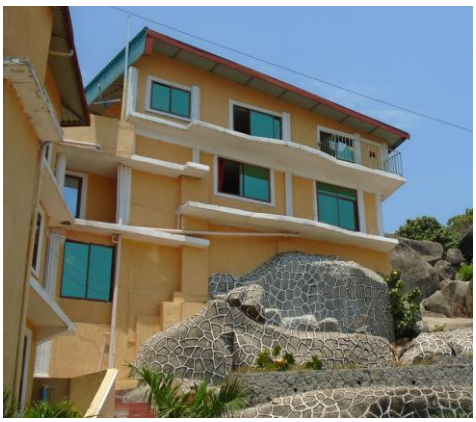
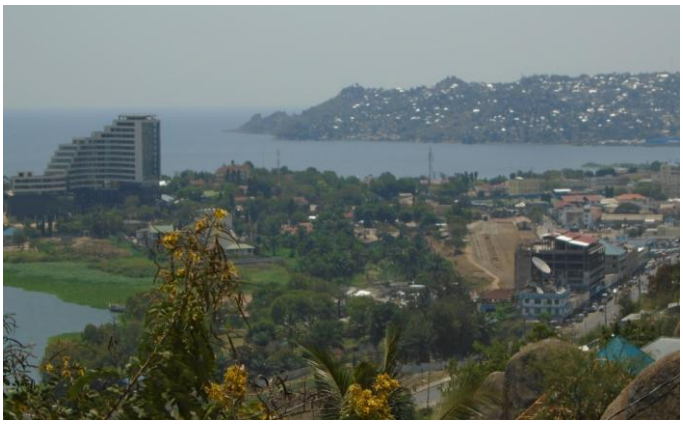
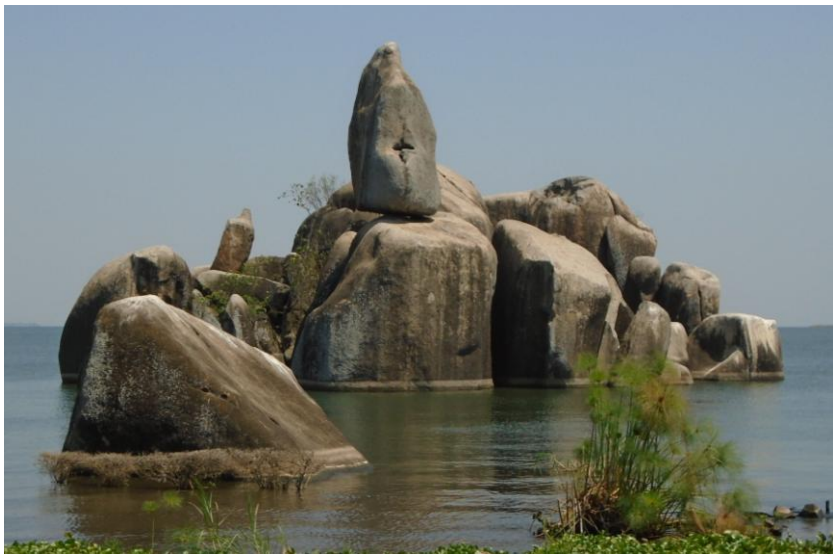
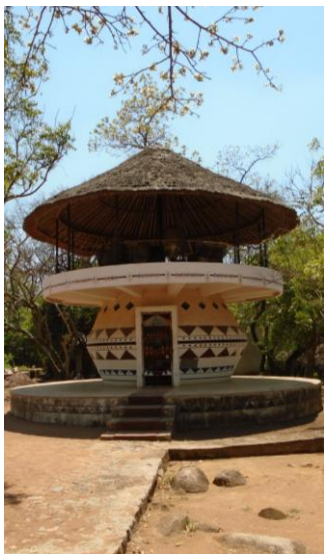
TANZANIA GEOLOGICAL SOCIETY (TGS)

2020 ANNUAL MEETING AND WORKSHOP

BOOK OF ABSTRACTS

MWANZA

25th – 29th November 2020

Front cover photos:

Top Left: *House built on granite, a common building style in Mwanza;* ***Top Right:*** *A view of Mwanza City Centre;* ***Bottom left:*** *Bismarck rock in Mwanza, a symbol of Mwanza City; and* ***Bottom right:*** *House designed in a shape of a Sukuma Chief's stool at Bujora Sukuma Centre.*

Message to Participants of the TGS 2020 Workshop

Dear participants,

On behalf of the TGS Executive Committee, it is my heartfelt pleasure to invite all geoscientists, engineers, academicians, young researchers, business delegates, and talented students from all geosciences perspectives to this year's TGS workshop. We have all travelled a great distance and the TGS is particularly happy to be your host in the cool gentle wind of this beautiful and geologically ancient city, '**Welcome to the Rock City**'.

This year's workshop aims to bring together a multidisciplinary group of brilliant geo-scientists working in different sectors to interact and share insight into the latest research, major milestones, technological advancements and new policies related to the mineral and energy industry in our country. The event features a series of 54 high-quality oral and poster presentations. The TGS is also excited for all companies that are exhibiting their projects and company activities within this workshop. A special platform of renowned and experienced scientists from the government and private institutions will discuss three important aspects; **Tanzanian Mineral and Gem Houses**, **Development in Oil & Gas and Energy Sectors in Tanzania**, and **Stakeholders' involvement in artisanal and small scale mining**.

Particularly, we can all agree that our mineral and petroleum industries today have advanced and become innovative and competitive. However, observation to geoscientific ethical codes has failed to keep pace with the advancement of geoscientific and related careers in Tanzania. This leads to a reflection **on Leadership, Professionalism and Ethics as Essentials of Mineral and Energy Sector Development** for this years' workshop. The TGS welcomes a vigorous open dialogue on professionalism and ethical related issues within the Tanzanian mineral and energy industries.

During the workshop the TGS will be honouring Mr. Faustus Rutahindurwa for his exceptional dedication to the tanzanite sector. His 28 years of service in the sector is highly appreciated, especially for the countless Tanzanian

geoscientists he has trained and his contribution to the understanding of mineralization in Mirerani. Hand in hand with that, the TGS is acknowledging Mr. Saniniu Laizer as a small scale miner who has trusted his operations in the hands of Tanzanian geologists.

Moreover, in this years' workshop, we are giving back to society. The TGS is launching a Small Scale Mining Development Project, a special and well-designed small scale mining training conducted in cooperation with GGM, NEMC, and UDSM. Miners will be equipped on how to use free available geological data to maximize output in their day to day operations.

The Tanzania Geological Society is grateful to all TGS members and all those who volunteered in one way or another to make this workshop a success. Special thanks to our sponsors and partners for their generosity and enthusiastic support; thanks to Geita Gold Mine (GGM), Ministry of Energy of Tanzania, Twiga Minerals Corporation Limited, PanAfrican Energy, Tanzania Petroleum Development Corporation (TPDC), Petroleum Upstream Regulatory Authority (PURA), University of Dar es Salaam (UDSM), Geological Survey of Tanzania (GST), Tanzania National Electricity Supply Company (TANESCO). Tanzania Geological Society (TGS) is hugely indebted for their continued support.

We are confident that you will enjoy the meeting, which is also coupled with a geological excursion and an interesting cultural tour of the Sukuma society. I believe that the career network and the knowledge that will be shared during this conference will be useful for our career development and the sustainable advancement of the mineral and energy sector in future Tanzania.

Workshop Organizing Committee

Tanzania Geological Society (TGS)

Organising Committee

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Workshop secretariat	Prof Abdulkarim Mruma Dr. Joas Kabete Dr. Elisante Mshiu Mr. Chone Lugangizya Ms. Mary Moshi Dr. Emmanuel Kazimoto
Editorial committee	Dr. Emmanuel Kazimoto Dr. Emily Kiswaka Mr. Mugwe Thomas
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Treasurer	Ms. Mary Moshi Ms. Clarah Kimani
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Dr. Elisante Mshiu

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Mr. Chone Lugangizya

Mr. Mary Moshi

Mr. Exaurd Humbo

Our Gold Sponsor

Geita Gold Mine | Anglogold Ashanti

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

Geita Gold Mine, one of the AngloGold Ashanti's flagship mines, is located in north-western Tanzania, in the Lake Victoria goldfields of Mwanza region, about 120 km from Mwanza and 4 km west of the town of Geita. It has been in operation as a large-scale mine since the 1930s. The Geita gold deposit is mined as a multiple open-pit and underground operation since 2016 and will continue to operate as such until the entire economic open-pit Mineral Resource is exhausted. The mine is currently serviced by a carbon-in-leach processing plant with an annual capacity of 5.1Mt.

As at 31 December 2018, the Mineral Resource is 6.26 million ounces. Approximately 4,130m of development was completed for the Star & Comet and Nyankanga underground sections, to access new areas for stope mining and for further exploration, in 2018. Open-pit mining at Nyankanga and Geita Hill continued with Geita Hill reaching the end of its economic life and Nyankanga scheduled to be completed in the first half of 2019. Surface exploration continued at Selous, a satellite pit 2.4km from Star & Comet, expected to supplement the underground operation in the near term.

Other notable projects at Geita were completion of the 40MW power plant and the purchase of underground mining plant and equipment. The power plant was commissioned in August and is currently in full operation, providing reliable, low-cost power to the mining operations. The purchase of the underground mining plant and equipment is in line with the strategy to transition to owner mining at Star & Comet, planned for the first half of 2019, with the full change over for the rest of the mine's sections expected to follow in coming years.

Our Gold Sponsor

Tanzania Petroleum Development Corporation | TPDC

info@tpdc.co.tz

Tanzania Petroleum Development Corporation (TPDC) is a wholly state owned Corporation established on 30th May 1969 through the Government Notice No.140 under the Public Corporations Act No.17 of 1969 and became operational in the year 1973. TPDC is a wholly owned Government parastatal, with all its shares held by the Treasurer Registrar. The Petroleum Act, 2015 designated TPDC to be the National Oil Company of Tanzania, in that respect, to undertake Tanzania's commercial aspects of petroleum in the upstream, midstream, and downstream operations and participating interests of the government in the petroleum and natural gas agreements.

To date, TPDC has overseen a massive discovery of natural gas of about 57.54 TCF (Trillion Cubic Feet) in the country. The huge reserves of natural gas has solved the problem of power supply in the country whereby 80% of the natural gas discovered in the country is used for power generation that contributes about 57% (894 Megawatt) to the national grid. This has stimulated the growth of industries by ensuring a constant power supply. On the other hand, natural gas on itself has been used directly by industries as a source of power whereby more than 48 industries are connected to the natural gas network. Furthermore, more than 385 households and 400 cars in the country are using natural gas. This development is regarded as the game changer in promoting the economic growth of the country.

Currently oil exploration is underway at Eyasi-Wembere Block, Lake Tanganyika North Block, West Songosongo, Block 4/1B and Mnazi Bay

North Block. More than 50% of the country is considered to have potential for hydrocarbons exploration which is suitable for investing. Other notable projects of TPDC include the Liquefied Natural Gas (LNG), The East African Crude Oil Pipeline (EACOP), National Natural Gas Infrastructure Pipeline (NNGIP), natural gas processing plants, piped and compressed natural gas distribution projects in Lindi, Mtwara, Dar es Salaam and Coast regions.

These projects have contributed to direct and indirect employment opportunities to Tanzanians including local suppliers of goods and services to the industry. Also, these projects have improved the socio-economic welfare of the people through Corporate Social Responsibility (CSR) undertaken in areas of health, education, water, sports and good governance.

A CALL TO INVESTORS: Come with a positive attitude and a win-win focus. Tanzania is a blessed land with huge discoveries that can transform economies and the social welfare of our people.

Our Gold Sponsor

Twiga Minerals Corporation

Twiga Minerals Corp is a joint venture between Barrick Gold Corporation and the Government of Tanzania. The company is owned for 84% by Barrick Gold Corporation and 16% by the Government of Tanzania, and is based on 50/50 sharing of the economic benefits generated by the mining operations after the recoupment of capital investments. The company was created to oversee the management of Barrick's mining operations in Tanzania. Recently, Twiga Minerals Corporation paid a maiden interim cash dividend of $250m and demonstrating the value-creating capacity of a true partnership between a mining company and the host nation.

Our Silver Sponsor

School of Mines and Geosciences | University of Dar es Salaam

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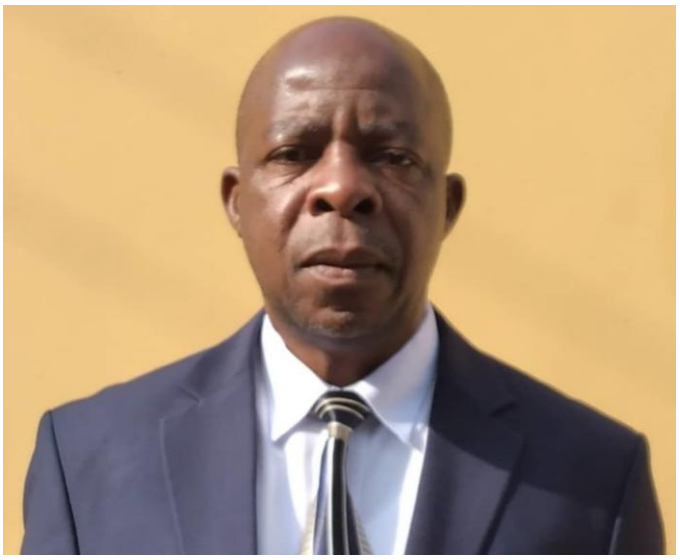
The newly started School of Mines and Geosciences (SoMG) of the University of Dar es Salaam comprises three departments, namely: Department of Geosciences, Department of Mining and Mineral Processing Engineering, and Department of Petroleum Science and Engineering. Among the major reasons for establishment of SoMG include the need to expand and consolidate departments producing Earth science and engineering professionals, following the pressing importance of Earth resources contribution to the national development; and to centralize research, consultancy and innovation in mining, petroleum, and geosciences so as to improve efficiency in Earth resources value-chain. The Vision of SoMG is to become the leading regional institution in producing professionals, research and public services in geosciences and Earth resources engineering. Whereas, the mission is to deliberate pursuit of innovative, scholarly and strategic research, training and public service focused on geosciences and earth resources engineering for sustainable socio-economic development of Tanzania and Africa at large. At its full functioning, SoMG will increase from 10 to 19 degree programs; thus, increasing annual enrolment to 440 and make a total number of students to gradually increase from 1130 to 1415. The long-term plan for SoMG is to become a Centre of Excellency in Geosciences and Earth resource engineering.

Recognition of the Outstanding Tanzanian Geoscientist



Mr. Faustus Felician Rutahindurwa

A token of appreciation is extended to Mr. Faustus Felician Rutahindurwa for his dedication to exploration and mining of Tanzanite (gem variety of zoisite) in Mirerani, Tanzania. He is man behind a number of successes in exploration and mining of Tanzanite. He has made an impact to the Tanzanite industry that will live for generations to come.

Recognition of an individual who promoted Geoscientists/geoscience in Tanzania

Mr. Saniniu Laizer

A token of appreciation is extended to Mr. Saniniu Laizer for seeking and utilizing geoscientific experts' opinion, and afterwards recognizing their role on his success in Tanzanite mining business. Mr. Laizer has set a very good example to other artisanal miners or other stakeholders of mineral industry in the country.

Editorial Team

Dr. Emmanuel O. Kazimoto
Department of Geology, University of Dar es Salaam.

Dr. Emily B. Kiswaka
Department of Geology, University of Dar es Salaam.

Mugwe T. Mugwe
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TGS 2020 Workshop Abstract Titles

Contents and Abstract titles **page**

Workshop Programme

DAY 1 (25-11-2020)

REGISTRATION & PRE-CONFERENCE EXCURSION

07:30 - 08:45	Arrival and Registration at the Bank of Tanzania Training Institute, Kapri Point Mwanza		
08:45 - 09:00	Meeting All before starting Excursion		
STOP/DURATION	**WHAT TO SEE**	**WHAT TO DO**	**RESPONSIBLE**
Stop 1 Bugando, Ujaluoni (09:00 – 09:15)	Granite outcrop View of the city (city centre, Butimba, Capri-point, Saanane Island, Nyamagana)	Brief discussion on Mwanza granite and its origin	All
Stop 2 Butimba, Kanisani (09:30 – 09:45)	Granite outcrop View of the city View of the Lake Victoria	Brief discussion on the origin of lake and any other issue related to the lake	All
Stop 3 Saanane island (National Park) (10:15 – 12:30)	Wild animals Beautiful scenery Granites	Tour and sightseeing	All
Stop 5 Igoma (13:00 – 14:00)	View of the Igoma Township, Building style on hills, & Granite, coarse grained, porphyritic in places	Have lunch together at the hill top (on a large Kopje)	All
Stop 4 Bujora Sukuma Centre (14:15 – 16:15)	Sukuma traditional items Sukuma tradition houses Python dance/play Sukuma dance	Tour and sightseeing	All

DAY 2 (26-11-2020) OPENING

07:30 - 08:30	Arrival and Registration	
08:30 - 08:40	Secretary, TGS: Welcoming remarks	
08:40 - 09:00	Greetings from the Gold sponsors	
09:00 - 09:45	Chairman, TGS: Speech, and to welcome Guest of Honour	
09:45 - 10:45	Guest of Honour	
10:45 - 10:55	Recognizing former TGS leaders or outstanding Tanzanian geoscientist	
10:55 - 11:05	Photo session	
11:05 - 11:25	HEALTH BREAK	
PANEL DISCUSSION: Tanzania Minerals and Gem Houses		
11:25 - 13:25 Convenor: **Dr. E. Mshiu**	Prof. Shukrani Manya	Executive Secretary, MINING COMMISSION
	Mr. Simon Shayo	Vice President, GEITA GOLD MINE
	Mr. Lister Balegele	Secretary General, FEMATA
	Representative	TAMIDA
13:25 - 14:25	LUNCH BREAK	
PANEL DISCUSSION: Development in Oil and Gas Sector in Tanzania		
14:25 - 15:55 Convenor: **Dr. C. Kasanzu**	Dr. James Mataragio	Managing Director , TPDC
	Eng. Charles Sangweni	Director General , PURA
	Director of Natural Gas	EWURA
	Ms. Martha Kamuzora	EQUINOR
	Adamu I. Zuberi	Commissioner, Ministry of Energy
15:55 - 16:10	HEALTH BREAK	
16:10 - 16:25	Gerald L. Chuwa	Mineral exploration challenges, risks and lessons: a perspective from the Central Africa Region.
16:25 - 16:40	Shimba Daniel Kwelwa	Updates on the geology and mineral prospectivity of the Nyamulilima Domain in the Geita Greenstone Belt, NW Tanzania.
16:40 - 16:55	Eric Bruno Kalondwa	Geologists` development program at Geita Gold Mine.
16:55 - 17.10	Rosemary Olive Mbone Enie	Geotourism and mineral sector development: Africa's prospect for sustainable rural development and poverty alleviation.
17:10 - 17:25	Ezekiel Julius Seni	Uchimbaji endelevu katika sekta ya uchimbaji mdogo Tanzania: changamoto na utatuzi.
17:25 - 17:40	Emily Barnabas Kiswaka	Remote sensing aided identification of salt deposition and remobilization in the Mandawa Basin: confirmation from 2D seismic interpretation.
17:40 - 18:00	Summary and End of discussion	
18:00 - onwards	**Cocktail Party** Venue: The Cask Bar & Grill	

DAY 3 (27-11-2020)

Time	Presenter	Title
08:00 - 08:30	Fixing Posters	
08:30 - 08:45	Charles H. Kasanzu	Isotopic and geochemical constraints on the protolith, redox state and paleo-tectonic setting of the Malagarasi Supergroup of North-Western Tanzania.
08:45 - 09:00	Gerald L. Chuwa	Geochemistry of mafic intrusive rocks from the Twangiza-Namoya Gold Belt, Eastern Democratic Republic of Congo: insights on petrogenesis and tectonic settings.
09:00 - 09.15	Emmanuel O. Kazimoto	Short Wavelength Infrared spectral characterization of the mineralogy of Gokona and Nyabigena andesite-hosted gold deposits in North Mara, Tanzania
09:15 - 09:30	Elisante E. Mshiu	Application of remote sensing in exploration for earth resources: a case study from gold prospecting in Tanzania
09:30 - 09:45	Almachius Mutasingwa	Mineralogy, geochemistry and depositional settings of the Middle Buanji Group Copper-hosted shales in Kimani area, Southern Tanzania.
09:45 - 10:00	Joas Kabete	Frontier exploration initiatives in the Archean Lusahunga Inlier, NW Tanzania: potential mid-tier gold discoveries
10:00 - 10:25	HEALTH BREAK & POSTER SESSION	
10:25 - 11:40	Stephen P. Magohe	Palynostratigraphy of the Jurassic Strata in the Onshore Ruvu Basin, Tanzania.
11:40 - 11:55	Edward P. Misana	Subsurface structures of the Usangu Basin based on gravity and aeromagnetic data
11:55 - 12:10	Ibrahim Wilson Mwakasole	Geochemical characterization of the Wingayongo Cretaceous Bituminous Sands.
12:10 - 12:25	Ibrahim Francisco Rutta	Resolution sequence stratigraphic analysis of Miocene to Pliocene Deltaic Systems of Tanga Basin.
12:25 - 12:40	Josephat Shigela	Overview of hydrocarbon exploration and production activities in Tanzania.
12:40 - 12:55	Venance Emmanuel Mboya	Tectonic evolution of seagap fault zone: it's implication to sediment distribution in offshore Tanzania.
12:55 - 13:55	LUNCH BREAK & POSTER SESSION	
PANEL DISCUSSION: Stakeholder's involvement in the artisanal and small scale mining		
13:55 - 15:20 Convenor: **Dr. E. Mshiu**	Dr. Musa. D. Budeba	Chief Executive Officer , GST
	Dr. A. Mwanga	Director, Mines Inspectorate & Environment Dept., Mining Commission
	Mr. Francis H. Mihayo	Assistant Commissioner , Ministry of Minerals
	Representative	NEMC
	Dr. Venance Mwase	STAMICO
PANEL DISCUSSION: Development in Energy Sector of Tanzania		
15:20 - 16:50 Convenor: **Dr. C. Kasanzu**	Eng. Kato T. Kabaka	General Manager , TGDC
	Dr. Tito Mwinuka	Managing Director , TANESCO
	Edward L Ishengoma	Commissioner, Ministry of Energy
	Director of Natural Gas	EWURA
	General Manager	ETDCO
16:50 - 17:10	HEALTH BREAK & POSTER SESSION	

17:10 - 17:25	Remigius Gama	Magnetic signatures and topographical expression of the polymetallic Mpanda Mineral Field, SW Tanzania.
17:25 - 17:40	Barnaba John Shio	Geological controls of gold mineralization in Roberts (Nyamulilima Cut 1), Geita Greenstone Belt, NW Tanzania.
17:40 - 17:55	Epiphania G. Mtabazi	3D structural-geological modeling of the East African Rift Basins in the South-western part of Tanzania.
17:55 - 18:10	Desmond Risso	Impact of architectural elements of linear aeolian dune in reservoir performance.
18:10 - 18:25	Hidaya Hassana	The characteristics of Cu-Ni-PGE mineralization in Mbesa Prospects, Southern Tanzania.
18:25 - 18:40	John D. Kalimenze	Role of minerals in petroleum generation, a laboratory perspective.
18:40 - 18:55	J. S. Sarota	Artisanal and small-scale gold mining in Tanzania: how can it contribute to mineral sector development?
18:55 - 19:00	**End of oral session and day 3**	

DAY 4 (28-11-2020)

Time	Presenter	Title
08:30 - 08:45	Tumbu L. Boniface	Multidimensional resistivity imaging using magnetotelluric data and its geological interpretation in Kiejo-Mbaka Geothermal Field, South-West Tanzania.
08:45 - 09:00	Karim Mtili	Discovery of new helium gas seeps and processes involved in the formation of the helium gas field within the Rukwa Rift Basin Tanzania.
09:00 - 09.15	Sadock Josephat	Assessment of recharge mechanism for the Meru Geothermal System, Northern Tanzania.
09:15 - 09:30	Clarah N. Kimani	Geochemical analysis of the noble gases in the Rungwe Volcanic Province, Tanzania: implication on volatiles sources and dynamics.
09:30 - 09:45	Mwita S. Maswi	Geological control on brine discharge in Itumbula Salt Dam, Momba District, Rukwa Rift, Tanzania
09:45 - 10:00	Adonias Mkangala	The essence of surface geology and shallow temperature gradient wells for geothermal system characterization in Kiejo-Mbaka Prospect, SE Tanzania.
10:00 - 10:25	HEALTH BREAK & POSTER SESSION	
10:25 - 10:40	Martha Nnko	Mechanical characterization and potential evaluation of the geothermal system in Songwe Field, Mbeya, Tanzania
10:40 - 11:55	Notka. H. Banteze	Geology, petrology and geochemistry of the coal resources at Mnywamaji area southern part of Ngaka Coal Field In Tanzania, East Africa.
11:55 - 11:10	Charles D. Moye	Mineralogical and geochemical characteristics of graphite mineralization, Chenjere area, South-Eastern Tanzania
11:10 - 11.25	Sindi Maduhu	Structural interpretation for hydrocarbon prospectivity of the Eyasi-Wembere Block
11:25 - 11:40	Rongino E. Festo	Determination of the nature of gold occurrence in host rocks to the New Luika Gold Mine: implications for maximum ore recovery
11:40 – 11:55	Winfrida Mtega	Demographic, labour productivity and challenges of mineral wealth to artisanal mining in Lake Victoria Mining Region, Northern Tanzania
11:55 - 12:00	**Closing TGS 2020 Oral Presentation session**	
12:00 - 13:00	LUNCH BREAK	
13:00 - 17:30	**TGS ANNUAL MEETING (TGS MEMBERS ONLY)**	
18:00 - onwards	**WORKSHOP DINNER** Venue: to be confirmed	

Poster Presentations

Presenter	Poster title
Onesphorius Balambirwa	Geochemical study of limestone, clay and laterite materials for the cement manufacturing at Kasulu District, Tanzania.
Mariamu J. Kiaze	Petrophysical analysis of the potential reservoir rocks intersected by Papa-1 Well of exploration Block 3, Offshore Tanzania.
Neema Maganza	Petroleum system modelling; an exploration tool for understanding source rock and charging potential of the area: a case study for Mnazi Bay North Block.
Loveness Njogela	Indirect detection of hydrocarbon microseepages by integrating remote sensing, gravity-gradiometry and geological data in the Eyasi Wembere Block.
Sindi Maduhu	Structural interpretation and hydrocarbon prospectivity of the Eyasi-Wembere Block.
Melania D. Maqway	Geochemical evaluation of Middle Karoo Tanga Beds for hydrocarbon potentiality.
Victoria Godfrey	TPDC laboratory services.
Adam Sajilo	Foraminifera and palynomorphs assemblages of the Late Campanian To Early Maastrichtian of the Southern Coastal Basins of Tanzania: It's implication to petroleum exploration.
Godfrey Modest Mwendenusu	Integrated studies intrigue to mineral prospectivity: applicability to Kikombo, Dodoma, Tanzania.
Mary Moshi	Mineralogy and lead isotopes composition of polymetallic vein deposits of the Mpanda Mineral Field in Katavi Tanzania.
Cornel Kanje	Application of blast movement monitoring explorer technique in ore loss & dilution control: a case study of Geita Gold Mine, NW Tanzania.
Benedicto Sagikwa	Mineral resource modelling "critical process steps": a case study of Geita Gold Mine, NW Tanzania.
Mgema J. Yedidia	Deeping digital marketing skills to influence mineral sector development.
Tryphone Dastan Ndubusa	Evolution and assessment of hydrocarbon prospectivity of the offshore part of East Pande Block, Southern Coastal Basin of Tanzania using 2D seismic reflection data.
Joyna Kabohola	Sedimentology and diagenesis of the Middle Jurassic Msata Succession, Ruvu Basin, Tanzania
Nice Nestory	Characterization of Coal Seams at the Mchuchuma Sub-basin, Tanzania

ISOTOPIC AND GEOCHEMICAL CONSTRAINTS ON THE PROTOLITH, REDOX STATE AND PALEO-TECTONIC SETTING OF THE MALAGARASI SUPERGROUP OF NORTH-WESTERN TANZANIA

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We report detrital zircon U-Pb ages, radiogenic Sm-Nd isotopic compositions, major and trace element compositions of the Neoproterozoic Malagarasi Supergroup of north-western Tanzania in order to elucidate the paleo-tectonic setting, source rocks chemistry and paleo-oxygenation in the basin. Assuming the provenance proxy ratios Sc/Th, Co/Th, La/Sc and Cr/Th in the detrital fractions of sediments behave as closed systems, we suggest that the detritus originated from more felsic rocks than those for upper crustal composites, Post-Archean Australian Shale (PAAS) and Proterozoic Shale (PS). This observation is also supported by enriched chondrite-normalized light rare earth elements (La/Sm_{CN} = 2.36-7.84; mean = 3.85), overall negative Eu anomalies (Eu/Eu^{*} = 0.56-0.93; mean = 0.69) and flat heavy rare earth elements patterns (Gd/Yb_{CN} = 1.01-2.04; mean = 1.47). Paleo-weathering proxies using the Chemical Index of Alteration (CIA ~59-78%) protocol indicate an overall moderate weathering intensity in the basin. The influence of post-depositional addition of Potassium to the detritus, metasomatism, is constrained using the Chemical Indices of Weathering (CIW) and the Plagioclase Indices of Alteration (PIA). Cr/V ratios (mean = 0.85; range = 0.43-2.06) coupled with intra-sample Ce anomalies reveal an overall oxidizing state during deposition. Mantle extraction ages (TDM = 1787-2394 Ma) suggest a diverse mixing of protolith terranes including Archean (Tanzania Craton), Eburnian (Ubendian Belt) and possibly the nearby Mesoproterozoic Kibaran Belt. However, radiogenic laser ablation detrital zircon U-Pb ages of between 1633 to 2382 Ma may preclude contribution of the Kibaran terrane as sediment sources. Given that Nd systematic in sedimentary rocks provides mixing ages of different hinterland source rocks, we suggest relatively juvenile sources such

as the local post-orogenic effusive bodies and the Irumide Belt south of the basin in the realm of Rodinia Supercontinent. This could indicate a northerly paleo-drainage flow direction of the paleo-river system.

GEOTOURISM AND MINERAL SECTOR DEVELOPMENT: AFRICA'S PROSPECT FOR SUSTAINABLE RURAL DEVELOPMENT AND POVERTY ALLEVIATION

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Geotourism is a relatively new type of tourism in Africa with significant growth potential. Initially defined in Europe, USA and Australia, it is an international developing academic, economic and sustainable rural development investigation field. The term geotourism has been in use since the early 1990s, although its precursor activities can be traced back to the 17th century. Benefiting from its significant social, historical and industrial archaeological underpinnings, the concept is still undergoing redefinition and refinement. This work explores current prospects on geotourism and mineral sector development in relation to Sustainable Development Goals (SDGs) and the Africa Agenda 2063. Furthermore, it explores current opportunities on the direct and indirect sustainable development impacts from geotourism and mineral sector development, and their implications on social, environmental and economic development across rural communities in Africa. The presentation will examine these concepts, present essential credentials for poverty alleviation and the achievement of the SDGs and Africa Agenda 2063 on the continent.

UCHIMBAJI ENDELEVU KATIKA SEKTA YA UCHIMBAJI MDOGO TANZANIA: CHANGAMOTO NA UTATUZI

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Kwa kipindi kifupi Tanzania imeshuhudia ongezeko kubwa la shughuli za uchimbaji mdogo ambao umeongeza mchango katika makusanyo ya sekta ya Madini Tanzania. Ili kuweza kuongeza mapato kwenye sekta ya madini kutoka katika sekta ya uchimbaji mdogo; ni lazima kuwa na uchimbaji endelevu ambao utakuwa na mifumo ya urasimishaji, matumizi ya taarifa za kijiolojia na wataalam, upatikanaji wa mitaji na usimamizi thabiti wa mazingira. Uchambuzi huu umetumia taarifa na takwimu za uchimbaji mdogo Tanzania na umejitika zaidi katika kuangalia changamoto zilizopo na kutoa mapendekezo ya suluhisho za changamoto hizo. Changamoto zilizobainika ni pamoja na matumizi hafifu ya taarifa za awali zinazopatikana katika Taasisi ya Jiolojia Nchini (GST); ushirikiano mdogo kati ya wachimbaji wadogo na kampuni za utafiti na uchimbaji; ushiriki mdogo wa wataalam wa fani ya uhandisi, uchenjuaji na wakemia; uharibifu wa mazingira unaosababishwa na udhibiti hasi wa shughuli za uchenjuaji (Vat leaching na Elution). Aidha, kwa upande wa utatuzi baadhi ya mambo yanayopendekezwa ni pamoja GST kuongeza kasi ya uelimishaji wa matumizi ya taarifa za awali za utafiti; taasisi zinazotoa elimu ya jiolojia, uhandisi, uchenjuaji na mazingira kutumia wanafunzi na wataalam kufanya tafiti za awali na kusaidia wachimbaji wadogo katika kuboresha shughuli zao; kuongeza kasi ya urasimashaji na uhakika wa madini kwa kwa ajili ya mitaji; na kuimarisha uthibiti wa shughuli za uchenjuaji kupitia leseni za Vat leaching na Elution. Uchambuzi huu unalenga kuwashirikisha wanajiosayansi kutoka katika taasisi za elimu, makampuni, mashirika, taasisi za kifedha na wadau mbalimbali wa maendeleo kushiriki katika fursa za kufanya tafiti na kutoa mitaji njia ambazo zitasaidia kuwa na uchimbaji mdogo ulio endelevu katika nchi ya Tanzania.

SHORT WAVELENGTH INFRARED SPECTRAL CHARACTERIZATION OF THE MINERALOGY OF GOKONA AND NYABIGENA ANDESITE-HOSTED GOLD DEPOSITS IN NORTH MARA, TANZANIA

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The mineralogy of Gokona and Nyabigena gold deposits in Tanzania have been studied using Short Wavelength Infrared (SWIR) Spectrometry technique. The aim was to fingerprint hydrothermal system responsible for the formation of the deposits and establish pertinent mineralogical signatures for gold deposition. Gokona and Nyabigena deposits are hosted in porphyritic andesite to basaltic andesite that contains plagioclase phenocrysts, pyroxene, hornblende and Fe-Ti oxides as primary minerals. Other minerals are actinolite, chlorite, epidote, albite and hematite, which indicate metamorphism of the rock under greenschist facies conditions.

Hydrothermal alteration of the rock produced chlorite, sericite, carbonates (ankerite, siderite and calcite), pyrite and quartz, which is consistent with formation of the minerals in mid-crustal levels (< 5 km). Depth of absorption features of SWIR spectra for chlorite and sericite from borehole samples revealed intense formation of the minerals in the deposits. Sericite is proximal to ore zones, less crystalline and mainly muscovitic to phengitic in composition, whereas chlorite occurs distal to the ore zones, and is mainly intermediate (Fe-Mg) to Fe-rich in composition. These phyllosilicates indicate both pH and temperature control during hydrothermal alteration and provide signatures that can be targeted in exploration to extend mine lifespan.

REMOTE SENSING AIDED IDENTIFICATION OF SALT DEPOSITION AND REMOBILIZATION IN THE MANDAWA BASIN: SUPPORTED BY 2D SEISMIC INTERPRETATION

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This work report remote sensing aided identification of salt deposition and salt remobilization within a more or less circular body with approximately equant dimensions in the Mandawa Basin. The circular body has been revealed by a calculated surface flow direction from Shuttle Radar Topography Mission - Digital Elevation Model (SRTM DEM) data. Internally, the body contains several structural highs and lows that are clearly reflected by multiple peaks and troughs displayed by profiles drawn across the body. These structural highs and lows were confirmed by seismic interpretation results, of which they conform to salt build-ups (salt pillows and domes) and sedimentary minibasins respectively. Seismic work, which was a follow-up investigation of the remote sensing findings, involved qualitative interpretation of 24 seismic profiles, 7 of which were chosen to represent the findings. Lika East 1 well tie was used to assign age of the studied interval, but also to confirm that features of interest are associated with salt accumulation and remobilization. Moreover, the Lika East 1 well tie corroborated that salt deposition and the associated build-ups are within the Nondwa Formation of the Pindiro Group. Remote sensing observation, coupled with seismic interpretation, has revealed that the Mandawa salt Basin was more extensive than it has been reported by previous researchers.

Oil seeps, which are potential indicators of a working petroleum system, have been reported in the Mandawa Basin. One of these seeps is associated with the demarcated circular body, adjacent to one of the mapped salt domes. This observation probably indicates influence of salt tectonics in the Mandawa petroleum system. Further work on better quality seismic images may help resolve the problem of hydrocarbon whereabouts in the study area.

GEOLOGICAL CONTROL ON BRINE DISCHARGE IN ITUMBULA SALT DAM, MOMBA DISTRICT, RUKWA RIFT, TANZANIA

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The Itumbula salt dam is situated in a depression formed by a process of removal of saline crystals deposited by springs within the Rukwa Rift Basin. Salt production that is linked with brine yield by springs required further geological investigations to understand factors controlling brine yield. A number of techniques were applied for different purposes. The techniques include detailed field geological mapping of the salt dam and its surroundings, laboratory analysis for the water samples to characterize spring water in the dam, and magnetic and electric surveys for studies of geologic structures.

The magnetic profile reveals a very low magnetic anomaly across the salt dam trending NW to SE, which is interpreted to be the main structure that controls fluid movement in the basin. Electrical resistivity survey delineated a low resistivity body in the central part of the dam, which is interpreted as porous formation with saline water. Geochemistry of the brine indicates high levels of sodium and chloride ions content. Based on field observations, the most likely sustainable recharge system is envisaged to be the nearby Lake Rukwa. The continuous discharge nature of the hot springs, along with structural controlled nature of the springs suggests that Itumbula salt dam is economically feasible for salt extraction. Future work should be directed towards exploration drilling stage to confirm on the identified permeable zones and measure spring flow rates.

GEOCHEMISTRY OF MAFIC INTRUSIVE ROCKS FROM THE TWANGIZA-NAMOYA GOLD BELT, EASTERN DEMOCRATIC REPUBLIC OF CONGO: INSIGHTS ON PETROGENESIS AND TECTONIC SETTINGS

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Two geochemically distinct mafic intrusive rocks are highlighted from a suite of mafic intrusive samples collected from the Twangiza-Namoya Gold Belt (TNGB) in the eastern part of the Democratic Republic of Congo. The first group comprises gabbro, diorite and quartz diorites. The second group that is characterized of gabbro, meta-dolerite and quartz-feldspathic porphyries is variably affected by hydrothermal alterations. The former suite hosts the Namoya deposit, Lugushwa and Kamituga prospects. This suite is characterised by Mg # = 23 – 47, SiO_2 contents of between 50 wt. % and 65 wt. %, and trace element ratios Ce/Pb = 3.5 – 6.4, La/Nb = 2.4 – 3.3 and Zr/Hf = 35-40. They have Th/Ta vs Yb and Th/Yb vs Ta/Yb typical of an active continental margin. In the primitive mantle normalized spidergram, they show elevated Cs and Rb contents, enrichments in K, Pb and depletions in Nb-Ta and Ti. Chondrite normalized REE spidergrams have a near-flat pattern with modest negative Eu/Eu* anomalies.

The second suite is characterised by trace element ratios; La/Nb = 0.83 – 3.78, Zr/Hf = 40 – 45, Nb/Ta = 13-16, Th/Ta vs Yb and Th/Yb vs Ta/Yb ratios typical of within plate basalts. In primitive mantle normalized spidergram, they display enrichment in immobile Nb, Ta contents and flat Ti. Chondrite normalized REE spidergram have elevated LREE contents over middle and HREE pattern and negative Eu/Eu* anomaly = 0.19 - 0.23. These trace elements ratios and characteristics suggest a mantle enriched source with crustal input in active continental margin settings for the first group of mafic intrusives. A depleted heterogeneous mantle source, emplaced in a predominantly extensional tectonic environment is suggested for the second group. These magmatic events are broadly correlated with the onset of supercontinent Rodinia assembly during the Mesoproterozoic and its fragmentation in the Neoproterozoic.

FRONTIER EXPLORATION INITIATIVES IN THE ARCHEAN LUSAHUNGA INLIER, NW TANZANIA: POTENTIAL MID-TIER GOLD DISCOVERIES

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The Archean Lusahunga Inlier, situated some ~150 km west of Geita Gold Mine in north-western Tanzania, sits within the NE-SW-trending Nyakahura-Burigi Terrane, accessible via Dar-es-Salaam, and/or Mwanza, Tanzania. The terrane forms part of the over 250 km long NE-SW-trending Archean inliers of granites and deeply weathered greenstones, which crops out intermittently from the southern part of Lake Burigi to northern tip of Lake Tanganyika. According to Kabete (2008) and Kabete et al. (2012), Archean inliers in the Eastern Tectonic Domain were once sutured to the gold-endowed Lake Nyanza Superterrane in the Archean Tanzania Craton. These crustal blocks were dismembered from each other sometimes during Proterozoic orogenic and tectonic events. The exposed part of the Archean Inlier occurs in an unroofed thrust window of the Eastern Kibaran Domain.

Qualitative interpretation results of high-resolution aeromagnetic and radiometric data in terms of available geological maps and previous geophysical data (e.g. GTK survey over Biharamulo) outline at least four contiguous sub-domains that make up the Nyakahura-Burigi Terrane. From west to east, these are: 1) Eastern Kibaran Sub-Domain of pelitic-sedimentary rocks and mafic-ultramafic sills; 2) Archean Inliers Sub-Domain of deeply weathered greenstones and strongly reworked granites, 3) Eastern Kibaran Sub-Domain of shallow basin siliciclastic sedimentary rocks tectonically overlain by graphitic siltstones and phyllite; and 4) Bukoban Domain of platformal sedimentary rocks. The Eastern Kibaran Domain and the Bukoban Domain are characterized by several mafic dykes and sills, implying multiple tectono-magmatic events, which involved the Archean basement rocks.

At least 3 gold prospects, situated along the contact between the Archean Inliers Sub-Domain and Eastern Kibaran Sub-Domain are host to significant gold mineralization hosted by: 1) stockwork quartz vein systems

(Kalukwete); 2) shallow (Mapuli) to steep (Kalukwete) easterly dipping quartz veins in strongly deformed and altered granites (quartz-sericite schist); 3) reactivated tectonic contact between the Archean inliers and Kibaran rocks (Mapuli); and 4) palaeo-placers exposed in the deeply eroded thrust windows of the Kibaran rocks. The Lusahunga Inlier is estimated to have an endowment of over 60 t Au hosted by Archean mafic granites and reactivated tectonic contacts between Archean and Kibaran rocks.

SUBSURFACE STRUCTURES OF THE USANGU BASIN BASED ON GRAVITY AND AEROMAGNETIC DATA

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The Usangu basin is one of the rift basins that developed within the western arm of the East African Rift System (EARS) during the Pliocene-Pleistocene epochs. The basin is located near the Mbeya triple junction, an area which is seismically active and has high heat flow related to geothermal activities. Tectonic activities in this area have also resulted to formation of different basement structures and sedimentation. In the present study, the magnetic and gravity data in conjunction with SRTM data have been used to investigate the structures and the variation of sediment thickness within the basin. Digital Elevation Model (DEM) shows only few lineaments including the Usangu and Chimala boarder faults on the basin flanks. Magnetic and gravity data shows three sets of structures, majority of which trend NW-SE, followed by WNW – ESE and NE – SW. These structures are both normal and strike-slip faults, dykes and shear zones. The major trend of faults is NE-SW. Located Euler deconvolution and gravity models used to calculate the depth to the basement show that the basement is shallow, less than 1.5 km, at the north and deepen southwards through 1.5 km to 4.5 km at the centre. The general thickness of sediments in the basin is 3 – 4.5 km reaching up to 4.5 km on depocentre. Such range of depth is reasonable for the formation of hydrocarbons, which makes the basin to be potential for hydrocarbon exploration.

APPLICATION OF REMOTE SENSING IN EXPLORATION FOR EARTH RESOURCES: A CASE STUDY FROM GOLD PROSPECTING IN TANZANIA

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The Tanzania mining sector is becoming the main economic backbone of the country. This is revealed by the observed increasing trend of the share of the mining sector to the GDP. For example, for the year 2014/2015 the contribution of the mining sector to the GDP was around 3.2% whereby in the year 2019/2020 the percent has increased to 5.1 %. The trend of the revenue collected has increased from TZS 207.92 billion in the year 2015/2016 to TZS 528.24 billion in the year 2019/2020; this is approximately 254% rise of mining sector revenue in just 4 years. Based on this observation, it is projected from this study that the Vision 2025, which aimed to attain 10 % contribution of the GDP from mining sector, will probably be realised earlier than expected. A good example and similar scenario has happened in the change of Tanzania economic status that has reached to middle-income-country at around 5 years earlier.

Despite all these positive impacts by the mining sector, major gold mines the likes of Bulyanhulu, Geita, Resolute's, and Tulawaka, are rapidly becoming depleted; with a very low rate of new discoveries reported. This trend is alarming, of which a call for unequivocally improved exploration techniques is inevitable.

The geology of Tanzania is still promising and prospective for variety of different mineral resources. However, for a long time the Tanzania mineral exploration industry has relied on the conventional geologic techniques for exploration; perhaps this explains the observed low rate of new discoveries. Based on recent improvements in technology, specifically in remote sensing, exploration of mineral resources has positively changed in terms of costs and effectiveness of the process. As a result new mining districts have been discovered in different areas of the world. The examples include the discovered world-class deposits in South America and Australia. It has been reported that the improved technology has simplified the exploration process

and reduced exploration costs. Hyperspectral, multispectral and DEM data are among the data sets and exploration techniques increasingly used in mineral exploration campaigns and have contributed to a large extent in revolutionizing the mineral exploration industry.

In this study application of geological remote sensing technique for exploration of earth resources is presented by show casing its success in exploration of gold deposit in Tanzania. The techniques can be used along with conventional exploration methods for validation of the results obtained.

Ongoing studies on the application of geological remote sensing; particularly applications of multispectral remote sensing data have returned positive results; most of the deposits have been mapped. Results obtained indicate a promising future of the Tanzania mining sector based on the revealed high possibility of discovering new mineral deposits by embracing new technologies such as remote sensing in mineral exploration activities.

PALYNOSTRATIGRAPHY OF THE JURASSIC STRATA IN THE ONSHORE RUVU BASIN, TANZANIA

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Palynologic investigation of the sedimentary strata deposited in response to the Gondwana breakup in the Ruvu Basin of the coastal region Tanzania informs on depositional ages of this, otherwise, poorly stratigraphic constrained basin. Marine palynomorphs preserved within the subsurface intervals (1215 m - 1235 m) of the Makarawe-1 well were recovered and palynologically analyzed. Based on the ranges of dinoflagellate cysts (supplemented by pollen – spore ranges), two main palynologic intervals (*Classopollis–Nannoceratopsis* Interval and *Wanaea clathrata* Interval) are established from consideration of the first-downhole occurrence of significant palynomorph taxa. The documented intervals correspond to late Middle Jurassic to Late Jurassic (Callovian – Kimmeridgian) and suggest a possible correlation with Malivundo and Chalinze formations of the Ruvu Basin of Tanzania while confirming the evidence of the Jurassic strata, overlying the late ?Carboniferous – Permian/early Triassic Karoo Supergroup in the basin. The findings presented herein suggest an extension of the *Wanaea clathrata* Interval (Oxfordian- Kimmeridgian age) from 900 – 945 meters of the Makarawe – 1 well, based on previously works, to 1215 – 1235 meters in this study. Ultimately, the data resulting from this study add important insight on stratigraphic framework and correlation of the poorly constrained stratigraphy of Tanzania coastal basin.

GEOCHEMICAL STUDY OF LIMESTONE, CLAY AND LATERITE MATERIALS FOR THE CEMENT MANUFACTURING AT KASULU, TANZANIA

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Development of most cement industries depends on availability of specific type of raw materials and their chemical composition of which play a significant role in manufacturing high quality cement products. Tanznaia has plenty of raw materials for cement production. However, finding the best raw material requires a dedicated research to investigate which materials meet standards for cement industry. Based on this, the Geological Survey of Tanzania (GST) conducted the research in Kasulu (QDS 74 & 74 W) to investigate the chemical properties of limestone, clay and laterite as potential materials for manufacturing of the cement in the study area. A total of 36 rock and soil samples were collected including limestone (9), clays (7) and laterites (20). The geochemical results are as follows: limestone contains 1.68 - 8.31 wt % SiO_2, 0.87 wt % Al_2O_3, <2.01 wt % Fe_2O_3, 16.30 - 40.93 wt % MgO and 24.03 - 31.82 wt % CaO, and < 0.36 wt % K_2O; Clay has 64.07 - 69.66 wt % SiO_2, 11.57 - 14.26 wt % Al_2O_3, 10.12 - 18.92 wt % Fe_2O_3, <0.36 wt. % CaO and <1.06 wt % MgO, and 0.52 to 3.25 wt % K_2O; and laterite is composed 18.35 - 50.22 wt % SiO_2, 17.28 wt % Al_2O_3, 32.73 - 67.20 wt % Fe_2O_3, <1.15 wt % MgO, <0.36 wt % CaO and 0.20 wt % K_2O. The presence of high MgO contents in limestone highlights its significance in the manufacturing of cement with high iron oxide far better than Portland cement. Variation of major oxides (SiO_2, Fe_2O_3 and Al_2O_3) in the clay and laterites signifies that they are suitable to be used as a raw material in form of silica, iron and alumina in the cement clinker respectively. The elemental composition obtained from the limestone, clay and laterites are within the acceptable range based on the quality control or for cement manufacturing industries.

MINERALOGICAL AND GEOCHEMICAL CHARACTERISTICS OF GRAPHITE MINERALIZATION, CHENJERE AREA, SOUTH-EASTERN TANZANIA

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This study focused on the mineralogical and geochemical characteristics of graphite in Chenjere area by conducting surface geological mapping, geochemical and petrographical analyses. The graphite mineralization of Chenjere area is of crystalline flake graphite type with medium to coarse flakes with long axis up to 1000 micrometres. Based on field observations, petrographic descriptions and comparison with other studies around the globe, it has been revealed that the Chenjere graphite is of sedimentary origin of syngenetic type. Graphite grade ranges from 3.03 wt. % to 16 wt. %. The gangue silicate minerals in the graphitic gneiss, which is the hosting rock of graphite are quartz, feldspar (mostly k-feldspar) and biotite. Graphite minerals are oriented in the matrix with the silicate minerals of the hosting rock. The mineralized zones are concordant to the rest of the lithologies of the area and biotite gneiss is forming the hanging and footwall. Again, the foliation is generally NE striking and dipping SE with the dip amount ranging from 30 to 60 degrees. Based on mineralogical and textural studies, graphite is characterized by medium to coarse flakes which meet the requirements for different applications in advanced technologies.

MINERALOGY AND LEAD ISOTOPES COMPOSITION OF POLYMETALLIC VEIN DEPOSITS OF THE MPANDA MINERAL FIELD IN KATAVI TANZANIA

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The Mpanda Mineral Field (MMF) in the Proterozoic Ubendian Belt SW Tanzania hosts significant polymetallic (Au-Cu-Pb) mineralisation in the Katuma Block. The mineralisation occurs as veins that are hosted within faults, fractures and shear zones cutting different rocks including metabasite, gabbro, orthogneisses, metapelite and granites. Most of these rocks formed and metamorphosed in Neoarchean (2.71 – 2.64 Ga) and Palaeoproterozoic (2.05 – 1.84 Ga) Andean-type active continental margins. Geochronological data indicate that these veins together with the surrounding hydrothermal alteration halos in host rocks formed about 1.2 Ga, circa 600 Ma after the Paleoproterozoic Ubendian orogenic event that formed or metamorphosed most of the host rocks. Similarity in age between the vein formation in the MMF within Katuma Block and first metamorphism of fluids fertile sedimentary rocks of the neighbouring Wakole Block, points to a metamorphic origin of the metaliferous fluids causing mineralisation in the MMF within Katuma Block.

Here we present results of Pb-isotopes analyses and detailed studies of ore and gangue mineralogy of the veins in order to characterise the mineralogy of veins and support the metamorphic origin of the fluids and polymetallic mineralisation. The ore and gangue mineralogy results have been studied using petrography, microprobe and x-ray diffraction analyses of representative samples from the MMF. Metabasites and gabbros that are associated with the mineralization contain numerous sulphide bearing veins, the significance and relationship of which with the mineralization is not yet established. Proximal to ore bearing veins, the amphibolite to granulite facies host rocks show hydrothermal alteration (chlorite ± carbonates ± K-feldspar), muscovite/sericite formation and an increase in sulphide disseminations. Deposits in MMF are significantly weathered, with sap rock

reaching up to 20 meters in thickness. Proximal to ore zones, host rocks are pervasively hydrothermally altered, with alteration halo reaching up to several tens of meters wide. Barite is also common and often associated with polygonal granoblastic quartz, disseminated pyrite, chalcopyrite, chalcocite and pyrrhotite proximal to the veins.

The veins show open fill textures, which include euhedral minerals, vugs and crustification, and are composed of coarse grained quartz, k-feldspar, siderite, barite and sulphides; mainly galena, pyrite and chalcopyrite. The gangue and ore minerals occur in bands. Gold occurs in contact with pyrite and chalcopyrite, whereas chalcopyrite is associated with chalcostibinite and tetrahedrite. Secondary minerals include covelite and digenite which replaces chalcopyrite, and hematite, secondary quartz, azurite, malachite and copper silicate minerals that form as products of weathering of primary vein minerals.

Lead isotopes data from mineral separates (mainly galena and pyrite/chalcopyrite) from representative ore samples when plotted against the plumbotectonic lead growth curves defined by Zartman and Zoe (1981) most lie in a cluster on the upper crustal curve, in the plot of $^{206}Pb/^{204}Pb$ versus $^{207}Pb/^{204}Pb$. On the plot involving thorogenic ^{208}Pb, the cluster is on the Lower crustal curve; indicating the origin of Pb and other metals from crustal sources. Our Pb-isotopes results are consistent with Pb-isotopes data from previous works of the veins.

ASSESSMENT OF RECHARGE MECHANISM FOR THE MERU GEOTHERMAL SYSTEM, NORTHERN TANZANIA

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Mount Meru is an active volcano located north of Tanzania in the Eastern arm of the East African Rift System. This volcano is believed to be the heat source for the Meru geothermal system. The surface geology in the area is dominated by unconsolidated volcanic materials ranging from young basaltic flows to volcanic ashes. The structural setting in Meru is dominated by NW-SE and NNW-SSE trending faults and lineaments while the less dominant structures trend in the NE-SW direction. Due to the fact that recharge mechanism for Meru was not known, a hydrological study was conducted to assess the recharge of the Meru geothermal system. Weather stations and water level loggers were installed in the prospect area to measure the amount of precipitation and amount of surface run-off through rivers. The results show that despite heavy precipitation in some days, water levels in the rivers had small increment. This indicates that most of water from precipitation is infiltrated to the subsurface possibly recharging the deep geothermal reservoir through permeable pathways. Therefore, the recharge mechanism for the Meru geothermal system can be hypothesized to be meteoric recharge in the highly elevated parts of Meru volcano.

THE ESSENCE OF SURFACE GEOLOGY AND SHALLOW TEMPERATURE GRADIENT WELLS FOR GEOTHERMAL SYSTEM CHARACTERIZATION IN KIEJO-MBAKA PROSPECT, SE TANZANIA

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Geologic mapping is an effective and reliable method for both geothermal and mineral resource exploration, assessment and development. In most cases, geothermal exploration starts with mapping of geology and surface manifestations followed by geochemical and geophysical surveys. It is anticipated that when surface exploration phase is successfully completed, the nature, size and reservoir conditions should be projected for exploration drilling. Due to different geological settings each field should have a customized data collection and interpretation technique. If the level of uncertainty after exploration studies is high, the temperature gradient wells drilling can be used to resolve underlying uncertainties prior to exploratory drilling. For example, in Tanzania, detailed surface studies have been completed in Kiejo-Mbaka geothermal prospect. The prospect is categorized as low-medium temperature, fault controlled geothermal system that could significantly be exploited for both electricity generation and direct utilization projects. For better understanding of temperature gradient and/or reservoir conditions of these kinds of systems, it is deemed necessary to drill shallow temperature gradient holes ranging from 200 to 300 m depth. This approach is cost effective and provides additional and useful subsurface insights (geology and temperature gradient) enough to further develop potential prospects and help to mitigate risks that would have been associated with deep drilling. Therefore, this paper presents the significance of surface geology and shallow temperature gradient drilling as a means of understanding the subsurface conditions for low-medium geothermal prospects, which exhibit uncertainties before embarking on slim and deep wells.

DEEPING DIGITAL MARKETING SKILLS TO INFLUENCE MINERAL SECTOR DEVELOPMENT

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Digital marketing professionalism in mineral development encompasses all marketing efforts that use an electronic device or the internet. Different businesses (e.g. gemstone business) leverage digital channels such as search engines, social media, email, and other websites to connect with current and prospective customers. Gemstone marketing refers to activity which involves buying and selling gemstone including precious and semiprecious minerals. Arusha market is the major gem center in the country, handling high quality goods suitable for faceting. Products traded include Tanzanite from nearby Merelani, tourmaline from Tanga and Arusha, green garnet from Arusha and Kilimanjaro and rhodolite from Tanga and Morogoro. Thus digital marketing makes a potential venture for such a market.

The purpose of this study is to provide an understanding of artisanal marketing patterns, their logic and their economic impact and use the information to promote digital marketing in gemstone business. This study has come at a time of sweeping changes in Tanzania's mining sector with respect to technology changes in marketing, and in the larger national economy. Tanzanian policy-makers face a unique opportunity in the swelling mining boom. They also have to prepare for its potential subsequent decline. The government introduce mineral trade centres in different areas especially in mine areas changes in science and technology requires transformation of mineral trade into digital ways that will reach many people quickly. Not only government but also private companies should ensure that the digital marketing technology applies for growth of their company’s economies. Since Tanzania began liberalizing and privatizing the mining sector a decade ago, the substantial economic potential of the industry is more and more apparent.

MAGNETIC SIGNATURES AND TOPOGRAPHICAL EXPRESSION OF THE POLYMETALLIC MPANDA MINERAL FIELD, SW TANZANIA

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Geological structures play an important role in the genesis of most of the structural controlled epigenetic metal deposits. For such deposits, studies of geological structures including lineaments are paramount, although mapping of such structures in the fields can be hard, time consuming and costly. The polymetallic Mpanda Mineral Field (MMF) hosts a number of veins within the Ubendian Belt. In this study, aeromagnetic and topographical data were used to ascertain the magnetic signatures and topographical expressions of MMF mineralisation. The reduced to pole total magnetic intensity image of the MMF illustrate the distribution of magnetic fabrics reflecting the general properties of surface geology. A zone of long wavelength magnetic anomalies surrounded by short wavelength anomalies characterises the central part of the MMF. Low to medium amplitude anomalies are related to the Proterozoic Uruwira sandstone found on the north-eastern part of the study area. Another zone of low magnetic anomalies trending N – S and NW – SE is related to Neogene sediments and metapellitic rocks of the Katuma Block.

Surface manifestation of structures was mapped from the Shuttle Radar Topography Mission - Digital Elevation Model (STRM-DEM). Aided with tonal variations on the STRM-DEM, lineaments were manually extracted from the MMF by using two different techniques. In the first place, shaded relief image that was created from the Digital Elevation Model was used in manually extracting lineaments at different orientations of topographic illuminations. In the second-place, flow direction was used in delineating different crustal blocks, which correspond to different lineaments. The latter approach revealed a large number of lineaments through demarcated tectonic blocks from patterns created by flow directions. Some of these lineaments were also picked from interpretation of the SRTM-DEM and

aeromagnetic data. Most of the identified lineaments trend in a NW - SE direction, which is a preferred orientation of the Paleoproterozoic Ubendian Belt. These basement fabrics may have played a great role in localisation of metalliferous hydrothermal fluids responsible for the mineralisation in the MMF.

GEOLOGY, PETROLOGY AND GEOCHEMISTRY OF THE COAL RESOURCES AT MNYWAMAJI AREA SOUTHERN PART OF NGAKA COAL FIELD IN TANZANIA, EAST AFRICA

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This work was aimed at characterising coals seams, within Ngaka coal field, which form part of the Karoo sedimentary rocks in Tanzania. Sedimentary successions of the Karoo age (lower Permian – Lower Triassic) occur in the southern part of the Ngaka coalfield (Mnywamaji area), whereby the successions complete the whole Karoo stratigraphy of Tanzania. The stratigraphy comprises (from old to young) Idusi, Mchuchuma, Mbuyura, Mhukuru, Ruhuhu, and Usili formations along with Manda Beds. The studied coal beds are within the Mchuchuma Formation, which has been mapped along Hangano, Liwindi and Ndesi streams in a strike distance of about 5 Km. Five coals seams, with thickness ranging from 1 – 8 metres, were identified along the Hangano stream profile. One coal seam with a thickness of 6 metres was observed in Ndesi stream close to the basement. The most economic seam is labelled as seam No. 4, which has a thickness of 8 m dipping about 60° NE, suggesting that it extends below the overlying successions of Mbuyura, Ruhuhu and Usili to the north, east and west. Estimated coal resources in the area drained by Hangano, Ndesi and Liwindi streams are 5 Mt measured, 35 Mt indicated and 105 Mt inferred.

Petrography and geochemistry of the economic seams have a wide variation of maceral groups; rich in inert macerals (20 - 98 vol. %) implying a typical Gondwana type. Total reactive macerals are in the range of 0.9 - 78 vol. % with an average of 44 vol. %. The calculated mineral matter content is generally medium to high with values in the range of 3.6 - 37 vol. % and an average of 8.8 vol. %. The gross calorific values range from 15 – 29 Mj/Kg and fixed carbon values range from 33 to 82% (Air-Dry Basis). Generally the total Sulphur content is low to medium with values ranging from 0.5 - 2% (Air-Dry Basis). Vitrinite reflectance of 0.5 – 0.8 RoV Random, calorific values of 29 Mj/Kg and the volatile matter up to 32% ranks the coal as High Volatile C (hvCb) to High Volatile B Bituminous (hvBb) according

to the ASTM coal rank classification. Coking parameters of coal; gieseler fluidity and dilation have zero values and the Grey King type A categorises, the coal as non-agglomerating and non-caking. Major elements with high concentrations are SiO_2 (43 - 66%), Al_2O_3 (18 - 42%), Fe_2O_3 (2 - 15%), SO_3 (0.4 - 2.5%), TiO_2 (0.9 - 3.8%) and P_2O_5 (0.0052 - 6%). The high values of SiO_2 and Al_2O_3 reflect high contribution of quartz and clay minerals on the coals. This indicates an acid character of the coal ashes. The elements CaO, Na_2O, K_2O, MgO and MnO have values less than 2%.

ROLE OF MINERALS IN PETROLEUM GENERATION, A LABORATORY PERSPECTIVE

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Petroleum is naturally generated by the pyrolysis of sedimentary organic matter; the process which can be simulated in the laboratory using analytical pyrolysis techniques. The aim of this study was to investigate the role of minerals in petroleum generation through effects of minerals interaction during analytical pyrolysis and evaluate whether they qualitatively affecting pyroproducts. Both pyrolysis temperature (750°C - 1000°C) and heating duration (8 -15 seconds) were set as kinetic parameters. The investigation of degradation behavior and structural analysis of asphaltene is indispensable for understanding and improving performance characteristics.

Asphaltene which was isolated from bitumen using n-hexane as an extracting solvent was a compound of interest through which silica (SiO_2) and pyrite (FeS_2) minerals were adsorbed on. Pyrolysis gas chromatography mass spectrometry (Py-GC/MS) was used as an influential tool for separation and identification of pyrolysate. The pyroproducts were dominated by a series of nalkanes and n-alkenes up to C32 showing the high aliphatic character of asphaltene fractions isolated from Kurdistan bitumen. The main aromatic hydrocarbons identified in the pyrolysate are alkyl benzene, naphthalene and methylnaphthalene. This study proved that minerals are qualitatively affecting pyrolysate e.g. silica observed to have insignificant influences on the generation of pyroproducts when compared to pyrite which showed significant catalytic effects on the pyrolysis of asphaltene. The catalytic activity of pyrite was proved by the production of methane of up to 10 times higher than that for silica though methane is also formed by normal thermal cracking processes due to free radical mechanism. Pyrite was also observed to enhance aliphatic hydrocarbons with prolonged heating.

PETROPHYSICAL ANALYSIS OF THE POTENTIAL RESERVOIR ROCKS INTERSECTED BY PAPA-1 WELL OF EXPLORATION BLOCK 3, OFFSHORE TANZANIA

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This work reports the petrophysical analysis of the late Cretaceous (Campanian) deep water turbidite sandstone reservoir of Papa 1 well at exploration Block 3, offshore Tanzania. The main objective of the study was to assess the hydrocarbon reservoir potential of sedimentary units encountered in Papa-1 well using well log data. The data sets that were available to the study included the gamma ray log, density log, neutron log, resistivity log and sonic log. The organization, processing and evaluation of the well log data were done using the Schlumberger Tech-log software in order to establish lithology, porosity, permeability, water saturation (Sw) and the hydrocarbon saturation (Sh) of formations encountered in the Papa-1 well at block 3.

The Papa-1 well was evaluated and gas bearing one sandstone reservoir zone was encountered at a depth interval of 4657.7 m-5049.6 m. Average porosity of the reservoir is 17.5 v/v and average permeability of 4.53 mD that indicate good porosity but poor permeability as a result of high shale volume (0.184 v/v). The net thickness of this reservoir is 391.9 m and has a net gross of a reservoir 0.87. The water saturation (Sw) of the reservoir is 58.5% and its hydrocarbon saturation (Sh) is 41.5%.

Generally, the reservoir is petroliferous and this well could serve as a control well for future petroleum exploration activities in this area. It is recommended that more wells drilled in and around block 3 in order confirm for the presence of oil and gas, and more information about distribution of reservoir in the deep waters of southern coastal Tanzania.

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DISCOVERY OF NEW HELIUM GAS SEEPS AND PROCESSES INVOLVED IN THE FORMATION OF THE HELIUM GAS FIELD WITHIN THE RUKWA RIFT BASIN TANZANIA

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Gas seeps across the western arm of the East African Rift System (EARS) in the Rukwa Rift Basin (RRB), the Lupa Hydrothermal System (LHS) and the Rungwe Volcanic Province (RVP) were analyzed for their bulk gas and noble gases isotopic composition in order to determine the origin of gases in natural seeps as well as processes that are involved in their formation and evolution. Our results reveal three geochemically distinct hydrothermal systems with distinctive N_2 - ^4He - CO_2 systematics as well as He-isotope (R_A = air 3He/4He) and concentration distributions. The seep gases from the RRB are dominantly N_2 and He, with >90% N_2 concentrations, high ^4He concentrations (2.4 - 6.9%) and strongly radiogenic He-isotopes (0.16 - 0.20 R_A). Seeps in the LHS - located between RRB and RVP - are characterized by high CO_2-^4He gas, with little to no N_2, high CO_2 contents (72 - 84%), relatively low He contents (0.008 – 0.15%), and high $^3He/^4He$ (0.95 – 0.99 R_A). The RVP gases have relative low contents of N_2 i.e. 18%, have high CO_2 and low ^4He contents, with He isotopes between 2.9 and 3.2 R_A. The Ne isotopes in all seeps are an admixture between air and Archean crust and air and Mid Oceanic Ridge Basalt (MORB). The largest $^{40}Ar/^{36}Ar$ anomalies occur in RRB, suggesting resolvable excess ^{40}Ar ($^{40}Ar^*$) from the crust. In summary, these data demonstrate interaction between two distinct helium gas sources, one of which is crustal (RRB) and the other which is mantle-derived (RVP). The extent of mixing is shown to be influenced by proximity to rift-related fault structures, groundwater systems, and magmatic heat. The systematic increase of He-isotopes (R_A) and concomitant decrease in He

concentrations from the RRB, into the LHS and towards the RVP provides insights into the processes controlling these geochemical shifts.

GEOCHEMICAL CHARACTERIZATION OF THE WINGAYONGO CRETACEOUS BITUMINOUS SANDS

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This report presents a comprehensive analysis and interpretation of Gas Chromatography-Mass Spectrometry (GC/MS) data by using Agilent MSD Productivity Chem-Station Data Analysis software. The analysis comprised of data from 4 samples from the Wingayongo Hill namely JE1SR2-D, JE2SR2-D, JE3SR2-D and JE8SR2-D. These samples were analyzed at the University of Aberdeen, Scotland. The analysis was done both qualitatively and quantitatively by careful observation of diagnostic parameters such as Pristane to Phytane ratio (Pr/Ph), Pr/n-C17 and Ph/n-C18 ratios of peak heights of the gas chromatogram. The preliminary information of the GC-MS data indicated that the source of organic matter was from marine carbonaceous shale deposited under relatively reducing depositional environment. The GC-MS data indicate a mature source rock with low to medium level of biodegradation.

MINERAL EXPLORATION CHALLENGES, RISKS AND LESSONS: A PERSPECTIVE FROM THE CENTRAL AFRICA REGION

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Mineral exploration is the process undertaken by an entity in finding ore (viable concentrations of minerals) to profitably mine and supplies various demands in society. It is much involved, professional and multi-disciplinary undertaking, which involves finding, testing, surveying and determining the value and cost of exploiting the mine. In this talk, I present the review of mineral exploration challenges, risks and lessons based on my involvement with various ventures in the Central Africa region. This review covers the 4 main stages of mineral exploration; 1) the start-up stage, 2) the pre-discovery stage, 3) the discovery stage and 4) the mine development stage. I look at important issues at each stage and explore key risks and lessons learned from past operations.

The issues include firstly, adequate planning during the start-up stage and acquiring the right skills, proper funding and budgeting. Secondly, establishing well constrained walk-away criteria and a robust and simple exploration database and quality check-assurance protocols, prudent application of new technologies, Thirdly, selecting cost-effective techniques to evaluate mineral resources, incorporating multidisciplinary skills early on during the discovery stage, coordination of project advancement and hand-over to the mine development team, and lastly establishing a life of mine sustainable exploration strategy.

These issues and lessons are synthesized in the context of the Tanzania mineral exploration industry. I thereafter, propose the right priorities and focus areas to ensure meaningful and sustainable development of the industry in the country. I hope to trigger a discussion on how the mineral exploration industry can be spearheaded to contribute to the nation's development agenda, profitability and sustainable natural resource exploitation.

INTEGRATED STUDIES INTRIGUE TO MINERAL PROSPECTIVITY: APPLICABILITY TO KIKOMBO, DODOMA, TANZANIA

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Detailed prospecting studies were carried to examine the possible mineralization zones by delineating subsurface structures and characterizing geochemical distribution of various elements hence integrating the results of the methods applied. The study area (Kikombo) has never undergone any prospecting studies as per Geological and Mineral Information System (GMIS) data. The prospecting methods utilized include geological methods, regional aeromagnetic, local ground magnetic, airborne gravity, induced polarization and geochemical surveys. Geological observation shows that the subsurface geology is composed of tonalitic-orthogneiss rock types whose regolith is composed of light to reddish brown sand. Gravity survey results suggest high gravity anomaly to most of the occupied area. Aeromagnetic surveys reveal high magnetic anomaly to most of the occupied area with a major NE-SW structural trending pattern. Local ground magnetic survey reveals absence of prominent structures with similar NE – SW (faults) that are deep and localized. However, shallow structures with similar trend were also revealed. The depth to the magnetic anomaly of various methods employed goes up to 494.1 m. IP results indicate high resistive and chargeable bodies at the basement with some faults striking NE - SW. Geochemical survey showed detectable levels of elements such as As, Au, Ca, Cr, Cu, Fe, K, Mg, Mn, P, S, Ti, V, Zn and Zr, whereby a strong positive correlation of Mn and Cu was found. A strong correlation of Mn and Cu suggests a close association of these elements in the study area implying that whenever Mn is found, there is a greater possibility of finding Cu. For further confirmation on the anomalies encountered, a drill target should be concentrated to the southern part of the study area.

NATURE OF GOLD OCCURRENCE IN HOST ROCKS OF THE NEW LUIKA GOLD MINE

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This study present result of the sampled lithologies from the New Luika Gold Mine (NLGM). Importantly, this work focused at addressing the gap in understanding nature of gold hosted in rocks Bauhinia Creek (BC) and Ilunga underground ore deposits. Grain size, ore texture, mineralogical composition and alteration of ore rocks were investigated in order to recommend mineral separation techniques that will maximize gold recovery from ore bodies. To accomplish this work, seven (7) samples were analysed from the New Luika Gold deposit. The results show that gold hosted in rocks is in form of native gold and Au telluride assemblage. Moreover, gold in these rocks is very fine, fractured and occur at the margin of sulphide grain boundaries as well as in inclusion. Under polished section, it was difficult to study silicate phases and alterations, as the result X-Ray Diffraction (XRD) method was employed to supplement for petrographic work. A total of 8 samples were analysed under XRD and the results show that the dominant silicate phases are quartz, albite, calcite and epidote. Alteration includes silicification, which is dominant and minor chloritization.

GEOCHEMICAL ANALYSIS OF THE NOBLE GASES IN THE RUNGWE VOLCANIC PROVINCE, TANZANIA: IMPLICATION ON VOLATILES SOURCES AND DYNAMICS

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Rungwe Volcanic Province (RVP) is a volcanically active area with widespread surface manifestation of active faults, hot and cold springs with gas emanations. The occurrence of silica under-saturated alkaline magmatism indicates that there is an active magma chamber below the surface, which is connected to the surface by an active fault system. In particular, the sources or origin of volatiles emanating from this area and the physical processes (e.g. fluid mixing) that are involved during the transport of these volatiles are not well characterized and are likely to be heterogeneous. Therefore, noble gas isotopic ratios and elemental compositions can be used as a tool to ascertain the source characteristics and processes involved in thermal fluid transfer from mantle and crustal regions to the surface.

Here we present two hydrothermal systems that are characterized by distinct $^{3}He/^{4}He$ ratios expressed as R/R_{air}, including low temperature Mazuku-gassy springs whose R/Ra values are up to 5.37Ra which suggest typical MORB-like ratios. This is interpreted to have as the resulted from isolated mantle-derived gas pockets that are decoupled from the rest of the hydrothermal system and not vulnerable from any sort of modification/contamination. Similarly, the mantle-like 3He/4He signature is evidenced in two of the hot-gaseous springs (Nzondahaki and Nzovwe 2) that show values as high as 6.52Ra.This is explained as the influence of direct underground release of magmatic volatiles and heat via incipient partial melting without the influence of crustal 4He radiogenic contamination.

On the contrary the mantle influence on the distal hot-gaseous springs progressively decreases up to 3.36 Ra.This suggests that magmatic volatiles

suffer a great chance of radiogenic 4He crustal contamination from the Precambrian basement rocks nearby. These preliminary results on isotopic ratios and elemental composition reflect contributions from different end-members i.e. upper mantle, crust and the sub-continental lithospheric mantle (SCLM), hence heterogeneous.

THE CHARACTERISTICS OF CU-NI-PGE MINERALIZATION IN MBESA PROSPECTS, SOUTHERN TANZANIA

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Mbesa prospect is a new discovery of magmatic Cu-Ni-PGE mineralization, located in the Ruvuma region in southern Tanzania. This deposit is Cu rich with chalcopyrite and bornite as the main sulfides, magnetite and Fe-Ti-Oxide as the main oxides. The prospect is situated within the Usagaran system which is part of the Mozambique belt. The main hosts rocks of mineralization are plagioclase amphibolite, hornblende gneiss with minor occurrences in biotite gneiss. The mineralization occurs as massive, semi-massive, veinlets and disseminated sulfides. The grade of Cu in massive ore is up to 30 wt. %, and up to 7 wt. % in the disseminated sulfides, the PGM grade is greater than 1.31ppm, and mostly associated with the massive ore. However, Ni contents are relatively lower across all mineralized rocks with the highest grade of 398 ppm. The main PGM minerals are michenerite (PdBiTe), sudburyite (PdSb) and Ni-Pd-Te, which are all hosted in sulfides. The proposed model of mineralization at Mbesa prospect suggests the potential for undiscovered Ni and PGE at deeper part of the deposits. In addition, the sulfur isotopes study fall within mantle range suggesting a magmatic origin for the Mbesa prospects although few samples evoke the addition of sulfur from external crustal sources.

RESOLUTION SEQUENCE STRATIGRAPHIC ANALYSIS OF MIOCENE TO PLIOCENE DELTAIC SYSTEMS OF THE TANGA BASIN

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The deltaic systems of the Tanga Basin preserve the unique record of sequence stratigraphy of Miocene to Pliocene along the passive margin of East Africa. This is imaged in the high-frequency seismic data which characterized different lithologies corresponding to base-level fall and rises.

The high-resolution sequence analysis of this basin was conducted using the 2D seismic data of two different vintages that cover the shallow and deep water area. The Miocene sequence is well recorded in the deeper part, interpreted as deltaic deposition characterized by clinoforms. The depositional cycles within Miocene are predominantly asymmetric whereby Transgressive System Tracts (TST) are thicker than the corresponding Regressive System Tracts (RST). These system tracts are separated by the Ravinement Surface/Transgressive surface (TS) or maximum regressive surface (MRS) observed in the seismic section with normal regression pattern. The flooding event during the end of Miocene that corresponds to base level rise pushes the shoreline towards the land.

The base level falling recorded during the beginning of Pliocene is characterized by forced regression event with Falling Stage System Tracts separated from Lowstand System Tracts continental sediments by an unconformity. Numerous incised channels and carbonate platform observed in the upper part of the seismic section indicate low to intermediate accommodation space and overall progradations of the ocean.

The interpretation of sequence stratigraphy of Tanga Basin provides a better understanding of shoreline shift and the associated facies distribution during Miocene and Pliocene that is significant in hydrocarbon exploration and production.

MINERALOGY, GEOCHEMISTRY AND DEPOSITIONAL SETTINGS OF THE MIDDLE BUANJI GROUP COPPER-HOSTED SHALES IN KIMANI AREA, SOUTHERN TANZANIA

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Integrated mineralogical and geochemical methods are applied to investigate the mineralogy, copper concentrations and formation mechanism of the copper occurred in the Middle Buanji Group of the late Paleoproterozoic (~2.0 Ga) Middle Buanji shale formation in the Kimani area, southern Tanzania. The ~300m thick Middle Buanji Formation is associated with shales, siltstones and it is intercalations with sandstones. Selected X-Ray Diffraction bulk mineral analysis of shale samples revealed the presence of silicates (Quartz, muscovite, biotite, chloritoid, ferroselite, bearsite, anatase and birnessite), non-silicate clay minerals (illite and chamosite) and phosphate mineral (pseudomalachite). Neither kaolinite nor smectite was found in the shales. The dominant non-clay minerals in the shales include quartz with a composition that ranges between 12.83-56.43 wt. % (avg. = 23.69 wt. %), bearsite and ferroselite that display lower concentrations that range between 0.47 – 0.7 wt. %. The illite is typically formed in shales with little chemical weathering and in areas of high relief where mechanical erosion is prominent. The results of the geochemistry show significant compositional variations of which SiO_2 (49.31 wt. %), Al_2O_3 (8.02 wt. %), Fe_2O_3 (7.31 wt. %), TiO_2 (0.66 wt. %) and K_2O (2.58 wt. %) constitute around 70wt% of the bulk composition. The XRF results showing a high percentage of copper concentrations (avg. Cu = 13.17 wt. %) are observed in the bottom green shales of which is ~2 times higher than the middle shale layers (Cu = 5.2 wt. %). The top shale layers (red shale) are showing a lower concentration of copper (Cu = 0.31 wt. %) compared to middle and bottom shale layers. The mineral pseudomalachite is the copper ore mineral occurred within shales of the Middle Buanji Group. The concentrations of major, minor and trace elements and their ratios indicate that these shales were deposited in the oxic environment. Despite CaO content being too low,

the occurrence of clay mineral chamosite indicate the shallow marine environment in the tropics and warm (20 °C) bottom water as essential paleodepositional condition. Further detailed studies are required to understand the occurrence of pseudomalachite and chamosite minerals in these sediments.

MULTIDIMENSIONAL RESISTIVITY IMAGING USING MAGNETOTELLURIC DATA AND ITS GEOLOGICAL INTERPRETATION IN KIEJO-MBAKA GEOTHERMAL FIELD, SOUTH-WEST TANZANIA

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In this work, the comparison results of MT 2-D and 3-D inversions are presented. A total number of 76 MT soundings acquired using Broad Band Magnetotelluric (BBMT) were inverted. The MT dataset was corrected for the static shift effects using spatial median filter techniques. Dimensionality and directionality analysis were performed prior to inversion, and depicted above 1 Hz lowest Swift-skew, ellipticities and phase sensitive-skew on the Mbaka flood plain. For low frequencies below 1 Hz, higher Swift-skews, ellipticities and phase sensitive-skews are observed in the ridge area. This suggests that the resistivity distribution within the research area distribute three-dimensionally, even beneath the sedimentary basin. This is the reason, why 3-D MT inversion was preferred. The comparison between MT 2-D and 3-D inversions results, with geological interpretation particularly, hydrothermal temperature alteration zones and structural lineaments are performed to reconstruct the subsurface resistivity distribution within the study area. Moreover, the MT dataset seems to be highly affected by 3-D resistivity distribution, therefore 3-D inversion might be more reliable in order to know the deep structures in the study area. The inversion calculations produced the resistivity models with a resistive central body surrounded by conductive anomalies. The resistive body inclines toward both SE and NW. It is delimited by two conductive zones; one SW-dipping with a high-angle, another NE-dipping and less inclined. The first is associated with the Mbaka fault, whereas the second has a direction correlating to the Livingstone border fault system. Four hydrothermal alteration zones were obtained from iso-resistivity surfaces, three of them inferred from the 10 Ωm iso-resistivity surface, and can be referred as low-temperature hydrothermal alteration zones. A fourth alteration zone was obtained from the 50 Ωm iso-resistivity surface and correlates to

manifestations within Lufundo cold springs. This zone may be related to high-temperature hydrothermal alteration.

PETROLEUM SYSTEM MODELLING AS AN EXPLORATION TOOL FOR UNDERSTANDING SOURCE ROCK AND CHARGING POTENTIAL OF MNAZI BAY NORTH BLOCK

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Mnazi Bay North Block is amongst the potential areas for Hydrocarbon (HC) exploration in the Ruvuma Basin. A number of discoveries with commercial quantities of natural gas surround the block. Despite the known potentiality of the area, uncertainties on source rock that charges the reservoir poses a challenge in understanding the prevailing petroleum system. The charging potential of the area was analyzed through 1D Petroleum System Modelling using Petromod software for three possible Source Rock (SR) intervals (Upper Jurassic, Cretaceous and Miocene SR) which might be responsible for charging the overlying Cretaceous and Miocene reservoirs. Seismic sections and wells from nearby fields were used to create the pseudo wells and model calibration to comprehend the burial and temperature history, maturation, timing and depth for generation and expulsion of the HC. The Model results depict that the Upper Jurassic SR has attained maturity and generation from Late Cretaceous to present. The Cretaceous SR is matured to oil window since early Oligocene and still generating oil to date while the Miocene SR is immature for hydrocarbon generation. These results are in line with the pyrolysis data from nearby wells, the presence of discoveries (Gas/Condensate), and oil/gas seeps within the basin. This study revealed that, the Jurassic and Cretaceous are the potential SR in the area and responsible for charging the overlying reservoirs through different pathways. However, the extent to which each SR contributes to charging of the reservoirs remains uncertain; this could be unlocked through detailed 2D/3D modelling.

INDIRECT DETECTION OF HYDROCARBON MICROSEEPAGES BY INTEGRATING REMOTE SENSING, GRAVITY-GRADIOMETRY AND GEOLOGICAL DATA IN THE EYASI-WEMBERE BLOCK

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Eyasi-Wembere is a frontier rift basin located in the Northern Tanzania, and is subdivided into Eyasi, Manonga and Wembere sub-basins. The basin is likely to be analogous to the Lokichar Basin further to the North and Albertine basin as they lie within the East African rifting system. The basin lacks macro hydrocarbon seep and is only covered with limited data required to prove the presence of working petroleum system.

Remote sensing and gravity-gradiometry techniques were employed to detect hydrocarbon microseepages in order to prove for a working petroleum system in the basin. Remote sensing involved interpretation of satellite imagery, whereby various band ratios, band combinations, False Colour Composite (FCC) and Principal Component Analysis (PCA) of ASTER and Landsat 7 TM+ imagery were applied to enhance the target signals. Structures (AGG leads) interpreted from gravity gradiometry and geological data were integrated with remote sensing anormalies to narrow out the interpretation results.

The results showed that Ferrous, Carbonate, and Kaolinite mineral alterations are mostly dominant along the major faults of the Eyasi, Manonga and Wembere sub-basins. These alterations may be related to the microseepages due to the vertical movement of light hydrocarbons from the reservoir through fractures and faults.

The remote sensing interpretation is well aligned with both gravity and geological data, however these results require further validation through Geochemical sampling and analysis. Upon validation, the results will be used to prioritise the area for further hydrocarbon exploration in the basin.

STRUCTURAL INTERPRETATION AND HYDROCARBON PROSPECTIVITY OF THE EYASI-WEMBERE BLOCK

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The Eyasi-Wembere Block comprises of Eyasi, Natron and Manyara basins. The Eyasi Basin includes three separate sub basins: Lake Eyasi, Manonga and Wembere Depression. These basins have been mapped geologically; neither wells have been drilled nor has seismic survey been acquired to shed light on the subsurface conditions in the area. This interpretation is based only on the potential field data from the recent aerial survey and an existing countrywide magnetic data.

Structural interpretation through integration of Falcon airborne gravity gradient, magnetic and geological data from Eyasi-Wembere block in northern Tanzania is here presented. The aim of this interpretation was to develop an improved understanding of the regional geology in a portion of the Tanzanian Divergence Zone of the East African Rift System with relevance to hydrocarbon exploration. Specific objectives for the qualitative interpretation was to determine the structural framework of the main rift-bounding faults, intra-rift faults, crossing structures (or relay fault zones) between rift basins, and locations of shallow intrusions. Whereas, the objective for quantitative interpretation was to estimate depth to basement, based on calculations on magnetic profile data and inversion of vertical and horizontal components of Aeromagnetic Gravity Gradiometry (AGG) data to model high density basement.

Depth to the basement estimations imply that the sediment accumulation is about 5 kilometres thick and identified as favourable for source rock maturation and prospective for hydrocarbon accumulation. Our results indicate that structural interpretation can contribute to an improved understanding of the geology and identification of specific areas considered to be prospective for hydrocarbon accumulation. Moreover, it has been found that the western and central sub-basins of the Eyasi Basin have best chances for thick sediments, extensive reservoir facies, and proximity to a hydrocarbon kitchen.

OVERVIEW OF HYDROCARBON EXPLORATION AND PRODUCTION ACTIVITIES IN TANZANIA

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Exploration activities in Tanzania commenced in 1950s whereby the first gas discovery was made in Songosongo Island in 1954 followed by Mnazi Bay discovery in 1982. Since then TPDC has continued to conduct exploration activities in partnership with International Oil Companies (IOCs) through Production Sharing Agreements (PSAs).

Currently, there are ten (10) active PSAs, whereby Seven PSAs (Block 1 & Block 4, Block 2, Ruvu, Ruvuma, Nyuni and Kilosa-Kilombero) are under the exploration phase and three PSAs (Songosongo, Mnazi Bay and Kiliwani North) are under production phase. To date, a total of 57.54 TCF (GIIP) has been discovered in both onshore and offshore basins of Tanzania. The gas produced from onshore reserves is used for industrial, household and power generation, while offshore gas resources will be developed through Liquefied Natural Gas (LNG) project with domestic obligation.

Following the enactment of the Petroleum Act, 2015, TPDC is fully engaged in commercial aspects of petroleum in the whole value chain as a National Oil Company. Under upstream operations, TPDC is conducting exploration activities in Mnazi Bay North, West Songosongo, Lake Tanganyika North, Eyasi Wembere and 4/1B Blocks. Currently, exploration activities in these Blocks are in different stages of geological and geophysical studies.

TPDC continues with hydrocarbon exploration activities in the country and encourage potential investors to work with TPDC in oil and gas exploration and development.

GEOCHEMICAL EVALUATION OF MIDDLE KAROO TANGA BEDS FOR HYDROCARBON POTENTIALITY

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Tanga Basin is located in the Northern part of Tanzania Coastal Basin and its evolution is linked to the tectonic event related to the Permo-Triassic breakup of the Gondwana Supercontinent. The Karoo Tanga beds were intersected through drilling of shallow stratigraphic boreholes of up to 206m deep in an onshore part of the basin. The recovered cores mainly composed of non-marine clastics sediment with some shales and few coals and coaly shales, which were used for evaluation of source rock potentiality.

A total of 69 core samples were collected from four (4) boreholes and subjected to Total Organic Content (TOC) analysis and pyrolysis to determine the quantity, quality and thermal maturity of the organic matter. Analytical results displayed TOC values ranging from 0.5 to 2.0 Wt. %; reflecting a fair to good source rock with exception of two samples displaying TOC values of 7.83 Wt. %. and 19.14 Wt. % attributed by the presence of coal fragments. Hydrogen Index (HI) values ranging from 57 to 365 (mg HC/g TOC) exhibiting dominantly Type III kerogen and few mixed Type II and III, mostly signifying a terrestrial origin of the organic matter. The samples displayed a Kerogen Yield (S2) values of <2.5 (mg/grock) suggesting a poor hydrocarbon generating potential with only four (4) indicating S_2 values from 5.85 to 47.86 (mg/g of rock) representing a good to excellent generating potential. The Karoo Tanga beds presented a (T_{max}) values ranging from 444℃ to 463℃ indicative of thermal maturity for Oil generation window to condensate-wet gas zone.

Generally, the Tanga beds indicated a sufficient organic content and attained a suitable temperature for hydrocarbon generation at a particular geological time. The high thermal maturity observed at shallow depth and the poor generation potential of most of the samples might be due to the uplift related to tectonic event as evidenced by the exposure of Karoo in Tanga Basin.

TPDC LABORATORY SERVICES

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Tanzania Petroleum Development Corporation (TPDC) Laboratory was established in 1988 through Norwegian Agency for Development Cooperation (NORAD) funds. It is operated in accordance to good oilfield industry practices. The Laboratory provides services to the Corporation and other clients while constantly adapting to new technologies for delivery of quality services. Currently, the Laboratory is in the certification process for International Standard Organization (ISO). Since its establishment, the Laboratory has offered various analytical services to different International Oil Companies, neighboring countries and research studies in collaboration with various Universities. TPDC Laboratory offers a range of analytical services from an outcrop scale, single well, data interpretations and reporting. Currently, the Laboratory comprises of four sections namely Geochemistry, Palynology, Micropaleontology and Petrology. The services provided include Total Organic Carbon (TOC) analysis & Pyrolysis, age determination, environmental deposition, thermal maturity and petrographic analysis. TPDC invites all stakeholders in the industry, research institutes, various entities and individuals to use our Laboratory facilities and the services.

FORAMINIFERA AND PALYNOMORPHS ASSEMBLAGES OF THE LATE CAMPANIAN TO EARLY MAASTRICHTIAN OF THE SOUTHERN COASTAL BASINS OF TANZANIA: ITS IMPLICATION TO PETROLEUM EXPLORATION

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A quantitative biostratigraphical analysis was performed on forty-six (46) core samples split of Late Cretaceous across two (2) shallow boreholes namely TDP 5 and 9 drilled by the Tanzania Drilling Project in Ruvuma and Mandawa basins respectively. The analysis of foraminifera recovered approximately 509 specimens with poor to good preservation, whereas the palynological analysis yielded dinoflagellate cysts and spore/pollen assemblages of low dominance, low abundance, and low to moderate diversity. The sediment successions span from Late Campanian to Early Maastrichtian with grey, dark grey to greenish-grey claystone as a principal lithology. Four planktonic foraminifera Biozonations and two Subzones were recognized. Results show that the Ruvuma Basin sediments were deposited in an estuarine to outer neritic marine whereas Mandawa basin sediments were deposited in relative deeper open marine. Spore and pollen dominate the palynomorphs assemblage in both basins suggesting a strong continental influence. Spore color index (SCI) suggest that the organic matter in the sediments from both basins are immature for producing hydrocarbon. Generally, the microfossil assemblages suggest three transgression circles during this period.

BIOSTRATIGRAPHY AND PALEOENVIRONMENT OF THE EYASI WEMBERE RIFT BASIN BASED ON OSTRACOD STUDIES

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TPDC drilled three shallow stratigraphic boreholes (Kining'inila-1, Luono-1, and Nyalanja-1/1A) in the Eyasi-Wembere Block with the objective of determining the stratigraphy of the basin. Fifty-seven (57) core samples collected from the boreholes were qualitatively analyzed for ostracod content in order to determine age of the formations and depositional environments. The specimens recovered were poorly to well preserved with low abundance and diversity, with only two species dominating the assemblage.

The recovered ostracods indicate the sediments are not older than Pliocene in age and were deposited in shallow lacustrine carbonate settings to profundal lake zone. *Limnocythere sp*. found at the upper boreholes intervals indicates shallow water depositional settings while the *Candona sp*., *Cytherissa lacustris*, and *Illyocypris bradyi* found at the deeper borehole intervals indicates deeper water depositional setting. The ostracods recovered prove that the paleoenvironment was initially a deep rift lake and later evolved to a shallow water environment. Based on the recovered ostracods, possible source rock materials were likely to be deposited in the profundal zone towards the basin centre in the early stages of lake history.

The down-hole declining of alkalitrophic *Limnocythere sp,* reflects the decreasing of salinity and alkalinity in the deeper section. *Ilyocypris bradyi* usually indicates freshwater input from natural springs and therefore, support freshwater paleoenvironment, especially the existence of the perennial lakes. Presence of microbial mats was definitely responsible for the precipitation and formation of the carbonate.

IMPACT OF ARCHITECTURAL ELEMENTS OF LINEAR AEOLIAN DUNE IN RESERVOIR PERFORMANCE

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Aeolian reservoirs have heterogeneity at different scales. Excluding how the fluid flow is controlled by high and medium scale, under certain conditions the primary strata types (PST's) have a governing role. With good connectivity in aeolian systems, at lamina and fine beds scale becomes important in cases of complex fluid mixtures. As it is not to model the whole reservoir in fines detail, it evident that a selective study needs to be done. This is to establish at how fines scale details may affect the reservoir performance. One of the aims of this project therefore was to establish under which conditions such details start affecting the recovery significantly. This work was aimed at studying architectural elements on two small portions of a linear dune in a dry aeolian system in the Wahiba Sand Sea, Sultanate of Oman. The details of sedimentary structures had been captured by ground penetrating radar. This was developed into models which were then populated with range of properties and simulated. The results of the study suggest that it is necessary to treat PST's separately, and study how the range of properties may be of effect as those with significant impact on recovery under some of the analysed conditions. It is possible to mitigate the negative effect by the appropriate recovery mechanisms, some of which were also analysed. Further the results of the study can be used in the construction of representative volumes of the models studies and upscaling to populate a reservoir in a field scale.

TECTONIC EVOLUTION OF SEAGAP FAULT ZONE: ITS IMPLICATION TO SEDIMENT DISTRIBUTION IN OFFSHORE TANZANIA

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The Sea Gap Fault (SGF) is a nearly N-S trending mid Jurassic sinistral strike slip fault, formed as a result of trans-tensional reactivation of extensional Lower Jurassic fault. The aim of this study is to understand the tectonic evolution history of the Sea Gap Fault and its impact on sediment distribution in the offshore Tanzania. To accomplish the objective, the interpretation of 3D seismic data interpretation, modeling for sediment distribution and stress field orientation were conducted. Four different fault sets were observed. These are the (i) Mid Jurassic normal faults that controlled syn-rift sedimentary wedge shaped packages, (ii) the NNW/N trending strike slip fault (The SGF) that controlled deposition of localized sediment packages along the SGF, (iii) associated NW-trending Riedel structures that join the SGF at an acute angle, and (iv) Upper Cretaceous/Paleogene Trans-tensional faults with flower structures on sea bed. The SGF was reactivated at different deformation phases (Mid Jurassic and Paleogene phases affecting sediment distribution along, within and away from the SGF. The orientation of the main SGF, fault splays (Riedels) and the geometry of the restraining and releasing bends along the SGF determines the orientation of the stress fields ($\partial 1$, $\partial 2$ & $\partial 3$) that caused Strike Slip deformation at SGFZ. Understanding regional evolution of the SGF unlocks a broader aspect of understanding regional tectonic evolution of East Africa Continental Passive Margin (EACPM) and distribution of potential petroleum systems in the region.

GEOLOGICAL CONTROLS OF GOLD MINERALIZATION IN ROBERTS (NYAMULILIMA CUT 1), GEITA GREENSTONE BELT, NW TANZANIA

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Roberts (Nyamulilima cut 1) deposit is located within the Nyamulilima domain, Geita Greenstone belt. The area is dominated by meta-sedimentary package intruded by various phases of igneous bodies ranging from Diorite, Tonalite, Granodiorite forming the Nyamulilima Intrusive Complex (NIC) and mafic dikes. The domain displays a general NW-SE structural trend as a result of series of deformation events preserved in the NW shallowly plunging synforms and antiforms.

A series of sub-parallel shear zones (late D3-D4) which occasionally show anastomosing patternutilize the axial surfaces of the fold systems trending NW-SE as well as intrusives-meta-sediment contacts. These shear zones moderately to steeply dip (50°– 80°) towards SW, display a braided pattern overprinting both intrusives as well as meta-sediments. Most of these shear zones show brittle-ductile condition with localized zones of intense brecciation. These shear zones are cut by the NE-SW trending faults that dip moderately towards NW. Gold mineralization in this domain is both structurally and lithologically controlled. The braided networks of moderate to steeply dipping shear zones trending NW-SE act as structural controls. These shear zones range in thickness from a few cm to about 60m and shows localized zones of breccia and micro-fractures development. Both intrusives and meta-sediments act as lithological controls where they are overprinted by shear zones. Higher grades are recorded where the shear zones cut through the intrusives – metasediments (Fe-rich) contacts as well as in tight folded metasediments sandwiched within Intrusives. Broad zones containing medium to low grades are recorded where the shear zone cuts through intrusive bodies with exceptionally higher-grade zones recorded when shear zones converge. The mineralized zones display pyrrhotite ± pyrite which occur as partial to complete replacement of magnetite layers as well as fracture -fill and disseminations in BIF. In all the litho-types; BIF,

intrusives and volcaniclastic units moderate to intense silicification and sometimes hydrothermal brecciation are observed.

EVOLUTION AND ASSESSMENT OF HYDROCARBON PROSPECTIVITY OF THE OFFSHORE PART OF EAST PANDE BLOCK, SOUTHERN COASTAL BASIN OF TANZANIA USING 2D SEISMIC REFLECTION DATA

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This study presents a comprehensive investigation of geological structures and processes through the use of 2-Dimensional reflection seismic data and borehole data in order to come up with the Lower Cretaceous to present day evolution of the offshore part of the East Pande Block, southern coastal basin of Tanzania and assessing its relation to the petroleum system development. Structural interpretation of seismic sections has revealed two episodes of deformation which are the Lower Cretaceous East Gondwana rifting, and the East African Rift System during Tertiary times. These tectonic movements have played a significant role in sedimentation and led to local periods of regressions, transgression, and turbditic currents. Lithology interpretation from Tende-1 well logs revealed two Lower Cretaceous turbiditic reservoirs which are Top Tende, Base Tende reservoir and the Top Tikiti, Base Tikiti North Deep Channel. The hydrocarbon entrapment configuration in this area is both structural and stratigraphic, which includes slope channels and fans in tilted fault blocks. There are also evidences of hydrocarbon entrapment within the shallow subsurface, hydrocarbon migration and a long history of canyons formation which are also a major feature of the present day seafloor.

3D STRUCTURAL-GEOLOGICAL MODELING OF THE EAST AFRICAN RIFT BASINS IN THE SOUTHWESTERN PART OF TANZANIA

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Successive exploration and identification of geothermal resources require detailed insight into 3D geological structure of the area of interest. A full 3D picture is only rarely available, but much can be learned from 3D geological models developed on the basis of 2D sections. One area of interest is the East African rift basin in south-western Tanzania. At present, comprehensive 3D models are lacking for this area. We aim to fill this gap in knowledge, by constructing the first 3D structural-geological model, based on a regional integration of available 2D geophysical and geological data sets. In a later stage, this model will be used for geothermal resource assessment.

The model area covers 500 km by 300 km and includes the Southern Tanganyika-Rukwa-Songwe-Nyasa and Usangu basins. The first step in the creation of the 3D structural-geological model was the interpretation of 2D geological sections based on global free air gravity data, integrated with the seismic reflection/refraction profiles, available from the literature. The compilation of the detailed geological map was also necessary to achieve this objective. The 3D model work flow involved the digitization of fault and geological contacts both on 2D map and cross sections and importing a digital elevation model which defines the top boundary of the model. The modelling was performed using geomodeller software. The first step involved generation of a fault model which shows NW striking trends in the Tanganyika, Rukwa, Songwe and Nyasa basins. In contrast, the Usangu Basin displays NE fault trends. Both trends, however, are consistent with the regional geometry of the East African rift. The next step involved adding geological formation to the fault model, obtained from interpreted 2D

sections and map. The final result is a new 3D structural-geological model. The modelled horizons show half graben geometries with a NW-SE general trend, and general thickening to the West in the Tanganyika basin and East in the Rukwa, Nyasa and Songwe basin (thickening towards the border fault).

The 3D model was validated by the comparison between the initial input 2D data and the modelled, interpolated 3D interfaces, both on map view and vertical cross sections. The results show close matches which indicates that the interpolation algorithm successfully reproduced the structures defined by the input data. Forward gravity modeling was then performed to see whether the 3D geometry and rock properties produce a response equivalent to the observed gravity anomalies. The best fit was obtained by iteratively adjusting the 3D model geometry and rock densities until it showed a good agreement in terms of spatial arrangements, though different ranges between the calculated gravity and observed gravity responses. This suggests that the 3D model forms a good representation of the true 3D structure, whereas the physical properties did not effectively account for the observed ground gravity. The resulted 3D model will be useful to further modeling, including a numerical assessment of the geothermal resource potential in the southwestern part of Tanzania.

STRUCTURAL INTERPRETATION FOR HYDROCARBON PROSPECTIVITY OF THE EYASI-WEMBERE BLOCK

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Eyasi-Wembere is a frontier rift basin located in the Northern Tanzania within the East African Rifting System (EARS), subdivided into Engaruka, Manyara, Eyasi, Wembere and Manonga sub-basins. The basin is likely to be analogous to the Lokichar Basin located on the eastern arm of the EARS and Albertine basin on the western arm of the EARS as they lie within the same EARS. These sub-basins have been mapped geologically, neither seismic survey have been conducted nor wells drilled to shed light on the subsurface stratigraphy in the area. This work is based on the potential field data from the recent Falcon Airborne Gravity Gradient (AGG) data and an existing countrywide magnetic data to asses Prospectivity of the area. Interpretations were carried out by integrating AGG, magnetic, and geological data to generate structural and depth to basement maps. The interpretation highlights structural framework of the main rift-bounding faults (trending NE-SW and NNE-SSW), intra-rift faults, locations of shallow intrusions and estimated depth to basement. The Eyasi, wembere and Manonga sub-basins have best chances for thick sediments, extensive reservoir facies, and proximity to a hydrocarbon kitchen. Depth to the basement estimations imply that the sediment accumulation is about 5 kilometers thick which is favourable for Maturation and accumulation/trapping of hydrocarbons. Results of this interpretation contribute to an improved understanding of the geology and identification of areas considered prospective for hydrocarbon exploration.

UPDATES ON THE GEOLOGY AND MINERAL PROSPECTIVITY OF THE NYAMULILIMA DOMAIN IN THE GEITA GREENSTONE BELT, NW TANZANIA

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Nyamulilima domain forms part of the Geita Greenstone Belt. This domain is located on the western part of the larger Geita Greenstone Belt hosting a number of gold deposits: Star and Comet, Ridge 8 and Roberts (Nyamulilima Cut 1) in which the first two are currently operational as underground projects whereas the latter was declared as marginal orebody back in 2008. Historical exploration programs within the domain since 1998`s by Anglo-America were mainly based on geophysical data interpretation and drilling focussed on pit-scale investigations. The programs did lack domain - scale interpretations that integrated robust set of geological information and hence resulted in the limitation in the geological understanding. Recent geological review conducted on the domain scale context in the year 2016 using integrated datasets from surface and underground geological mapping, drill core/chips reviews, geochemical, geophysical data and geochronological assisted to change the geological understanding. In this context, I present the updated domain-scale geological maps and stratigraphy of the area. Moreover, a domain-scale deformation scheme which suggests that gold mineralization occur during D3 event is established. These new information have assisted to turn around the geological understanding which resulted in massive resource addition in the previously considered marginal orebodies such as Nyamulilima Cut 1 (Roberts: Our New Open Pit Mine expected to start in 2021) as well as identification of several exploration targets which are under various stages.

APPLICATION OF BLAST MOVEMENT MONITORING EXPLORER TECHNIQUE IN ORE LOSS & DILUTION CONTROL: A CASE STUDY OF GEITA GOLD MINE, NW TANZANIA

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During mining activities, blasting is one of the key activities which assist fragmentation of the rock in small pieces that are readily available to be hauled as ore materials or wastes. Process of separating ore from waste materials after blasting in order to effectively get the designed ore polygons has been affected by the vibration imparted by the blasting event leading to variable shifts in the exact position of the ore zones. This phenomenon results into ore loss and/or dilution compared to the designed ore polygons.

Historically, Geita Gold Mine open pit mining team used Polypipe technique to mitigate the effect of blasting. However, this technique provided limited information which could sometimes lead to imprecise judgment in terms of direction of movement of the designed ore polygons. These shortfalls forced the company to look for an alternative technique that could effectively perform the work. Back in 2010, the company adopted BMM Explorer technique which accounts blast movement magnitude in 3D perspective more precisely compared to the old versioned 2D polypipe method. We present the application of BBM Explorer as an effective technique in open pit mining at Geita Gold Mine. The technique works on quantifying the three-dimensional blast muck pile movement and utilize the displacement/movement data to define post-blast ore polygons during block modelling. Therefore, the technique quantifies/control ore loss or dilution that could lead to loss of company`s revenue per blast.

MINERAL RESOURCE MODELLING "CRITICAL PROCESS STEPS": A CASE STUDY OF GEITA GOLD MINE, NW TANZANIA

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Mineral Resource Models are fundamental for Economic and Mining evaluation before and during mining project life cycle. These models are produced for specific end users such as Exploration Target generation, Pre-feasibility to Feasibility studies and eventual mine production. In recent years integration of geological, geometallurgical and geochemical factors have proven to be significant into producing Resource Models with high level of confidence. At Geita Gold Mine, Mineral Resource Modelling and Reporting is conducted are as per AGA set of guidelines, in accordance to International Reporting Guidelines (SAMREC/JORC Code). These guidelines serve as a framework to standardize Resource Modelling and Reporting process and appropriate set up structure of Resource Models handover to Mine Planning. Thenceforth, serving as a key input into short term, medium term and long-term business planning processes. This overview focuses on the critical process steps practiced at Geita Gold Mine (GGM) during Mineral Resource Modelling and Estimation.

GEOLOGISTS` DEVELOPMENT PROGRAM AT GEITA GOLD MINE

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Geita Gold Mine like any other multi-national companies needs to have a team of highly qualified employees, who will be able to fulfil company`s short, mid and long terms objectives as well as mission and vision. However, most of the companies have failed to put up a systematic procedure that ensures competency of the workforce in order to fulfil the set objectives.

In this context, the Geology department at Geita Gold Mine decided to formulate a geologists` development program that will ensure that the geologists working at various sections of the department are well equipped with necessary knowledge and skills that assist them to provide solutions to the emerging operational challenges. This presentation provides the framework of the career path for the geologist from the young stage to the most matured level. In addition, the program ensures the company to have a pool of talented geologists to support GGM`s strategic vision and therefore assuring the sustainability of the company at large.

DEMOGRAPHIC, LABOUR PRODUCTIVITY AND CHALLENGES OF MINERAL WEALTH TO ARTISANAL MINING IN LAKE VICTORIA MINING REGION, NORTHERN TANZANIA

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One of the strategies of the Government of Tanzania to improve the welfare of Artisanal and Small Scale Miners (ASM), as stated in the new 2010 Mining Act, is to facilitate social and economic welfare of the small scale miners. To achieve its goals, Government has in 2011 conducted its second baseline survey (last survey was 1996) in order to evaluate the number of miners and performance of ASM activities and prepare ASM viable social economic programs.

This abstract outlines the demographic distribution and the labour productivity in the Lake Victoria mining region, located in the Northern Tanzania, in terms of mining zones, districts to individual mine camps. The small scale mining activities conducted in this region include mining of gold (58.2%); building / construction materials (23.6%); coloured gemstones (12.0%); copper (1.5%), diamonds (2.5%), salt (2.1%) and rest 1.0% deals with other minerals. In order to determine labour productivity, the miners' work input was correlated with the mineral product produced. Based on this approach, the labour productivity for various mineral commodities was calculated. On average the productivity for gold ores mined is equivalent of 20 kg per person per day, while productivity of ore processed is 4kg/day/person; similarly, labour productivity in gemstone mining areas varies from 5 – 50kg/day/person with an average of 20kg/day/person. Productivity of ore processed varies from 2–20kg/day/person with an average of 9kg/day/person. In addition, the paper highlights participation of women in mining, state of mining technology in past 20 years, mercury and environmental impacts and Government participation in regulating the sector.

MECHANICAL CHARACTERIZATION AND POTENTIAL EVALUATION OF THE GEOTHERMAL SYSTEM IN SONGWE FIELD, MBEYA, TANZANIA

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Tanzania is one of the East African countries with large amount of geothermal potential that has not been used yet and has only been explored to a limited extent. The national power system relies greatly on hydropower and natural gas. Willing to propose an alternative, the government of Tanzania has made geothermal development a priority. The area around the city of Mbeya, located at the junction of two branches of the East African rift system has been identified as a first priority region from which two specific targets have been defined, the volcanic region of Ngozi and the half-graben of Songwe. In this study focus is made on the Songwe basin.

In geothermal exploration and development, numerical modelling is essential to understand both regional and reservoir scale processes. Key factors determining geothermal systems potential are temperature and fluid flow. Numerical models allow constraining reservoir geological properties and fluid flow behaviour to better plan the well path design and field production. In Tanzania, only geophysical (MT and TEM), geochemical studies and field geology have been done. A need therefore arises for numerical modelling to evaluate and assess the potential of the geothermal fields which is the purpose of this study.

In order to evaluate the potential of the geothermal system in Songwe, the study approach includes the reconstruction of the geological model to get the geometry, thermal modelling, geothermal modelling, laboratory testing of hot springs fluid to find the chemical properties, and laboratory testing of rock samples to obtain their physical and mechanical properties. The study presents a reconstructed geological model with the deep structure, a realistic geometry that is essential for thermal modelling and geothermal modelling work. Thermal modelling with different scenarios to understand how temperature is distributed in the subsurface at a steady-state is also presented in the study and temperature values compared. The study will also

incorporate the mechanical and physical parameters from the laboratory measurements and construct a geothermal model that will help in understanding and predicting the long-term geothermal production.

ARTISANAL AND SMALL-SCALE GOLD MINING IN TANZANIA: HOW CAN IT CONTRIBUTE TO MINERAL SECTOR DEVELOPMENT?

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When we talk about Leadership, Professionalism and Ethics as Essentials for Mineral Sector Development, we mean behind our minds sustainable development of mineral sector in a particular jurisdiction.

This writing attempts to explain how Artisanal and Small-Scale Gold Mining (ASM) in Tanzania can contribute sustainable development of mineral sector in Tanzania. It explains how it is organised or structured and who the actors are. It also considers their challenges and opportunities.

The challenges include inefficient methods and less scientifically studied way of how they mine, how they process the gold ore to recover gold Dore, how they beneficiate, how they market their produce and also how they are organised in terms of their operations. On the other hand, the opportunities include further formalisation of their activities, and creating approaches to improvement and transformation of ASM so as to bring sustainable development in the mining sector.

SEDIMENTOLOGY AND DIAGENESIS OF THE MIDDLE JURASSIC MSATA SUCCESSION, RUVU BASIN, TANZANIA

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This work describes sedimentology and diagenesis of the Middle Jurassic Msata Succession in the Ruvu Basin (Tanzania). The Msata Succession is composed of Bajocian to Bathonian sedimentary rocks formed when the coastal basin of Tanzania became fully continental marine shelf with a widespread marine transgression. Msata Succession is found in the Lugoba Formation which comprises of silic-carbonate rocks that have high potential as reservoir for hydrocarbon, deriving from the stratigraphically underlying Karoo Formation. The aim of this study is to determine sedimentary facies, digenetic processes and reconstruct the depositional environment. The study involved field and laboratory works. Fieldwork was conducted at Msata quarry, from which nine fresh samples were sent to the Utrecht University laboratory for thin section preparation. Three samples were stained and resined; six were normal thin sections (10-15 mμ). Petrographic investigations were conducted at the University of Dar es Salaam, Geology Department.

Facies analysis reveals that the Msata Succession were deposited within a complex array of depositional environments, ranging from alluvial, fluvial channels to marine transitional environments. Ten lithostratigraphic units were identified, and were divided into three facies association. These are: inclined conglomerate and sandstone (FA 1), inclined sandstone and siltstone (FA 2) and bioclast matrix supported limestone (FA 3). Petrographic investigations indicated that diagenetic processes which have modified the Msata Succession were; micritization, cementation, dissolution, neomorphism and compaction. Analysis of facies and their association in space and time between the study sections reveal a succession of two distinct depositional environments i.e. the continental/terrestrial (alluvial to fluvial channel) and marginal marine depositional settings. The deposition environments were strongly influenced by fluctuations in relative

sea level (transgressive and regressive). In general the sandstones of Msata would not be reservoirs for hydrocarbons due to their primary porosity being destroyed by compaction and carbonate cement.

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