabuni	The Middle Triassic Flora of the Tanga Basin, Tanzania
Ronald Machumu	The Role of Academic-Industry Partnerships in Fostering for Future Geoscientists
Mussa Kimweri	Tanzania's Uranium Potential: A Framework for Accelerated Sustainable Economic Growth and Smooth Energy Transition
William A. Kalinga	The Role of Natural Gas in a Low (Zero) Carbon Future: The Case Study of Tanzania
George Minja	Sustainable Energy Transitions and Climate Change: Mitigation and Adoption
Calvin Goodluck	Application of Landsat Remote Sensing Data for Geological Mapping in Magmatic Nickel Sulfide Deposit: A Key Tool for Value Chain Optimization in Tanzania Strategic Mineral Industry
Daniel Chege	Essential Clean Cooking Education and Environmental Movements With Energy4Me
Hadija H. Tola	Prospecting for Extension of Lead Deposit in Kunene Region, Northwest Namibia
Anthony R. Maswi	Evaluation of the Reservoir Potential for Carbon Dioxide Sequestration Using Well Logging Analysis: A Case of the Mandawa Basin, Southern Coastal Tanzania
Tryphone Ndubusa & Faustine Matiku	Hydrocarbon Exploration in the Eyasi-Wembere Area, NE Tanzania
Agnes Matulanya	Licensing Procedures for Companies to Conduct Petroleum Operations in Tanzania
Innocent R. Mvamba	An Overview of the Methodologies Applied in Palynological Preparations and Palynostratigraphy and Their Implication in the Oil and Gas Industry
Johanes Kakoki	Palynological Study of the Early Jurassic to Cretaceous Sediments of the Mandawa Basin, Southern Tanzania
Mugwe T. Mugwe, Japhet N. Fungo & Gerald L. Chuwa	Application of 3-Dimension Modelling in Assisting Data Interpretation and Visualisation: Towards Better Management and Planning of Geoscientific Projects

ABSTRACTS

SEDIMENTARY FACIES AND DEPOSITIONAL ENVIRONMENT OF THE KAROO-EQUIVALENT ROCKS OF THE TANGA BASIN, TANZANIA

Joyna L. Labohola[1,*], Justina J. Saroni[1], Emily B. Kiswaka[1], Emmanuel O. Kazimoto[1]

University of Dar es Salaam, School of Mines and Geosciences

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The Tanga Basin of northern coastal Tanzania comprises Upper Carboniferous to Cenozoic sedimentary sequences. This work presents a detailed facies analysis and deposition environment investigation of the Karoo rocks of the Tanga Basin. The study involved a detailed sedimentological study of the Karoo-equivalent outcrops and a petrographic analysis of the collected outcrop samples. Preliminary results indicate that the Karoo-equivalent rocks of the study area have 23 sedimentary facies that include matrix-supported diamictite (Dmm), clastic-supported conglomerate (Gmc), massive sandstone (Sm), and massive mudstone (Fm). Detailed analysis of these sedimentary facies has revealed 14 facies associations (FA1-FA14) representing different deposition environments; sediments were deposited mainly in a lacustrine environment with subordinate glacial-fluvial, delta-plain, profundal, coastal, and fluvial channels. The glacial deposition environment is defined by thick, poorly bedded diamictites, thick, massive, homogeneous diamictites, and ripped-to-laminated sandstone with occasional dropstones (FA1, FA2, and FA3, respectively). Lenticular to sub-horizontal sandstone (FA4), wavy sandstone (FA5), and tabular beds of sandstone, siltstone, and mudstone (FA6) define the delta-plain depositional regime in

the Tanga Basin. The profundal environment is defined by carbonaceous shale (FA7), thick undulated siltstone and mudstone beds (FA8), and thin stratified carbonaceous silt and shale (FA9). Thicker wedged to horizontally stratified sandstone (FA10), tabular, massive, horizontally stratified sandstone (FA11), tabular, horizontally stratified mudstone interbedded with siltstone and occasional sandstone (FA12) define the coastal environment. Gently inclined multi-storey sandstone (FA13) and amalgamated stratified sandstone (FA14) characterize the fluvial depositional systems. The current facies description and facies associations have not been presented before; a detailed sedimentological assessment was missing in the Tanga Basin. The results of this study will be of interest to local and international researchers and hydrocarbon exploration companies working in the region. This is because detailed facies characterization is key to establishing an understanding of the distribution of the possible hydrocarbon reservoir rocks and petroleum source kitchens.

TANZANIA GEOLOGICAL SOCIETY AND ITS SERVICES TO THE SOCIETY; DOES IT MATTER?

Remigius Gama

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Curiously, this short note is interested in exploring if the Tanzania Geological Society (TGS) matters as a standalone vehicle linking, updating, and shaping Tanzanian geoscientists working and interested in the rapidly evolving extractive industry. TGS members are from multiple geoscientific fields including mineral exploration, mining, oil and gas, and water sectors. Has TGS managed to link the Tanzanian experts from these multiple sectors? This question may be tackled from multiple angles, including TGS growth trends in recent years and a comparison between projected total Tanzanian geoscientists (from graduation records) versus those who are TGS members. Is TGS doing enough to reach out and connect all Tanzanian geoscientists? If not, what are the failure factors, and what should be done for the successful TGS? With the Tanzania Geological Registration Board (TGRB), a state-controlled registration board in the pipeline, what will be the position of TGS to its members? Is there any chance for TGS as an organisation to get a role on the national agenda such as "Vision 2030?" It is a debate for us! In my opinion, TGS can still be important if it keeps working and collaborating on issues that matter to its members. By doing so, members will be proud of their organisation.

THE USE OF AUDIO MAGNETOTELLURICS (AMT) TECHNIQUES TO EXPLORE TANZANIAN'S STRATEGIC MINERALS

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The exploration of strategic minerals in Tanzania is crucial for the country's economic growth and technological advancement. Audio-magnetotelluric (AMT) techniques have emerged as a powerful tool for mineral exploration, offering high-resolution subsurface imaging capabilities. This work entails applying AMT techniques in strategic mineral exploration in Tanzania, highlighting their effectiveness in identifying and characterising mineral deposits.

The AMT method utilises natural electromagnetic fields to measure the Earth's subsurface resistivity, providing valuable insights into geological structures and mineral compositions. In Tanzania, AMT surveys may be conducted in various regions known for their mineral potential, including the Craton regions and Greenstone belts. The technique can help to identify subsurface anomalies associated with key minerals such as gold, copper, cobalt, and rare earth elements.

In Tanzania, the associated fieldwork has involved deploying a network of AMT stations across target areas, with data acquisition focusing on both low and high-frequency ranges to achieve a wide depth of investigation. Thereafter, the collected data underwent advanced processing and inversion techniques to generate detailed resistivity models of the subsurface. These models may reveal significant geological features, including fault zones,

mineralized veins, and alteration zones, which are indicative of strategic mineral deposits. The use of AMT techniques in Tanzania has demonstrated several advantages, including non-invasive exploration, cost-effectiveness, and the ability to penetrate deep subsurface layers. Moreover, the integration of AMT data with geological and geochemical information has enhanced the accuracy of mineral exploration, reducing the risk and uncertainty associated with traditional methods.

In conclusion, AMT techniques have proven to be an invaluable asset in the exploration of strategic minerals in Tanzania. The successful application of this method paves the way for more extensive and efficient exploration programs, contributing to the sustainable development of the country's mineral resources. Future research will focus on refining AMT methodologies and expanding their application to other regions with similar geological settings.

PROSPECTING POTENTIAL GEOTHERMAL RESOURCES THROUGH MAPPING OF SURFACE HYDROTHERMAL ALTERATION MINERALS AND GEOLOGICAL STRUCTURES IN THE SONGWE REGION, SW TANZANIA

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Geothermal energy is one of the most valuable and preferable renewable energy sources, given that it produces sustainable, dependable, and clean energy. Understanding the geothermal systems, parameters such as heat, fluids, and structures help to identify potential geothermal systems. These parameters are manifested as hot springs, fumaroles, and hydrothermal alteration minerals. Hydrothermal alteration minerals and geological structures play an important role in the identification of potential geothermal resources. This study employed remote sensing technology in the identification of hydrothermal mineral alterations and delineating geological structures which provided invaluable information for identifying prospective geothermal resource zones in the Songwe geothermal field, SW Tanzania.

The ASTER and ASTER DEM data were used to identify hydrothermal alteration minerals and delineate geological structures, respectively. The selective principal component analysis (SPCA) was utilised to map minerals (argillic, phyllic and propylitic), whereas ISO cluster classification was utilized to detect specific minerals (kaolinite, smectite, calcite, chlorite, and

muscovite/illite). Furthermore, DEM Derived Flow Direction approach was used to extract, delineate, and map geological lineaments (faults). This approach regarded geological structures to be formed by tectonic movement, whereby the flow direction algorithm was employed to demarcate tectonic blocks, with their boundaries identified as the faults of interest.

Results revealed that the regions that were mapped with indicator hydrothermal alteration minerals were also associated with geological structures as well as coincided with existing hot springs, thus indicating potential geothermal resources. The fieldwork, X-ray diffraction (XRD), and Analytical spectral devices (ASD) laboratory analysis results indicated a good match with the findings from the remote sensing data. The approach applied in this study may be used along with other techniques during the early phases of geothermal exploration to define geothermal potential targets.

ADVANCED GEOLOGICAL MAPPING: HIGH-RESOLUTION UAV-BASED MAGNETIC SURVEY FOR MINERAL EXPLORATION IN NORTHERN TANZANIA

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This study investigates the application of Unoccupied Aerial Vehicles (UAVs) in conducting high-resolution magnetic surveys and 3D magnetic inversion for geological mapping in Northern Tanzania. In August 2024, Tukutech Ltd. in collaboration with Radai Ltd. conducted UAV-based magnetic surveys and created detailed maps of magnetic field intensity and 3D models of subsurface magnetized structures to aid in mineral exploration. The UAVs are equipped with a 3-component fluxgate magnetometer and data-logging unit that records magnetic field intensity, temperature, barometric pressure, and GNSS (Global Navigation Satellite System) time and location data. The flights were executed with precision altitude control and monitored in Extended Visual Line-Of-Sight (EVLOS) mode to ensure data quality and operational safety.

One of the magnetic surveys was done in one day covering a 10 square kilometer area with a total length of 225 line-kilometers, producing high-resolution Total Magnetic Intensity (TMI) data. After basic data processing, Equivalent Layer Modeling (ELM) was used to compensate for flight path variations and to provide noise-free maps of magnetic anomalies. The ELM-processed magnetic data was then used as a basis for further analysis. Firstly, Fourier transform methods were used to make Reduction-to-Pole (RTP) corrections and to compute consecutive derivate results of TMI data. The derivatives include First and Second Vertical Derivative (1VD, 2VD),

Horizontal Gradient (HoriG), Tilt Gradient (TiltG), and Total Gradient (TotG), also known as Analytical Signal (AS) and downward continued TMI data. The derivative results were used in structural interpretation and qualitative interpretation of TMI data.

In addition to the ELM and Fourier results, a 3D magnetic inversion was conducted to model the subsurface magnetic susceptibility distribution. The 3D inversion uses an Occam-type smoothing constraint to create a voxel model representing the distribution of magnetic sources at varying depths. The results, presented as iso-surfaces and vertical and horizontal cross-sections of the final 3D model, revealed the depth, orientation, and extent of magnetized rock formations, likely enriched with iron-bearing minerals like magnetite and hematite. The 3D inversion model further refined the geological understanding by mapping magnetic source depths and continuity across the survey area.

This study highlights UAV-based magnetic surveying and 3D magnetic inversion as valuable tools in geological mapping and mineral exploration, emphasizing their role in enhancing data resolution on both surface and subsurface geological features. It also demonstrates the cost-effectiveness of UAV-based methods compared to traditional survey methods.

FAST-TRACKING TANZANIA STRATEGIC MINERALS: IDENTIFICATION, DEVELOPMENT AND VALUE CHAIN OPTIMIZATION

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Strategic minerals are important components of the clean energy sector, driving the transition to a more sustainable and eco-friendly future. These minerals include graphite, rare earth elements, lithium, cobalt and tungsten. Tanzania is in the early stages of fast-tracking strategic minerals identification, development and value chain optimization, with several exploration and mining projects in progress. This is exemplified by three operational graphite projects which include Lindi Jumbo graphite (in Lindi district), Permanent Minerals (Mirerani in Simanjiro district) and GodMwanga graphite (in Handeni district). In addition, there are many advanced projects ready for development such as Nickel (Ngara District), Rare Earth Elements (Songwe region) and niobium (Songwe region) projects.

The government through the Ministry of Minerals should emphasise proactive measures, aimed at attracting local and international investors, such as identifying specific areas endowed with these minerals for development and value chain optimization through different ways. These ways may include (1) Undertaking a series of legal reforms (Amendment of Mining Act), (2) The Geological Survey of Tanzania (GST) accelerating the plan to undertake a High-Resolution Airborne Geophysical Survey, as well as the use of drones to acquire data for identifying potential mineral deposits, (3)

Local content and capacity building, and (4) Environmental and Social Governance.

The development of local beneficiation facilities will increase Tazania's share in the benefits of its strategic minerals. The enforcement of a mineral policy and law to process these minerals domestically, thereby producing finished products will ensure higher prices on the global market. Generally, fast-tracking the Tanzania strategic minerals will play a vital role in the green energy transition by providing essential metals and minerals required in the production of clean energy technologies. This will address the UN Sustainable Development Goals, SDG 7 by ensuring clean and affordable energy.

THE HELIUM BUDGET IN THE EAST AFRICAN RIFT SYSTEM

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The East African Rift System presents a typical setting for radiogenic helium accumulation. This is because, as a prerequisite for accumulation, a considerable high heat flow anomaly is required from tectonothermal events to drive the release and circulation of radiogenic helium in the continental crust. Here we apply statistical analysis on geochemical data observed in thermal springs and recorded heat flow to account for crustal helium mass balance for each tectonothermal event in the region.

The results demonstrate anomalously high heat flow ~64-99 mW/m2 with a consistent trend of helium isotopic ratio and fluid chemistry notably in the Rukwa Rift. Mass balance calculation shows that the whole crustal volume underlying the East Africa Helium Pool (EAHP) has the capability of producing radiogenic helium of about ∽9.9 x 106 mol/yr (∽22 x 10-6 mol 4He/m2 yr) while the total radiogenic helium flux ranges between ∽2.39 x 106 mol/yr and ∽2.68 x 109 mol/yr. The Tanzania Craton contributes largely to radiogenic helium releasing up to 50% of the total capacity in the region. The total ^{4}He emission in the Rukwa Rift Basin is about ∽4.45 x 105 - 5.01 x 108 mol/yr which is thus equivalent to 19-21% of the total production capacity in the region. We suggest that the helium accumulation in the EAHP

would have started as early as Palaeproterozoic (2.349 Ga). However, subsequent release has been accelerated largely by tectonic events associated with high heat flow. These results provide qualitative and quantitative insights into assessing both helium and geothermal potentiality in the region.

DAMAGE DISTRIBUTION OF THE MW5.9 SEPTEMBER 10, 2016, KAGERA EARTHQUAKE WITH IMPLICATIONS FOR SITE EFFECT AMPLIFICATION

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The Kagera earthquake of magnitude Mw5.9 occurred on September 10, 2016, at 12:27 GMT, 15:27 local time, with an epicenter located northwest of Bukoba town, in Minziro village, close to the border of Tanzania and Uganda. The earthquake resulted in widespread damage within the Kagera region, with an officially announced death toll of 17, many residential structures destroyed, and others damaged beyond repair. Following the earthquake, a macroseismic survey was conducted by interviewing various affected people using macroseismic questionnaires to delineate the distribution of seismic energy and establish the effects of ground shaking. The results of the macroseismic survey indicate variations of intensity values from IV-VIII on the MSK-64 scale, with more frequently assigned intensity values ranging from VI-VII. The orientation of the intensity pattern is elongated towards the southeast, consistent, with the rupture directivity towards Bukoba town and with the orientation of the fault rupture from the focal mechanism and the distribution of aftershocks. The duration of shaking in many localities was observed to be over 20 s, resulting in resonance effects. Both findings of the observed variations of the intensity values and the duration of shaking indicate that side effects resulting in the amplification of the seismic signals likely played a vital role in the damage distribution. The maximum intensity of VIII, corresponding to the instrumental magnitude

of 6.2, differs from the instrumental result of magnitude 5.9 by a factor of 0.3; the difference is attributed to the amplification by side effects within the region. The observed side effects, therefore, emphasize the importance of reinforcing the buildings and, in the future, adherence to seismic building codes and specifications in all regions within the East African Rift System (EARS). The database of the intensity from the macroseismic survey will be useful as input for the seismic hazard assessment within the region and the entire EARS.

BUILDING LANDSLIDE RESILIENCE IN TANZANIA: A LESSON LEARNT FROM THE HANANG CATASTROPHIC EVENT

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Tanzania, like many other countries with sloped terrains and mountainous landscapes in the world, experiences landslides amongst many other natural geohazards. Tanzania's varied topography in various regions makes it susceptible to a range of landslides, some of which may occur frequently. A number of these events have been witnessed causing disasters ranging from a scale of property loss, and human fatality to an unparalleled threat to sustainable development. In recent decades, the effects of climate change extremes have further aggravated the disaster vulnerability incidences in Tanzania posing grave risks to the economy, environment, infrastructure, health and livelihoods. The Hanang catastrophic landslide which occurred on December 3rd 2023 claiming 89 lives in the Katesh Town and neighbouring villages is an undeniable fact of how deadly the geohazards can strike. It is worth noting that the Hanang catastrophe is just a representative sample of what could happen in similar sloping mountainous areas showing the potential of landslide occurrences in Tanzania such as Oldoinyo Lengai, Rungwe, Meru, and Kilimanjaro mountains, etc.

The government of Tanzania has shown significant efforts to deal with geohazards such as landslides in unstable towns and villages, via its institutions and government bodies coordinated by the Prime Minister's office. Despite the good practices and disaster risk reduction initiatives by the government, the frequency and intensity of disasters are observed to be on an increasing trend. Notable landslide risk is substantially increasing in Tanzania as a result of growing urbanisation and associated infrastructure expansions together with increasing precipitation trends due to climate change. As a result, when catastrophic incidents occur there is a dire need to build landslide resilience, be proactive, and enhance early warning systems to save property and lives. Building landslide resilience is vital for disaster management and planning development activities in the landslide susceptible areas of Tanzania.

DEFORESTATION AND CHANGES IN LAND USE AND COVER CAUSED BY THE ARTISANAL AND SMALL-SCALE MINING IN THE BIHARAMULO FOREST RESERVE, TANZANIA

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This study investigates the spatial and temporal dynamics of deforestation, land cover transformation and ASM growth within the BFR using remote sensing methods, Geographic Information Systems (GIS) analysis, and on-the-ground assessments. Landsat imagery from 1995, 2009, and 2023 were selected and filtered in Google Earth Engine, supervised image classification using random forest algorithm was employed in imagery classification. It assesses changes in land cover classes and tracks their persistence and distribution for the periods 1995-2009 and 2009-2023. In 1995, the study area consisted of 51.23% forest, 29.86% bushland, 6.17% grassland, 4.49% mining, and 8.25% other land use/cover. By 2009, these proportions shifted to 21.77% forest, 36.61% bushland, 12.15% grassland, 10.97% mining, and 18.51% other land use/cover. By 2023, the proportions further transformed to

10.17% forest, 19.70% bushland, 14.66% grassland, 1.47% mining, and 54.00% other land use/cover. The classification achieved a high overall accuracy of more than 80% for each respective year. The main result is the significant reduction of forest and bushland, with mining areas also decreasing and being replaced predominantly by other land uses/cover and grassland over the studied period. The rate of this replacement varies temporally and spatially across the entire Biharamulo Forest Reserve. The study concludes that there is a decline in forest cover and an increase in other land uses/cover and grassland due to the commencement and cessation of mining in the studied area. The study recommends effective forest conservation strategies, regulating ASM activities, promoting sustainable land use practices, and further research to comprehend the drivers and impacts of land cover change.

IMPACT OF URBANISING WATERSHED ON FLOOD: CASE STUDY OF MSIMBAZI CATCHMENT DAR ES SALAAM

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This study aimed to analyze and predict the combined impact of urbanization and climate change variability on flooding disasters within the Msimbazi watershed in Dar es Salaam. Urbanization is measured by the impervious surface area (ISA) change, which was assessed through Landsat images collected in 1989, 1995, 2009, and 2015. The ISA was analyzed by the minimum noise fraction in combination with the linear spectral mixture analysis method and projected to future 30 and 50 years using the Markov chain cellular automata method. Daily rainfall data from 1985 to 2015 were used to analyze the variation in total annual, seasonal, and extreme rainfall events using non-parametric Mann Kendal. The hydrological model of HEC-HMS simulated the rainfall runoff of the Msimbazi watershed to understand the trend of flood peak flows and discharge volumes from 1985 to 2015 based on the soil conservation service curve number. The impact of urbanization on flood was assessed using a comparison of sub-watersheds and impervious surface area impact index.

The result indicated that urbanization within the Msimbazi watershed has increased from 11% in 1989 to 53% in 2015 and is expected to increase to 66% by 2050. The total annual rainfall has decreased at a rate of 5.8 to 8.6 mm/year; meanwhile, extreme rainfall events are significantly increasing at a rate of 0.2 to 0.87mm/year within the Watershed. The curve number indicates that the runoff potential of the watershed increased from 1985 to 2015, with a spatial distribution of 70 to 90 in 2015. The overall trend of

surface runoff was found to have significantly increased from 1985 to 2015 due to ongoing urbanization, reducing the surface area for infiltration and increasing the concentration time. Urbanisation increased flood peak discharge by 24% in W820, 337% in W630, 164% in W480, 60% in W510, and 590 from 1985 to 2015. The impervious Surface Area Impact index varies from 4 to 107% among sub-watersheds, with the highest in downstream sub-watersheds that are highly urbanized.

The multiple regression model of flood prediction developed for subwatersheds can be used to predict future flood peak discharges in events of climate change and increased urbanization. The modal indicates rainfall as a primary cause of floods amplified by urbanization. Finally, the finding indicates that the effect of urbanization on the flood decreases with an increase in catchment-scale size, and therefore, smaller watersheds are affected more.

FACTORS CONTROLLING THE RATE OF MOVEMENT OF THE SHIFTING SAND, NGORONGORO-LENGAI GEOPARK, TANZANIA

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In Tanzania, tourism is a vital sector contributing to the country's economy. The country's rich natural beauty and diverse attractions have led to initiatives to develop the tourism industry. One such effort is the development of geoparks and natural geological heritage preservations. Ngorongoro-Lengai geopark is the only globally recognized geopark in East Africa and one of the two in Africa. The geopark boasts unique geosites including the Ngorongoro crater, one of the 100 natural wonders of the world and Shifting Sand (Mchanga wa maajabu). These geosites have remarkable geology and thereby understanding the value of the geosites is crucial for their human-nature relationship sustainability.

The shifting sand is one of the most unique geosites, rich in mafic-ultramafic minerals giving it a notable black colour. This geosite is not only a sand dune in a non-desert region but also the only known terrestrial volcaniclastic sand dune in Africa. Research has placed the origin of the shifting sand to be the Ol Doinyo Lengai mountain, with dune movement westwards at a rate of between 17m/year and 23m/year. The dune has been detected and monitored since 1969. However, the factors driving the dune's movement as well as selection of its path have been a myth for decades. This study has identified the possible causes of the movement of the shifting sand. This has been achieved by studying the sand's properties, weather components (wind, rainfall and temperature), and how they affect its rate of movement. The

correlation of weather parameters and distance travelled by the shifting sand suggests there is a relationship between the distance travelled by the sand and wind. The results have strongly suggested wind to be the driving force of the movement. Similarly, rainfall, temperature and the sand's physical properties may have been important in controlling the rate.

The study is relevant in unlocking the hidden potential of the geosite where the knowledge gap is going to positively impact the local societies on the area and also on the growth of the geotourism industry. The knowledge on the rareness and the value of this geosite can be a door attracting tourists to witness such unique phenomena and hence promote the geotourism industry of Tanzania.

CALCITE SCALING POTENTIAL IN THE SONGWE GEOTHERMAL PROSPECT, SOUTHWEST TANZANIA

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Precipitation of travertine deposits which are mainly composed of carbonate polymorphs of Aragonite and Calcite are known to cause scaling of geothermal wells and pipes in geothermal fields around the world. The Songwe geothermal prospect in Southwest (SW) Tanzania exhibits signs of potential scaling, evidenced by travertine deposits in many surface manifestations such as hot springs. However, to date, no studies have quantified the calcite scaling potential of the Songwe geothermal prospect. This study examines the potential for $CaCO_3$ deposition in the Songwe geothermal prospect. Data from five hot springs, two warm springs, and one river sample, collected by the Tanzania Geothermal Development Company (TGDC) across five clusters, has been analyzed to assess and quantify this potential. The clusters include Ilatile, Main Spring, Songwe, Rambo, Madibira, Ikumbi, Aqua, and Songwe River respectively. The chemical compositions in mg/kg have been systematically processed by chemical methods of mass-balance, mass-action, and heat balance using the Powell spreadsheet, empirical relations, and computer codes namely WATCH and PHREEQC. Songwe geothermal fluids are bicarbonate rich, with reservoir temperatures of 125±25°C. Many of the samples also show evidence of mixing with meteoric water. The composition of hot-spring fluids is modified from the original reservoir fluids by the significant reduction in calcium and

bicarbonate ions. This effect is mostly apparent in Ilatile Springs, whose carbon dioxide reduction is significant. No significant changes are observed in chemical composition for the warm spring samples. Calcite deposition rate ranges from 8.85733 x 10-22 to 1.21551 x 10-22 in m per second. Ilatile hot spring sample shows that the scaling mass of the simulated exploration and production wells based on its composition difference data is 60 kg and 80 kg. These results show that the calcite scaling potential of the Songwe geothermal prospect is high and based on the rate of deposition, significant amounts can be deposited inside production wells up to several centimetres in a short production time of a few months.

GEOCHEMICAL MAPPING AND GEO-HEALTH- CONCEPT, PRINCIPLE AND APPLICATION

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Geochemical mapping, an essential tool in environmental and health studies, involves the systematic collection and analysis of geochemical data to understand the composition of the earth's surface, subsurface, and atmospheric systems. Geochemical mapping has become increasingly relevant in the context of geo-health, an emerging interdisciplinary field that explores the relationship between geochemical factors and public health outcomes. This study aims to present a comprehensive overview of the concepts, principles, and applications of geochemical mapping in geo-health, emphasizing its importance in identifying health risks related to natural environmental factors.

The principle of geochemical mapping lies in the spatial analysis of chemical elements and compounds present in soil, water, air, and biota. It enables the identification of natural geochemical anomalies and anthropogenic pollutants that could pose risks to human health. The primary goal of such mapping is to detect harmful concentrations of elements like arsenic, lead, iodine, selenium, fluorine, cadmium, and other toxic substances, which are linked to various health issues such as cancer, neurological disorders, and developmental problems. Geo-health specifically refers to the study of how environmental exposures to geochemical variables influence the incidence of Endemic diseases through overdose or deficiency of the elements such as Goiter (iodine deficiency), Kaschin-Beck Disease（KBD) (selenium

deficiency), Endemic Fluorosis（Fluoride overdose), Endemic Arsenism（Arsenic overdose), Tumor (cancer), thereby connecting earth sciences with public health strategies.

Methods involved in geo-health studies include synthetic geological survey which is a regional geo-health survey, soil geo-health survey deals with the distribution and circulation of elements in soil, water geo-health survey involving the distribution and circulation of elements in water, geophysical survey to ascertain the subsurface conduit and hazardous elements. These datasets can then be analysed to identify geographic regions with elevated concentrations of hazardous elements or pollutants. The results of geochemical mapping can be used in the evaluation of environmental policies, land-use planning, and public health interventions. By integrating geochemical data with demographic, epidemiological, and socioeconomic information, researchers can develop predictive models for assessing health risks and formulating targeted public health strategies. The results also play a role in epidemiological studies, supporting the identification of spatial clusters of disease linked to environmental exposures.

In conclusion, all substances are potentially poisonous. The dose dictates its potency as a poison. The key question is; how to determine the Threshold Value, which can be difficult. However, reference values or relative values may be used.

ADVANCES IN GEOCOMPUTATION AND GEOSPATIAL ARTIFICIAL INTELLIGENCE (GEO-AI) FOR MAPPING

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Geocomputation and geospatial artificial intelligence (GeoAI) have essential roles in advancing geographic information science (GIS) and Earth observation to a new stage. GeoAI has enhanced traditional geospatial analysis and mapping, altering the methods for understanding and managing complex human-natural systems. However, there are still challenges in various aspects of geospatial applications related to natural, built, and social environments, and in integrating unique geospatial features into GeoAI models. Meanwhile, geospatial and Earth data are critical components in geocomputation and GeoAI studies, as they can effectively reveal geospatial patterns, factors, relationships, and decision-making processes. This work provides a comprehensive overview of geocomputation and GeoAI applications in mapping, classifying them into four categories: (i) buildings and infrastructure, (ii) land use analysis, (iii) natural environment and hazards, and (iv) social issues and human activities. In addition, the work summarizes geospatial and Earth data in case studies into seven categories, including in-situ data, geospatial datasets, crowdsourced geospatial data (i.e., geospatial big data), remote sensing data, photogrammetry data, LiDAR, and statistical data. Finally, the study presents challenges and opportunities for future research.

IMPROVING COMMUNITY LIVELIHOODS THROUGH IMPROVED AVAILABILITY OF WATER RESOURCES IN SEMI-ARID AREAS

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Water is an essential factor that supports human life, animals, and plants. It is generally obtained from two principal natural sources: surface water (e.g., freshwater lakes, rivers, and streams) and groundwater (e.g., boreholes and well water). Population growth and climatic change have become major challenges, increasing water demand and forcing the utilisation of groundwater resources as an alternative water source for domestic purposes. The extraction of groundwater resources is achieved through exploration and drilling of boreholes.

Globally, the lack of adequate water supply especially in semi-arid areas poses a significant challenge for domestic and other uses. This hinders the achievement of sustainable development goals, particularly in ensuring access to water and sanitation for all, as outlined in Goal 6 of the Sustainable Development Goals (SDGs). It is reported that 785 million people worldwide still lack access to safe water, with 490 million residing in rural areas of sub-Saharan Africa. Furthermore, the availability of water is decreasing over time, and the water crisis is ranked as the fifth highest risk to society according to the 2020 edition of the World Economic Forum's Global Risks Report.

Groundwater is the most dependable and accessible source of water in semi-arid areas. However, there are insufficient water supplies due to inadequate

borehole yields. The low borehole yields are partly caused by outdated groundwater exploration technologies and complex geological formations. Additionally, water sources are often contaminated due to unsustainable human activities such as small-scale mining, agriculture, and livestock keeping. All of these factors combined contribute to the inadequate availability and access to water in semi-arid areas.

Improving exploration technologies involves using advanced methods to identify potential groundwater sources. Proper borehole siting and drilling require thorough hydrogeological assessments to locate suitable drilling sites and ensure the installation of efficient and sustainable boreholes. Alternatively, rainwater has served as an important water source in areas with significant precipitation. The implementation of rainwater harvesting structures includes various techniques such as rooftop collection systems, check dams, and water storage tanks to capture and store rainwater for future use. When effectively implemented, these measures have the potential to significantly enhance water availability in semi-arid regions, leading to improved agricultural productivity, access to clean water, and overall economic development. Additionally, by addressing water scarcity, these initiatives align with the pursuit of sustainable development goals, the realization of the National Development Vision, and the overarching objectives of global and national poverty alleviation strategies.

TGSMC: REPORTING CODE FOR ARTISANAL AND SMALL-SCALE MINING (ASM/SSM) IN TANZANIA

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A Reporting Code for Artisanal and Small-Scale Mining (ASM/SSM) in Tanzania (TGSMC) is a simplified user-friendly bankable statement designed to create confidence, transparency and a snapshot of the exploration and mining projects' viability. These are the factors that determine the participation of key stakeholders such as investors, financial institutions and the Government in the fast-growing ASM/SSM sector in Tanzania. With near-surface resources becoming depleted, TGS and STAMICO have partnered to support ASM/SSM in adopting advanced exploration methods. This collaboration aims to formalise and improve the subsector by introducing professionalism and providing a tailor-made systematic resource evaluation that bridges the gap between raw mineral potential and the structured requirements of investment-ready projects. The statement includes a rigorous classification of mineral resources, progressing from inferred to measured categories to provide high-confidence data on deposit size, quality, and viability. In brownfield and active ASM/SSM operations, exploration efforts involve geological mapping, sampling, and targeted drilling to better define the extent of mineralization and life-of-mine potential. Due diligence parameters, such as ownership validation, permit status, and regulatory compliance, are essential to ensure projects meet all legal and environmental

standards, making them more attractive to potential investors and financial institutions. A core part of the statement is the assessment of risks unique to ASM/SSM mining projects, which can range from technical and operational to social and legal factors. Key risks include establishing reliable grade and density data, overcoming bottlenecks in mining and processing, and ensuring tenure security. Social risks, such as maintaining community relations, and environmental protection measures are also critical, as disruptions can delay operations and affect profitability. Risk analysis in the statement considers these variables, providing sensitivity analyses to highlight how factors like fluctuating grades or community issues could impact project stability and returns. Ultimately, the ideal bankable statement provides a well-rounded economic outlook for potential investors, incorporating location, permits, resource estimates, mine life projections, capital expenditure needs, production targets, and compliance certificates. By including stakeholder engagement plans and detailed feasibility models, the statement demonstrates the project's adherence to international standards. For TGS-STAMICO's ASM/SSM projects, this comprehensive and transparent approach helps build investor confidence and aligns Tanzanian ASM/SSM mining ventures with the expectations of both local and international financiers, promoting sustainable investment in Tanzania's mining sector.

LITHOMAGNETIC DOMAINS AND METALLOGENIC ZONES IN THE KARAGWE ANKOLEAN BELT OF NORTHWESTERN TANZANIA: INSIGHTS FROM ONGOING REGIONAL-SCALE AEROMAGNETIC AND GRAVITY DATA INTERPRETATION

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The northwestern part of Tanzania comprises Archaean Tanzania Craton (TC) bounded by Proterozoic mobile Belts of Ubendian-Rusizi, Karagwe Ankole, and the Neoproterozoic Malagarasi Supergroup rocks. The area comprises several structurally complex domains that host multiple metallic resource potentials, particularly gold, nickel, copper, tin, tungsten, and columbite-tantalite. The Karagwe Ankolean Belt (KAB) is of particular interest as it hosts known Ni-Cu deposits along the Kabanga-Musongati-alignment of mafic complexes and also significant tin-tungsten occurrences in hydrothermally altered zones near S-type granites in Ngara and Kyerwa localities. Moreover, gold mineralization associated with quartz-carbonate-sulphide quartz veins in shear zones occurs in several localities close to the tectonised KAB-TC contact zone. Regional scale aeromagnetic and gravity data interpretation over the area revealed up to 4 distinct lithotectonic and metallogenic domains based on their unique responses and contained structural features. These are the Eastern, the Central, the Western, and the Northern Domains. They are distinct based on their magnetic and gravity responses, including lineament orientations and magnetic and gravity intensities. When these domains are reviewed, combining regional geology and mineral occurrences, they reveal associated and integrated metallogenic

zones that broadly coincide with the specific magmatic and tectonic characteristics.

The Eastern Zone has a myriad of gold and potential Ni-Cu base-metal hosted in Archaean Greenstone Belts and mafic-ultramafic complexes associated with NE-SW dolerite dykes. The Central Zone located west of the dolerite dykes swarm has similar Ni-Cu associated with mafic-ultramafic sills intruded in high sulfur sediments as well as shear-hosted gold deposits associated with the contact between the Archaean TC and the lower basal metasedimentary rocks of the KAB. The Western Zone comprises parts of the KMA complexes and hydrothermally altered contact zones with S-type granites and pegmatites that host Sn and W occurrences along the entire domain. Refolded folds and sheared intrusion-metasedimentary contact zones are also favourable for orogenic Au mineralization. Lastly, the Northern Zone is metallogenic, similar to its southern extension into the Western Zone comprising potential for Ni-Cu associated with KMA mafic complexes and sills, and Sn-W associated with structurally deeper S-type granites in areas such as Kitambuzi deposit in Karagwe. Similarly, alkaline intrusions associated with Neoproterozoic rifting post-KAB occur along rocks similar to the Western Zone in southern Burundi. Such an occurrence suggests the potential for these alkaline intrusion-hosted rare earth and rare metal deposits to exist in NW Tanzania.

The ongoing interpretation of the geophysical dataset is essential in prioritizing areas of focus during regional prospecting, including directly delineating targets for immediate follow-up work. Furthermore, the dataset provides coverage of geology, especially on undercover regional features,

highlighting potential extensions of zones of interest. Based on this tentative ongoing work, the potential of KAB as a metallogenic domain is enhanced.

APPLICATION OF PRINCIPAL COMPONENT ANALYSIS (PCA) IN REMOTE SENSING FOR MAPPING REE-BEARING CARBONATITES: A CASE STUDY OF THE SANGU-IKOLA CARBONATITES SOUTH-WESTERN TANZANIA

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Principal Component Analysis (PCA) is a statistical technique that simplifies complex datasets by transforming correlated variables into a set of uncorrelated components called principal components. These components capture the maximum variance in the data, helping to identify patterns and reduce dimensionality. PCA is applied to multispectral imagery, to isolate specific mineralogical features, making it easier to identify and map minerals in complex datasets.

This study investigated REE-bearing carbonatites in Sangu-Ikola, southwestern Tanzania, through a multi-faceted remote sensing and GIS approach, integrating mineralogical, structural, and geospatial data. Using ASTER multispectral data, spectral indices sensitive to carbonate minerals were generated, and Principal Component Analysis (PCA) was conducted to isolate spectral features associated with carbonate minerals.

The Remote Sensing study done after mineralogical analyses via optical microscopy, X-ray diffraction (XRD), and an Analytical Spectral Device (ASD) confirmed that the carbonatites are dominated by calcite and dolomite, with REE-hosting phases like pyrochlore and apatite. Integrating Remote Sensing and mineralogical data enabled detailed mapping of

alteration zones and structural features, providing insight into the spatial distribution of carbonatites in the Sangu-Ikola complex.

GEOCHEMICAL CHARACTERIZATION OF THE CENOMANIAN - CAMPANIAN RED SANDSTONE GROUP OF SW TANZANIA: IMPLICATIONS FOR PROVENANCE, CLIMATE AND PALEO-AMBIENT REDOX CONDITIONS

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Trace and major element compositions and rare earth elements (REEs) are presented for the Cretaceous Red Sandstone Group of the Songwe basin, SW Tanzania, to elucidate source rocks composition, paleo-weathering intensities, climatic variations, and paleo-ambient redox conditions. In interpreting the obtained trace element data, it was assumed that elemental ratios such as La/Sc, Th/Sc, Cr/Th, Th/Co, La/Co, and REEs in the detrital silicate fraction of the samples behaved as a closed system during weathering, transportation and eventual deposition in the basin. With negative Eu* anomalies, studied shales show less fractionation of REE (LaN/YbN = 0.28 – 4.43; mean = 1.33). These ratios are lower than the Post-Archean Australian Shale (PAAS) [(La/YbN)PAAS = 9.5, and can be attributable to a more felsic protolith for the Red Sandstone Group rocks. Furthermore, the trace element ratios of La/Sc, Th/Sc, Y/Ni, Cr/Th and Th/Co indicate a more felsic source than that for the Upper Crust Compositions (UCC) and (PAAS). Discriminant diagrams of Co/Th vs La/Sc and Cr/V vs Y/Ni enabled us to make inferences of source rocks to be the meta-anorthosites of the Ubendian and Cratonic granites around and to the NE of the basin. The calculated Chemical Indices of Alteration (CIA) indicate mainly intermediate magnitudes, suggesting sporadic variations of climates. Considerations on Al/Na and CIA values point to prevalent warm-

humid climates during the deposition of the Red Sandstone Group rocks. On the other hand, [V/(V + Ni], V/Cr, Nii/Co and calculated Mn* redox proxy parameters demonstrate an overall well-oxygenated/oxic environment when the sediments were deposited in the Songwe basin.

OVERVIEW OF THE PETROLEUM INDUSTRY IN TANZANIA

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The Tanzanian petroleum industry has evolved significantly over the past six decades, beginning with initial exploration efforts in 1952 and achieving the first natural gas discovery at Songo Songo Island in 1974. This marked the start of a series of discoveries, including key findings at Mnazi Bay, Kiliwani North, Mkuranga, and deep-sea blocks 1, 2, 3, and 4. While Tanzania has yet to discover oil, substantial natural gas resources have been identified, amounting to an estimated 57.54 trillion cubic feet (tcf), with 47.12 tcf located offshore.

Upstream activities in the sector involve extensive onshore, offshore, and rift basin exploration, with significant investments in seismic data collection and drilling operations. Infrastructure developments include major gas processing plants in Madimba and Songo Songo, as well as comprehensive pipeline networks facilitating gas transport and distribution for power generation, industrial applications, and residential use. Currently, significant portion of Tanzania's electricity is generated using natural gas underscoring its vital role in the country's energy mix.

The regulatory landscape is defined by robust legal instruments, such as the Petroleum Act of 2015 and the National Energy Policy, which ensure the sector's governance and promote sustainable growth. Key players include the Ministry of Energy, the Tanzania Petroleum Development Corporation (TPDC), and regulatory bodies like PURA and EWURA.

Tanzania's strategic position and resource potential present significant investment opportunities in gas-powered projects, infrastructure expansion, LNG development, and cross-border pipeline initiatives. The government actively seeks collaboration to enhance regional integration and invites investors to explore and contribute to the sector’s growth and diversification.

GEOLOGY OF EYASI WEMBERE BASIN, NE TANZANIA: POTENTIAL FOR PETROLEUM EXPLORATION

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The oldest structures in a rift basin define incipient rift architecture and modulate the patterns of landscape evolution, sedimentation, and associated hazards in subsequent phases of rift development. However, critical early-rift processes remain poorly understood due to deep burial beneath younger, thick syn-rift sequences and limited resolution of seismic imaging. In the Tanganyika Rift, East Africa, we augment existing 2-dimensional (2-D) seismic reflection data with newly acquired aeromagnetic and Full Tensor Gradiometry (FTG) data to investigate the deep basin and underlying basement structure. Seismically-constrained 2.75-dimensional forward modeling of the aeromagnetic and (FTG) data reveals: 1) an anomalously high-density (2.35-2.45 g/cc) deep-seated, fault-bounded wedge-shaped sedimentary unit that directly overlies the pre-rift basement, likely of Mesozoic rift (Karoo) origin; 2) a ~4 km-wide sub-vertical low-density (2.71 g/cc) structure within the 3.2 g/cc basements, interpreted to be an inherited basement shear zone, 3) significant intra-basin early-rift fault co-located with the modeled shear zone margins, defining a persistent intra-basin ‘high’, and 4) a shallow intra-sedimentary zone of comparatively dense material (~2.2 g/cc), interpreted to be a younger axial channel complex confined between

the intra-basin ‘high’ and border fault. These results provide insight into the earliest basin architecture of the Tanganyika Rift, controlled by inherited basement structure, and provide evidence of their persistent influence on the subsequent basin evolution.

PETROPHYSICAL IDENTIFICATION AND CHARACTERIZATION OF CENOZOIC HYDROCARBON RESERVOIR ZONES AT THE R FIELD, NORTHERN ROVUMA BASIN, TANZANIA

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Cenozoic reservoirs of northern Rovuma Basin, Tanzania, have not yet been characterized in detail. Combined well log patterns and fracture indicators have not been presented before. This work used petrophysical analysis of density, neutron, gamma ray (GR), resistivity, and sonic well logs to characterise reservoir zones at the study area. Twelve reservoir zones (A-L) have been identified based on lithological properties and resistivity anomalies. The presence of hydrocarbons in these zones is concluded based on acoustic parameters involving acoustic impedance and Vp/Vs ratio, and ΔTC and neutron porosity crossplots. Fractured sedimentary fills in different stratigraphic levels were assessed based on resistivity-logs crossplots. Results show that eleven zones (A-F and H-L) are gas-filled and zone G is devoid of hydrocarbon. We have shown that, in areas with resistivity anomaly, all GR-resistivity combined patterns may be used to indicate hydrocarbon bearing layers except when there is a co-occurrence of funnel-shaped pattern for both logs. The distribution of fractures and hydrocarbons suggests the existence of compartmentalised reservoirs. These reservoirs have been discussed based on a geoseismic model created to support our arguments. Our technique has allowed easier identification of hydrocarbon-bearing zones through well Rx. This technique may be applied in other sedimentary basins.

UNLOCKING ENERGY POTENTIAL: TANZANIA'S NEXT OFFSHORE LICENSING ROUND

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The upcoming licensing round for offshore Tanzania presents a significant opportunity for energy investors and exploration companies. With a proven history of successful exploration, Tanzania boasts multi-TCF gas discoveries, particularly in the Upper Cretaceous and Tertiary turbidite reservoirs charged by Jurassic and Karoo source rocks. The region is supported by extensive modern Gravity/Magentic, Bathymetric, 2D, and 3D seismic data, and well data as well-established exploration and appraisal history, including key fields like Mzia and Jodari.

Despite the major gas discoveries already made in the country, there remains a wealth of undrilled and high-potential plays, indicating substantial untapped petroleum reserves. The strategic position along the Davie Fracture Zone and the Seagap fault systems contributes to robust traps, migration pathways and reservoir qualities. Investors are encouraged to capitalize on the available high-quality data and the potential for discoveries that reinforce Tanzania's standing as a key player in East African energy exploration.

This licensing round represents a chance to harness these advantages for sustainable and profitable energy development in Tanzania.

HYDROCARBON POTENTIAL FOR MANDAWA SALT BASIN

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The Mandawa salt basin is located in south-eastern Tanzania. It is part of the East African Rift system, which is known for its significant hydrocarbon resources. The basin is recognized as having hydrocarbon potential, primarily natural gas. The Exploration activities in the Mandawa Basin have primarily focused on natural gas whereby several exploration wells have been drilled in the area to assess the hydrocarbon potential of the basin. The discoveries made in the neighbouring offshore basin, which is geologically similar to the Mandawa Basin, emphasize the hydrocarbon potential of the basin.

Seismic interpretation and geological studies indicate the presence of structural and stratigraphic traps that could potentially contain commercial quantities of natural gas. Further, the area is characterized by deep-seated reservoirs and regional-scale shale which acts as a seal. The intensive hydrocarbon exploration in the Mandawa Basin might lead to the discovery of hydrocarbon resources in the area which in turn could foster socio-economic growth in the area. This paper aims to narrate the hydrocarbon potential of the Mandawa salt basin, and the projected social and economic advantages.

INFLUENCE OF IGNEOUS INTRUSIONS ON MATURATION OF THE CRETACEOUS-EOCENE SOURCE ROCKS OF THE OFFSHORE TANZANIAN BASIN

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The offshore Tanzanian Basin contains numerous igneous intrusions emplaced at various stratigraphic levels. Previous studies indicate these intrusions to have impacted the petroleum system, affecting key elements such as source rocks, reservoirs, seals, migration pathways, and trapping mechanisms. However, due to the limited number of wells drilled in the region, there have been few studies reporting the associated thermal effects on source rock maturation and their role in hydrocarbon generation. In order to gain a comprehensive understanding of the intricate relationship between intrusions and the petroleum system, particularly source rock, an integrated geochemical and resistivity log analysis was carried out. The geochemical results show that the Cretaceous-Cenozoic sediments of the study area have low total organic carbon contents (TOC < 1 wt%), kerogen yield (< 1 Mg HC/g), and Hydrogen Index (< 100 Mg HC/g TOC), primarily composed of Type III (gas-prone) to Type IV (inert) kerogens. These sediments have undergone varying levels of thermal maturity, ranging from post-mature (within Cretaceous), matured (in Paleocene) to immature (in Eocene) thermal states. The Cretaceous strata located proximal to the intrusions exhibit

significant thermal alteration, resulting in a reduction of both organic matter (OM) content and source potential compared to the Eocene and Paleocene samples. This observation is consistent with the estimated paleotemperature (T) and resistivity log (ILD) along the depth profile, which have mapped local thermal alteration increasing from the base Paleocene to the Cretaceous. These findings have implications for source rock potential and thermal evolution history in the offshore Tanzanian Basin. This study highlights the necessity for thorough subsurface mapping in the area to identify both younger and older intrusive rocks. These intrusions pose a potential risk in petroleum exploration, especially when they intrude into matured source rock intervals.

THE MIDDLE TRIASSIC FLORA OF THE TANGA BASIN, TANZANIA

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The diverse plant fossil assemblages from the Tanga Basin in Tanzania, originating from the Bamba, Pangarawe, and Kakindu outcrops, include Pagiophyllum, Voltziopsis, Heidiphyllum, and possibly Sphenobaiera. This floral composition indicates a Middle Triassic age for the fossiliferous beds. The plant remains are preserved in fine-grained shales and silts, suggesting deposition in low-energy environments, such as lakes, with minimal transport from surrounding growing areas. The plants likely thrived in a dynamic ecosystem composed of coniferous forests interspersed with open vegetation, reflecting adaptation to varying environmental conditions driven by a seasonal, monsoonal climate. This study highlights the significance of the Tanga Basin in elucidating the floristic composition of Gondwana's mid-latitudes and contributes to our understanding of biogeographical patterns and biome distributions in the Triassic flora.

TANZANIA'S URANIUM POTENTIAL: A FRAMEWORK FOR ACCELERATED SUSTAINABLE ECONOMIC GROWTH AND SMOOTH ENERGY TRANSITION

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Tanzania is currently positioning itself as a continental hub for strategic minerals that are important for energy, economic, military, or technological development globally. Uranium is one of the strategic minerals found in Tanzania with a projected investment of $1.2 billion currently, which highlights the country's diverse mineral wealth and its potential to become a major player in the global mining industry. From precious metals like gold to essential elements for modern technology such as uranium, Tanzania's mining projects promise to boost the economy and create numerous opportunities. Tanzania's favourable geology makes it a prime location for uranium exploration and mining. Tanzania is on the verge of entering a new phase in large-scale uranium mining as substantial uranium deposits have been discovered in several regions of the country through radiometric surveys carried out in the 1970s. Currently, various companies are conducting exploration activities in diverse geological settings. The Mkuju River Uranium Project in Namtumbo, Ruvuma region (southern Tanzania) is considered a world-class uranium deposit with around 58,500 metric tons of Uranium. Another significant uranium project is the Manyoni uranium project in the Lake Bahi catchment area, with an estimated capacity of up to 29 million pounds of Triuranium Octoxide (U3O8). There are also

substantial uranium deposits in other areas of Tanzania, including Minjingu, Simanjiro, Lake Natron, Galapo, Madaba, Nachingwea and Tunduru. Proven uranium deposits in Tanzania were estimated at 55,000 tonnes as of 2023. The potential for uranium in Tanzania has already began to have an impact through direct and indirect job creation in various exploratoration projects, with a projected increase these opportunities once mining begins. At the onset of mining, the government will generate cash through taxes and royalties, as well as by from uranium exports. Infrastructure will also be enhanced in areas with potential for mining, benefiting the local populations. Tanzania's uranium potential, if fully realised, will provide a strong foundation for energy transformation both locally and but also contribute to the global supply. Uranium can help the development of nuclear energy, lowering dependency on fossil fuels and diversifying energy sources. Nuclear power is a constant and reliable energy source that promotes industrial growth and ensures a stable energy supply. Transitioning to nuclear energy can reduce carbon footprints while harmonising with global climate goals. Establishing strong legal frameworks to control mining operations, defending community rights and environmental preservation, and funding worker education and training to advance their expertise in the mining and nuclear energy industries, is indispensable. Investing in technology can help to advance the study and application of environmentally friendly mining techniques like "in-situ leaching," which can serve as a framework for sustainable development and aid in the smooth transition to sustainable energy sources and sustainable economic growth. Tanzanian uranium mining operations can be kept safe by taking environmental factors into account, such as management through the development of trustworthy systems for handling radioactive waste safely, rehabilitation plans through the

implementation of plans for land restoration following mining operations, and environmental impact assessments to reduce ecological harm. Furthermore there is the option of exploring more environmentally friendly mining techniques such as considering the use of in-situ recovery (ISR) mining techniques Importantly, a continuous evaluation of the effectiveness of these techniques will be expedient. Tanzania's uranium deposits offer a path toward more sustainable energy and future economic expansion. Tanzania may successfully utilize these resources while maintaining environmental and social responsibility by putting in place a comprehensive framework that emphasises sustainability and community involvement. By focusing on environmental protection, social responsibility, and economic development, Tanzania can benefit from the long-term vision for uranium mining projects. In its turn, the Uranium project can help to meet the global demand for nuclear power, while also creating jobs, boosting economic growth, and improving infrastructure.

THE ROLE OF NATURAL GAS IN A LOW (ZERO) CARBON FUTURE: THE CASE STUDY OF TANZANIA

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As the global community seeks pathways to mitigate climate change and transition to low- or zero-carbon energy systems, natural gas is increasingly viewed as a bridging fuel that can support this transition. This study investigates the role of natural gas in achieving a low-carbon future in the United Republic of Tanzania, a nation endowed with significant natural gas reserves yet facing pressing energy challenges.

Utilizing a mixed-methods approach, this research examines the current state of Tanzania's energy landscape, including energy demand projections, the potential of renewable energy sources, and the integration of natural gas into the energy mix. The study analyzes the environmental implications of natural gas exploitation, considering lifecycle greenhouse gas emissions compared to coal and biomass, which currently dominate the country's energy supply. Furthermore, this study explores the socio-economic impacts of natural gas development, assessing how investments in infrastructure and technology can promote energy access, economic growth, and job creation, particularly in rural areas. The study also evaluates policy frameworks and regulatory measures that could enhance the role of natural gas in energy transition, including incentives for clean technology adoption and frameworks for carbon capture and storage.

Preliminary findings suggest that while natural gas can play a pivotal role in reducing carbon emissions in the short to medium term, its long-term sustainability will depend on strategic integration with renewable energy

sources and robust policy frameworks that prioritize climate resilience. This study will highlight key recommendations for policymakers and stakeholders aimed at leveraging natural gas as a vital component in Tanzania's journey towards a sustainable, low-carbon energy future. By addressing both the opportunities and challenges associated with natural gas, this study contributes to the broader discourse on energy transition in developing countries and underscores the need for tailored solutions that reflect local contexts and capabilities.

APPLICATION OF LANDSAT REMOTE SENSING DATA FOR GEOLOGICAL MAPPING IN MAGMATIC NICKEL SULFIDE DEPOSIT: A KEY TOOL FOR VALUE CHAIN OPTIMIZATION IN TANZANIA'S STRATEGIC MINERAL INDUSTRY

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Recently advances in technology and the climate revolution toward a green economy have made nickel (Ni) a premier target for mining and exploration companies. Parallel to this, a series of advances in remote sensing and geographic information systems (GIS) have become available at very low cost. This study aimed to assess the viability of remote sensing and geographic information system (GIS) techniques for geological mapping and prospecting for magmatic nickel sulfide deposits in northwest Tanzania. Landsat band 7,5,3 and Landsat band ratios 4/2,6/2,6/7 as well as R: G: B composite images 7:5:3 and 6/7:6/2:4/2 were used in identifying rock types in the study area. Band ratio managed to distinguish rocks composed of clay minerals, iron oxide, and ferrous minerals. Composite image of band ratio allowed discrimination between different lithologies whereby different rock types were identified. These rocks include metasediments appearing as dark green and pale blueish green, the syn-orogenic granite in reddish blue, post-orogenic granite in pale blue, and recent sediments in pale yellowish green. Calculated surface flow direction was then used to discriminate structures of different orientations for an improved understanding of structural control in mineralization. Results from Landsat data have shown a clear lithological

correlation between Landsat images and the available geological map in the study area, implying that remote sensing methods may be used to accomplish lithological mapping successfully. Geophysical data can be used to clarify The effectiveness of Landsat data in geological mapping and streamlining interests may be supplemented by geophysical methods and confirmed by ground truthing.

ESSENTIAL CLEAN COOKING EDUCATION AND ENVIRONMENTAL MOVEMENTS WITH ENERGY4ME

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Currently, with the Government's strategy to ensure its people use clean cooking energy, the Energy4me program under the SPE University of Dar es Salaam Students' chapter has extended its roots to reach people and help the government to meet the projected outcome in the National Clean Cooking Strategy which target on increasing awareness among citizens and institutions on the importance of using clean cooking solutions. Having a transition from the use of firewood and charcoal in cooking to the use of clean cooking energy has become a challenge to people in transforming themselves due to lack of funds and lack of knowledge to understand the side effects of using unfriendly environmental and unhealthy cooking sources. So far, Energy4me has approached villages and schools in the Mwanga district in the Kilimanjaro Region and participated in UDSM research weeks to educate people and equip them with essential knowledge for a successful transition and its impacts on environmental conservation. Our goal is not yet achieved as we plan to reach more places that need this education. Being a new program, Energy4me is ready to collaborate and partner with any company or organization that is eager to promote environmental and socio-economic development to all Tanzanians.

PROSPECTING FOR EXTENSION OF LEAD DEPOSIT IN KUNENE REGION, NORTHWEST NAMIBIA

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The Kunene Region in northwest Namibia presents a favourable geological setting for lead mineralization. This study explores the potential extension of an existing lead deposit within the area using an integrated geophysical and geochemical approach. The extension of lead deposits in the Kunene region can revitalize the mining sector and enhance Namibia's position as a leading mineral exporter.

The Airborne radiometric data were used to identify areas with anomalous uranium or thorium concentrations, an aspect that can be associated with lead mineralization. These data were also used to delineate structural features and potential fault zones, that often serve as pathways for mineralized fluids. The geochemical analysis was then employed to determine lead geochemical anomalies with the indicator elements of Zn, Ba and Cu. Both former and later approaches were supplemented by Geological data, including lithological units and structural features, to identify target areas for potential lead mineralization. Additionally, Topex gravity data were downloaded and analysed to support the geological map by highlighting the high-density areas that can be the area of focus.

The used geochemical data identified zones with elevated lead anomalies. The integration of geological, geophysical, and geochemical data led to the identification of six target areas with a high probability of hosting lead mineralization. The Kunene Region demonstrates significant potential for the

extension of the lead deposit. The results of this study provide a robust foundation for future exploration activities. Further investigations, including ground truthing of the deskwork and drilling programs which are necessary to confirm the resource potential and assess the economic viability of the deposit, are recommended. The successful extension of the lead deposit can contribute to the diversification of Namibia's economy, create jobs, and boost the country's international standing as a reliable supplier of mineral resources.

EVALUATION OF THE RESERVOIR POTENTIAL FOR CARBON DIOXIDE SEQUESTRATION USING WELL LOGGING ANALYSIS: A CASE OF THE MANDAWA BASIN, SOUTHERN COASTAL TANZANIA

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Carbon capture and storage (CCS) involves the capture of CO2 produced from industrial and power generation sources followed by transportation of the captured CO2 to the underground geological sites. Once CO2 has been captured, it is then compressed into a liquid state and transported by pipeline, ship, rail or road tanker and then injected into deep geological formations (depleted oil and gas reservoirs, unmineable coal seams and saline aquifer) usually at a depth of more than 800 m for permanent storage. This study focuses on evaluating the potential for CO2 sequestration in a saline aquifer, a case of the Mandawa Basin. A saline aquifer is considered one of the most feasible technologies as it provides the largest potential storage volume.

The Mandawa Basin is taken as the prospective potential storage site as is the only salt reservoir in the coastal basin. The salt plasticity, elasticity and hydraulic properties and its seal integrity favour storage potential for Carbon dioxide. It is also proximate to the anticipated main Carbon emitters such as prospective Tanzania Liquefied Natural Gas (TLNG) and Dangote Cement factory which are both within the optimal distance of 300km to the injector. Once the prospective Tanzania LNG project in Lindi becomes operational, will be expected to produce and add emissions to the atmosphere. It is estimated methane from LNG operations contributes an emission amount of close to 1.9 million metric tonnes (MMT) in units of Carbon dioxide

equivalent emission (CO2e) that is equivalent to about 1.3% of methane from all the segments that make up the natural gas systems. In addition, the Dangote Cement factory is also considered the main contributor to greenhouse gas emissions. Generally, one ton of cement typically produces about 0.8 to 0.9 tons of CO2 emissions, resulting in approximately 8% of the world's anthropogenic CO2 emissions, and about 25% of all industry carbon emissions. Nevertheless, worldwide there is significant potential for CO2 storage sites which are situated far more than 300km optimal distance from these emitters which add on unjustified cost whenever will be taken as storage alternative for these sources.

Therefore, this study intends to explore the optimal storage potential nearby that will cater for the transport cost. The study will also add on initiatives set out to meet net zero carbon emission and limit the increase of global mean temperature to 2℃ pre-industrial level as stipulated in the Paris Convention; a more stringent temperature restriction of 1.5℃ was noted in the Copenhagen accord. The aim of this study is to evaluate the indicative parameters for Carbon dioxide storage potential at the Mandawa Basin, specifically the evaluation of containment assurance, estimation of CO2 Storage capacity, and assessment of gas and water saturation that may reduce the chance of having an effective storage capacity and finally estimation of the required injectivity parameters – predict and assess injectivity. This study will contribute significantly to minimizing carbon emissions and decarbonization of industrial emitters.

HYDROCARBON EXPLORATION IN THE EYASI-WEMBERE AREA, NE TANZANIA

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The Eyasi-Wembere area is located in the North-Eastern part of Tanzania along the Eastern branch of the Great East African Rift System. The area covers approximately 10,634.9 km2 and is composed of three frontier sub-basins namely; Eyasi, Wembere and Manonga. The area is dominated by Neogene sediments and volcano-sedimentary rocks which encompass sedimentary units of about 2 to 4.5 km thick.

Hydrocarbon exploration endeavors in the Eyasi-Wembere area began with several geological, geophysical, and geochemical surveys from 2015 to 2022 including Airborne Gravity Gradiometry (AGG), Aeromagnetic, Amplified Geochemical Imaging and shallow stratigraphic borehole drilling. These surveys identified areas of thick sediments, potential hydrocarbon source rocks, and stratigraphic/structural features of interest. This promising exploration campaign fueled Tanzania Petroleum Development Corporation (TPDC) to acquire a reconnaissance permit over the Eyasi-Wembere area in February 2023 and thereafter acquire 260 Line Kilometers (LKM) of 2D seismic data in September 2023. The acquired 2D seismic data revealed that the Eyasi sub-basins and part of the Wembere sub-basins have the best chance of hydrocarbon maturation and generation due to the presence of thick sedimentary rocks and extensive facies. Therefore, further exploration activities have been planned to focus on this part of the Block.

Among the planned activities include the ongoing acquisition of 1,100 LKM of infill and additional 2D seismic data. This program is planned to be

executed in two (2) phases for a contract duration of three (3) years with Africa Geophysical Services (AGS). The current phase-1 is planned to cover the acquisition of infill and an additional 779 LKM of 2D seismic data which commenced in July 2024. Subject to the interpretation results of 779 LKM of 2D seismic data, TPDC will have the option of acquiring 321 LKM infill 2D seismic data in phase 2. This infill survey will aid a better definition of structural/stratigraphic leads identified by the previous (2023) 2D seismic survey, delineate possible drillable prospects and estimate the available hydrocarbon resources in the basin.

The Eyasi-Wembere Basin thus presents a promising frontier for petroleum exploration in Tanzania, with potential contributions to the national economy and energy security. Its geological similarity to Turkana and Albertine basins in Kenya and Uganda respectively where significant hydrocarbon discoveries have been made also presents a possibility of the presence of a viable petroleum system in the Area. Further research, strategic partnerships, and technological applications will be key to unlocking its full potential.

LICENSING PROCEDURES FOR COMPANIES TO CONDUCT PETROLEUM OPERATIONS IN TANZANIA

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For local and foreign companies to undertake petroleum operations in Tanzania, a set of procedures must be followed. Such procedures, covering a range of issues from submission of an application to a grant of petroleum rights, are governed by the Petroleum Act, Cap 392 and related regulations. This abstract outlines key steps that the Government undertakes before permitting a company to partner with the National Oil Company to undertake petroleum operations. The assignment involved a rigorous review of the existing legal and regulatory frameworks governing petroleum operations in Tanzania specifically the Petroleum Act, Cap 392, Model Production Sharing Agreements of 2013 and respective regulations.

Generally, the initial step requires the Minister responsible for petroleum affairs to publish areas proposed to be opened for petroleum operation and an invitation of tender in a newspaper of wide circulation. Following the invitation, interested bidders apply to the Minister, expressing their interest in the proposed exploration areas or blocks. Upon receiving the application, the Minister reviews the company's technical and financial capabilities. If the review is successful, a negotiation process for a Production Sharing Agreement (PSA) between the Government, the National Oil Company, and the applicant (herein to be referred to as the Contractor) follows. The Model Production Agreement, an instrument approved by the Cabinet, provides overall guidance to negotiations. The PSA, among other issues, outlines the terms of resource sharing, exploration rights, royalties, taxes, and

responsibilities. The Cabinet must approve the PSA before signing. Once the PSA is approved and signed, the National Oil Company is required to apply for a petroleum exploration license to the Minister in respect of a block. The Minister shall, within 60 days after receiving applications and upon the advice of the respective Regulator, communicate the decision to grant or refuse to grant such a license.

The National Oil Company may assign the contractor exclusive rights to conduct exploration activities in the contract area, except where joint operations have been established in the agreement, the contractor shall have the exclusive right to conduct petroleum operations in the contract area on behalf of the license holder. Upon obtaining an exploration license, the contractor is allowed to commence exploration and production activities while abiding by the Tanzanian regulatory frameworks such as environmental and local content requirements. This licensing process is designed to ensure the responsible and sustainable management of Tanzania's hydrocarbon resources, balancing economic development with environmental protection and local community involvement.

AN OVERVIEW OF THE METHODOLOGIES APPLIED IN PALYNOLOGICAL PREPARATIONS AND PALYNOSTRATIGRAPHY AND THEIR IMPLICATION IN OIL AND GAS INDUSTRY

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The study of microfossils, or micropaleontology, is a major field of research in the geological sciences with numerous applications. Because of their small sizes, usually less than 1 mm, microfossils can be recovered from various sedimentary rocks, both marine and terrestrial, in great numbers and diversity. A small sample can reveal an entire ecosystem of organisms that can be used to reconstruct paleoenvironmental conditions (e.g., climate, water depth, and salinity), the evolutionary history of a group (paleobiogeography, origination, and extinction of species), and for relative dating (biostratigraphy and correlation). For these reasons, micropaleontology is used routinely for the study of core samples, just as macrofossils such as mollusk shells, vertebrates, or plant fossils have been studied when examining exposed surfaces in cores. The different branches of micropaleontology focus on specific fossil groups, characterized by their constitutive material, whether inorganic walled (calcareous microfossils such as foraminifera and coccolith, including radiolarians, diatoms, and phytoliths, or phosphatic such as conodonts) or organic-walled, the latter being specifically relevant to palynology.

Palynologists rely on a common extraction method that involves the use of inorganic acids and reagents to recover palynomorphs from rocks and sediments. In this paper, I review and present major groups of palynomorphs, geological evolution, their preparation techniques, and applications in the Petroleum Industry. Each of these groups offers different applications in the study of the evolution of life, relative dating (biostratigraphy), paleobiology, paleoenvironments, paleogeography, paleoclimatology, and geological resources such as hydrocarbon production. The methods and palynological techniques involve sampling technique, sample preparation (cleaning and washing), drying of the washed sample under neat dishes, mechanical processing (crushing of the sample into small pieces), weighing of the sample, and chemical processing which involves using chemical reagents (hydrochloric acid and hydrofluoric acid) for removing the carbonate and silicate materials from the samples, heavy mineral separation by using zinc chloride in association with a centrifuge machine, sieving the residue using 20 μm sieve mesh, mounting and slide preparation, light microscope examination of all palynomorph and photographic techniques, Age determination, paleoenvironments reconstruction and maturity of sediments for hydrocarbon generation.

PALYNOLOGICAL STUDY OF THE EARLY JURASSIC TO CRETACEOUS SEDIMENTS OF MANDAWA BASIN SOUTHERN TANZANIA

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Thirty-three (33) sediment-cutting samples from well X located in the Mandawa Basin, southern coastal Tanzania have been studied. The focus was on palynological analysis of the sediments from 150 m to 3040 m depth. The objectives of this study were to determine the age of the samples, the depositional environments, identification of kerogen types, and maturation levels of organic matter by using the spore color index (SCI) technique. The recovered palynomorphs were predominantly terrestrial with fair to good preservation status and low to medium diversity and abundance; however, few marine dinoflagellates were encountered. The age of the samples ranged from early Cretaceous to early Jurassic. Depositional environments ranged from non-marine, fluvial, deltaic, and shallow marine (inner neritic), as evidenced by the dominance of spores and pollen and few dinocysts. Additionally, mature to over-mature gas-prone type III kerogen was observed.

APPLICATION OF 3-DIMENSION MODELLING IN ASSISTING DATA INTERPRETATION AND VISUALISATION: TOWARDS BETTER MANAGEMENT AND PLANNING OF GEOSCIENTIFIC PROJECTS

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Integrating multiple datasets to facilitate better interpretations and provide insights into features otherwise subtle or unrecognisable in 2D is vital in geosciences—for instance, advanced geological studies in terrains and prospecting benefit from multiple perspectives and complex data visualisation. The 3D data integration spans multiple sectors such as oil and gas, gold resource evaluation and mining, hazards and seismic monitoring; multiple datasets are integrated using a suite of software incorporating artificial intelligence to harvest multiple-for-the-purpose 3D visualisation scenes. In geosciences, mainly geological research, highly detailed 3D geological maps present realistic and easy-to-visualise subsurface features that enhance the understanding, assist in planning for follow-up work and improve historical and current dynamics.

This project focuses on applying publicly available datasets, such as topography, quarter degree sheets geological maps and many published research results, to integrate them into customised 3D visual scenes. These 3D scenes, as demonstrated in this presentation, assist in a better understanding of critical features such as mineral occurrences and the extent of exploitation of these occurrences by various stakeholders. Moreover, the techniques developed can be applied to a broader span of scientists, researchers and institutions ranging from town planners, forestry and parks

monitoring, hazards monitoring, road construction and medium to large mines to help their operations in control monitoring, planning and modelling. Using the basics of GIS and incorporating multiple datasets to provide a near-to-real-time 3D scene is crucial in Tanzania's endeavour to excel and better manage its natural resources, fostering in-country talent and utilising multidisciplinary interactions for a broader sustainable development of multiple sectors, including mining.

THE ROLE OF ACADEMIC-INDUSTRY PARTNERSHIPS IN FOSTERING FOR FUTURE GEOSCIENTISTS

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In the field of geosciences, the cooperation between academic institutions and industrial entities plays an important role in shaping the careers and budding earlier career geoscientists. Since technological development, various geological inventions and discoveries, and market expansion have led to increasing demand for skilled geoscientists, then academic-industry partnerships must also become effective in raising young career geoscientists. The partnership not only bridges the gap between theoretical knowledge and practical application but also equips young career geoscientists with the skills necessary to thrive in a competitive field of geoscience. This study explores in detail, the current and prevailing challenges facing earlier career geoscientists in their capacity building, and provides some insights on ‘way-outs’ towards the challenges in which they face.

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