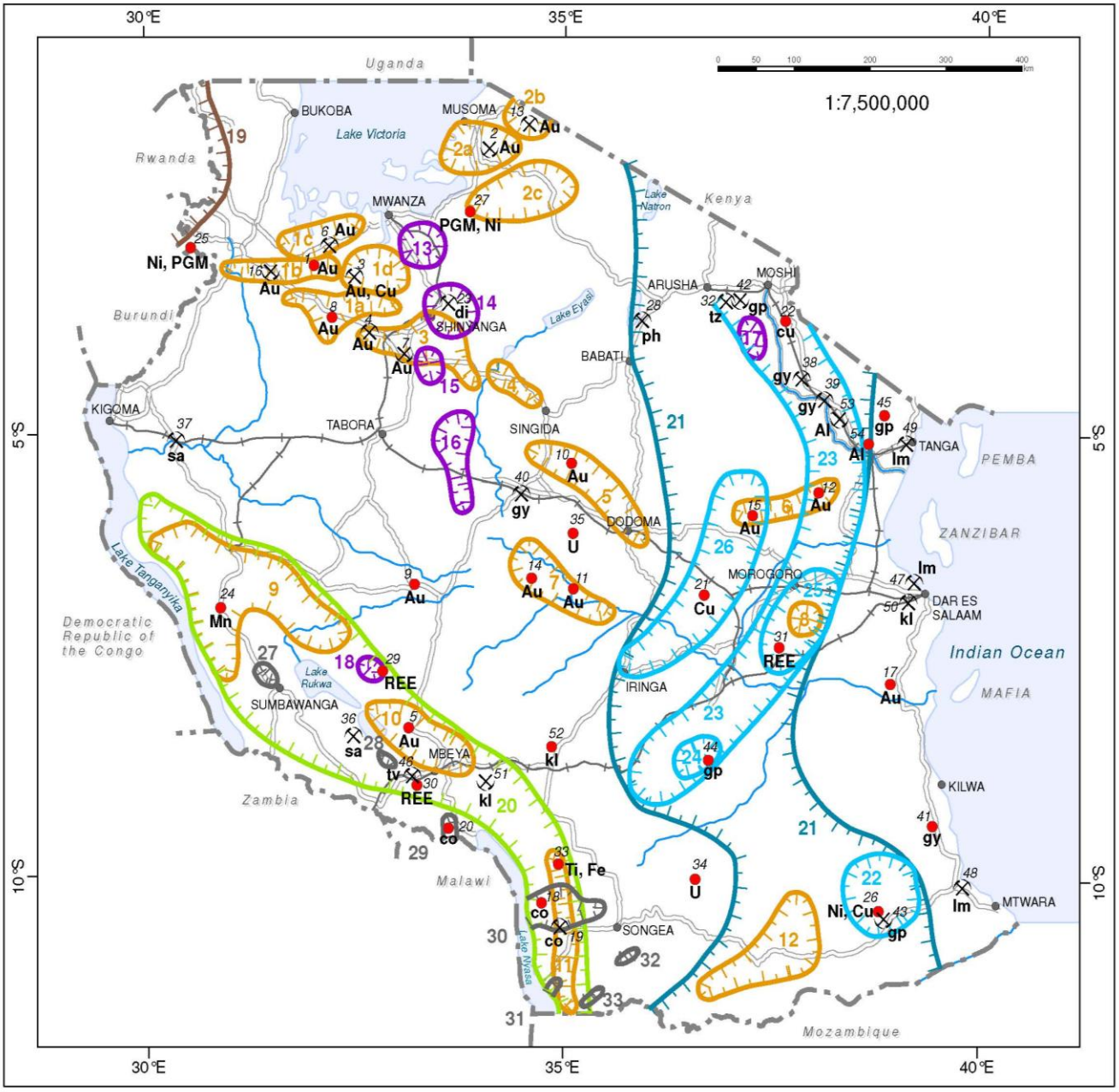
TGS 2015 Workshop

Book of Abstracts



The Role of Geoscientists in the Tanzania Socio-Economic Development

Date: 27 - 28 November, 2015
Venues: UDBS Block (A 106 & C520)

Mining Districts and Mineral Fields

	Gold
1	Mwanza Gold fields
1a	Kahama Gold field
1b	Rwamagaza Gold field
1c	Geita Gold field
1d	Mabale Gold field
2	Musoma - Mara Gold fields
2a	Musoma Gold field
2b	Mara Gold field
2c	Kalimafedha Gold field
3	Nzega Gold field
4	Sekenke Gold field
5	Sambaru-Dodoma Gold zone
6	Mkurumu-Magambazi Gold zone
7	Mazoka-Mafulungu Gold zone
8	Uluguru Gold occurrences
9	Mpanda Gold field
10	Lupa Gold field
11	Mbinga Gold occurrences
12	Tunduru Gold occurrences
	Diamond
13	Ngudu Diamond field
14	Mwadui - Shinyanga Diamond field
15	Nzega Diamond field
16	Ndala Diamond field
17	Lelatema mountains Diamond occurrences
18	Rukwa Diamond occurrences
	Sn-W
19	Karagwe Sn-W field
	Polyminerals
20	Western Rift Mineral field (Au, Cu, Pb, Ti, Fe, REE, Mica)
	Mica-Gemstone
21	East Tanzania Gemstone Belt
22	Nachingwea Mica field
23	Mahenge-Lushoto Mica belt
24	Mahenge Ruby field
25	Uluguru polymineral field (Ti, Fe, Mica, Gemstone)
26	Mwapwa Mineral field (Cu, Au, Mica, Gemstone)
	Coal fields
27	Ufipa Coal fields
28	Galula Coal field
29	Songwe-Kiwira Coal field
30	Ketwaka-Mchuchuma-Ngaka Coal fields
31	Mbamba bay Coal field
32	Njuga Coal field
33	Mhukuru Caol field

Front cover Map:
Leger, C., Barth, A., Falk, D., Mruma, A.H., Magigitta, M., Boniface, N., Manya, S., Kagya, M., Stanek, K.P., 2015. Explanatory notes for the Minerogenic Map of Tanzania. Geological Survey of Tanzania. ISBN. 978-9987-477-94-4.

Message to participants of the TGS 2015 workshop

The TGS 2015 workshop was organised by the Tanzania Geological Society (TGS) in collaboration with the Department of Geology, University of Dar es Salaam (UDSM). Initially the workshop was meant to mark the 50th Anniversary of the Faculty of Science (FoS), UDSM, established in 1965. The UDSM Faculty of Science expanded to form the College of Natural and Applied Sciences (CoNAS) in 2009. However, the 50th Anniversary of FoS/CoNAS has been postponed to March 2016.

The UDSM Geology Department is one of the seven academic units of CoNAS. The Department was established in 1974 making the University of Dar es Salaam the leading institution in the country for training most of the geoscientists who are working in the sectors of mining, oil and gas, and groundwater.

TGS 2015 brings together all geoscientists in the country and the UDSM geoscientists alumnae to reflect their social economic role in the Tanzanian society and the region at large. It is our aim that a two-days workshop will be a platform for Tanzanian geoscientists to reunite and join hands to build a stronger body for the benefit of each individual, government institutions, and private sectors dealing with geosciences in the country.

For this workshop, more than 20 abstracts are submitted from participants working in private and government sectors. More than 50 geoscientists have registered to attend the workshop. The abstracts, compiled in this book of abstracts, will be presented in one session under four major themes, which include:

1. The role of geologists in mineral business
2. Geologists in building materials, are we doing enough?
3. The current status of the Tanzanian Petroleum & Energy Resources
4. Status of groundwater and the Environment in Tanzania

In addition, TGS members will deliberate on the progress of the establishment of the registration body for geologists that aims at protection and development boost for Tanzanian Geologists. We, the Tanzanian geoscientists should use this workshop to exchange ideas in order to understand better our roles in Socio-Economic Development of our nation as we are key players in the up-, middle- and down- streams in the sectors of minerals, energy and groundwater.

The Organising Committee wishes you a successful TGS 2015 workshop meeting at the University of Dar es Salaam, Tanzania.

Prof. Abdul Mruma (**Chairman**) and Dr. Nelson Boniface (**Secretary**)

ORGANISING COMMITTEE

Prof. Abdul Mruma (Chairman)
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Department of Geology, UDSM

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Department of Geology, UDSM

TGS 2015 WORKSHOP

Abstract titles **page**

WORKSHOP PROGRAMME

Day One: Friday, 27 November 2015

08:00–09:00	Registration	
09:00–09:10	Secretary, TGS: Opening	
09:10–09:20	Chairman, TGS: Welcoming remarks	
09:20–10:00	**Keynote speaker**: Dr. Joas Kabete **Title**: "The role of geologists in the mineral business."	
10:00–10:30	TEA BREAK	
Time	**Presenter**	**Title**
10:30–10:50	Dr. Elisante E. Mshiu	Remote sensing application in earth resources exploration: an alternative approach to restore the Tanzania mineral sector
10.50–11:10	Mr. Paul Mbuya / Mr. Gerald Chuwa	The role of geoscientists in the social development of Tanzania: perspectives from the gold exploration and mining industry
11:10–11:30	Dr. Crispin Kinabo	Demographic and challenges of mineral wealth to artisanal mining in the Lake Victoria Goldfields, Tanzania
11:30–11:50	Mr. I. J. Bisansaba	A decreasing trend of mineral deposits discoveries – a stimulant for innovations and change
12:00–13:00	LUNCH BREAK	
13:00–13:30	**Keynote speaker**: Mr. Sadiki Hamza **Title**: "Status of groundwater and the Environment in Tanzania."	
13:30–13:50	Prof. Hudson H. Nkotagu	Application of environmental isotopes to groundwater recharge studies of the semi arid selected areas of central Tanzania
13:50–14:10	Dr. Isaack M. Marobhe	TEM and electrical soundings for the investigation of groundwater in volcanic rocks of the Mt. Kilimajaro, northern Tanzania
14:10–14:30	Ms. Epiphania G. Mtabazi	Tectonics of the Triassic-Jurassic Mandawa basin of Coastal Tanzania: Implication for Gondwana rifting and drifting
14.30–14:50	TEA BREAK	
14:50–15:10	Dr. Nelson Boniface	Petrological records of Paleo- and Neoproterozoic subduction zone metamorphism in Tanzania
15:10–15:30	Dr. Emmanuel O. Kazimoto	Neoarchean to Paleoproterozoic crustal evolution in the Ubendian Belt, Tanzania
15:50–16:00	Secretary, TGS: Announcements & first day - closing remarks	

Day Two: Saturday, 28 November 2015

09:00–09:40	**Keynote speaker**: Dr. James Mataragio **Title**: "The current status of the Tanzania Petroleum Resources."	
Time	**Presenter**	**Title**
09:40–10.00	Dr. Charles Kasanzu	From source to sink in central Gondwana: coeval exhumation of the Precambrian basement rocks of Tanzania and sediment accumulation in the adjacent Congo basin
10:00–10:30	TEA BREAK	
10:30–10:50	Mr. John Gama	Oil and gas exploration by using 2D and 3D seismic reflection data at Mnazi bay gas field, Tanzania
10.50–11:10	Mr. Chone Lugangizya	Effective anisotropy of a thinly layered reservoir versus fluid saturation
11:10–11:30	Mr. Vincent E. Mosha	3D Petroleum system modelling of the Songosongo source rocks, southern coastal offshore Tanzania
11:30–11:50	Mr. Ernest S. Mulaya	Petrophysical evaluation of a shaly sand reservoir
11:50–12:10	Mr. Emily Kiswaka	2D seismic interpretation, basin and petroleum system modelling of the offshore southern Tanzania
12:10–13:20	LUNCH BREAK	
13:20–14:00	**Keynote speaker**: Mr. Manyama M. Makweba **Title**: "Geologists in the industrial minerals and building materials sector: are we doing enough?"	
14:00–14:20	Dr. Augustina K. Rutaihwa	Strategic extraction and utilization of coal resources of Tanzania for sustainable economic development
14.20–14:40	Mr. Simon Gerald	Exploration and resource estimation of gypsum deposits in Chamwino, Dodoma
14:40–15:00	Ms. Lilian Chacha	The mineralogy of graphite-bearing siliceous marble of Chunyu - Mihewe, SE Tanzania
15.00–15:20	TEA BREAK	
15:20–15:40	Prof. Shukrani Manya	Generation of Palaeoproterozoic tonalites and associated high-k granites in SW Tanzania by partial melting of underplated mafic crust in an intracontinental setting: constraints from geochemical and isotopic data
15:40–16:00	Mr. Steven Urassa	The role of geoscientists in Tanzanian socio-economic development
16:00–17:15	Speaker: Prof. Abdul Mruma Title: "A registration body for geologists: a protection and development boost for Tanzanian geologists."	
17:15–17.30	Chairman, TGS: Vote of thanks & Workshop closing remarks	
17:30–20:00	Cocktail party at the Department of Geology	

A DECREASING TREND OF MINERAL DEPOSITS DISCOVERIES – A STIMULANT FOR INNOVATIONS AND CHANGE

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Mineral Exploration and Mining industry is one of those admired ventures, but it goes with so many challenges. Although the two industries seem to be different but they are quite closely related. Explorationists often face remote harsh conditions, modern explorationists have to deal with deep cover, new technologies, and enormous accumulation of data as well as local communities' engagement in early stages. Mining on the other hand is challenged to break and move thousands of tonnes each day in a manner that is safe and cost effective.

In cycles, From Boom to Bust, there has been significant variations of Exploration spend in the industry over the last forty years worldwide. The expenditure can be reduced to as low as 60%, during a down turn. This is significant and can affect the discovery process, and in particular new ones. Tanzania has not seen a world class Gold deposit discovery for the last decade, although there has been significant additions of Mineral Resources and Reserves in the industry locally.

This presentation briefly shares where does exploration money go and why the country (Tanzania) has not seen tier 1 deposits discovered in the last decade. It is argued here that there has been some tier 2 or 3 or less deposits which have not so far been feasible. The reason to author's opinion is that those deposits have been of decreased quality. Low quality in terms of grades, quantity and accessibility. Nevertheless, this presents opportunity for Innovation and change.

Pressures for quality discoveries, feasible mine projects at this era would require innovation. To Explorationists; (1) Embracing and effective applications of advances in geochemical, geophysical and remote sensing technology. (2) Taking advantage of advances in understanding of Ore forming processes. (3) Embracing new ways to integrate and interrogate data. These are key in general terms.

On the other dimension, particularly in Tanzania, The explorationists have to continue looking for different commodities other than metals. The recent discovery of Graphite in search for Uranium is a classic example, a change is

paramount. In the mine front, the increasing age of many existing operations means increasing costs of operations, when this is combined with decreased cut offs the pressure for innovations and change amounts. Miners have to continually improve /embrace; (1) mine to mill site specific parameters to optimise fragmentation sizes. (2) Grade and physical characteristics of ore bodies in the “right scale” (3) Characterisations of Waste rock and tailings beyond simple NAF and PAF. (4) Modern effective fleet management in operations.

From Regulators front, it is argued that the government should always be mindful of what is happening in the industry globally and be able to change to accommodate the “challenges of the era”. In general the government should be able to provide a more mining and exploration friendly environment. Also the government should be able to provide to the industry a competitive geological database to improve perception of the country’s mineral potential.

There is a history of innovation and change in the industry, such as new ways to engage with local communities and government; advances in mine performances approach and exploration techniques. These require a more looking forward thinking and adventurous company’s traits, which with commitment in exploration, an improved new quality discoveries are possible.

APPLICATION OF ENVIRONMENTAL ISOTOPES TO GROUNDWATER RECHARGE STUDIES OF THE SEMI ARID SELECTED AREAS OF CENTRAL TANZANIA

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Environmental isotopes of ^{3}H, ^{2}H and ^{18}O have been used to delineate groundwater recharge rates and mechanisms in a semi-arid selected areas of central Tanzania, The area is predominantly underlain by fractured crystalline basement aquifer systems that are overlain by weathered rocks that form intergranular shallow groundwater flow system.

Water samples from deep and shallow groundwater flow systems along with the rainfall events and surface water bodies were collected and analyzed using standard methods for the isotopic and chloride content of the study area. The distribution of ^{3}H, $\delta^{2}H$ and $\delta^{18}O$ data along with chloride values among adjacent boreholes indicate that groundwater recharge is predominantly due to local rainfall and is about 3% of the long term mean annual rainfall of 550mm. The isotopic and chloride data show sporadic variations in $\delta^{2}H$ and $\delta^{18}O$ among adjacent boreholes indicating existence of discrete fractured aquifer systems. The $\delta^{2}H$ and $\delta^{18}O$ content of deep and shallow groundwater along with both surface water bodies and local rainfall at the study area indicate that groundwater recharge mechanism is through both matrix and macropores flow using preferred pathways under by pass flow mechanism. Chloride data show that 60% and 40% of groundwater recharge is through Macropores and matrix flow respectively. Consequently the chemical character of groundwater is found to be influence by the recharge mechanism where both Nitrate and fluoride data are observed to be abnormally high.

It has been concluded that the isotopic and chemical character of groundwater in fractured semi arid areas may provide the most effective complementary means of groundwater recharge assessment and therefore is very useful in the management of the water resources.

DEMOGRAPHIC AND CHALLENGES OF MINERAL WEALTH TO ARTISANAL MINING IN LAKE VICTORIA GOLDFIELDS, TANZANIA

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ASM in Tanzania plays an important role as a dynamic contributor to local economic growth and survival of a rapidly growing population estimated at more than 44.9 million people. The government's efforts to improve the sector however faces challenges, as stated in the new 2010 Mining Act, which requires the Government to facilitate social and economic welfare of the miners. To achieve its goals, Government has in 2011 conducted its second baseline survey (last survey was 1996) in order to evaluate performance of ASM activities and prepare ASM viable social economic programs.

This paper outlines the demographic distribution people engaged in ASM, the prospects, opportunities and challenges facing ASM in the Lake Victoria Goldfields. Activities 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. It's noteworthy to mention that, compared to 1996 census, new emerging mining activities include mining of gemstones, moonstones, base metal (Pb, Zn and Cu) ores.

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 reglating the sector.

EFFECTIVE ANISOTROPY OF A THINLY LAYERED RESERVOIR VERSUS FLUID SATURATION

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Anisotropy has proved to be a reliable means for determination of the rock properties necessary to characterize the subsurface. VTI is a form of anisotropy which provides an estimate of the layered earth. This report summarises a work done on well data acquired in one well in Cote d'Ivore. The data consisted P- and S-waves velocities and density of isotropic thin layers at different fluid saturations.

Backus averaging was used for creation of the effective medium in the form VTI. Stiffness coefficients of the effective media were then determined from which the vertical P- and S-waves velocities were calculated. Additionally, the three anisotropy parameters, epsilon, delta and gamma were calculated for each fluid saturation. Analysis of the variation of all the five parameters has been made, from which the P-wave velocity has been found to increase when water is in the pores as compared to oil and gas. Fluid substitution has been found to have a negligible effect on S-wave velocity and gamma.

Gas has also been found to have the largest effect on P-wave anisotropy. The move out parameter delta has been observed to have a more complex response to fluid substitution bringing an attention and a call to revisiting the conclusion that eta is invariant of fluid saturation.

EXPLORATION AND RESOURCE ESTIMATION OF GYPSUM DEPOSITS IN CHAMWINO, DODOMA

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Tanzania has a large potential of industrial minerals, for example, there is a large number of soda, kaolin, gypsum and phosphate deposits. As geologists we have a role to play in ensuring contribution of these resources in our economies and for the country at large. Despite having several monetary institutions in the country, funding in the industrial minerals sector is reported to be a major hindrance. This study suggests that resource estimation for industrial minerals would probably be a step towards attracting funds enough for small and medium scale mining. GIS tools like ArcGIS and MapInfo, quantitative and qualitative analysis (such as XRD and XRF); are techniques easily accessible in Tanzania. The above techniques have been very useful in the exploration and resource estimation of industrial minerals. We are presenting the use of some of these methods in exploration and resource estimation of gypsum in Manda village in Chamwino district, Dodoma.

FROM SOURCE TO SINK IN CENTRAL GONDWANA: COEVAL EXHUMATION OF THE PRECAMBRIAN BASEMENT ROCKS OF TANZANIA AND SEDIMENT ACCUMULATION IN THE ADJACENT CONGO BASIN

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Apatite fission track (AFT) and (U-Th)/He (AHe) thermochronometry data are reported and used to unravel the un-roofing history of crystalline basement rocks from the elevated (>1000m a.s.l.), but low relief Tanzanian craton (TC). Coeval episodes of sedimentation documented within adjacent Paleozoic to Cenozoic basins of southern Tanzania and the Congo Basin (CB) of the Democratic Republic of Congo (DRC) indicate that most of the exhumation/cooling in the basement rocks in Tanzania was linked to erosion. Basement samples were from an exploration borehole located within the central TC, and up to 2200 m below surface. AFT dates range between 317 ± 33 Ma and 188 ± 44 Ma whereas FT corrected AHe dates are between 533 ± 86 Ma and 149 ± 23 Ma. Joint inverse modeling of the AFT and AHe data reveals two important discrete periods of cooling; one during the Carboniferous-Triassic (350 – 220 Ma) and a later, less well defined period, during the late Cretaceous-Paleogene (ca. 100-30 Ma). Using a geothermal gradient of 10^{o} C/km constrained by the AFT and AHe data and a mean surface temperature of 20^{o}C, cratonic data indicate removal of up to 7 ± 2 of overburden since the end-Palaeozoic. The correlation of erosion of the TC and sedimentation and subsidence within the CB in the Palaeozoic is likely induced by far field stresses related to compressional tectonics during the formation of Pangea, and the later event is linked to intraplate tectonics related to the early phases the East Africa Rift System.

GENERATION OF PALAEOPROTEROZOIC TONALITES AND ASSOCIATED HIGH-K GRANITES IN SW TANZANIA BY PARTIAL MELTING OF UNDERPLATED MAFIC CRUST IN AN INTRACONTINENTAL SETTING: CONSTRAINTS FROM GEOCHEMICAL AND ISOTOPIC DATA

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The southwestern part of the Palaeoproterozoic Usagaran Belt in the Njombe area of SW Tanzania is intruded by two types of synchronous granitic rocks with different chemical and petrological characteristics. The first type consists of hornblende-rich tonalites that have major element compositions similar to those of Archaean TTG but differ significantly in their trace element composition. The tonalites are spatially and closely associated with felsic, high-K, I-type granites, some of which are gneissic and/or aplitic.

U-Pb zircon geochronology shows that the emplacement of tonalites at 1887±11 Ma was largely contemporaneous with emplacement of high-K granitic gneisses at 1877±15 Ma and aplitic granites at 1857±19 Ma. The data also reveal the presence of Archaean crust of 2648±25 Ma in the zircon cores of some samples in the otherwise Palaeoproterozoic terrane. The tonalites are characterized by MgO contents of (1.60 – 4.11 wt%) at a SiO_2 range of 58.1 – 67.9 wt %, the Mg# of 34 – 55, lower Sr contents (220 – 462 ppm) and less fractionated REE patterns (La/Yb_{CN} = 3.55 – 12.9) compared to Archaean TTG (Sr > 500 ppm, La/Yb_{CN} > 20). These features, coupled with the εNd (1887 Ma) values of +0.37 to -4.23 as well as the associated mafic enclaves are suggestive of derivation of the tonalites by low pressure partial melting of a mantle-derived mafic underplate that was subsequently contaminated with small amounts of pre-existing igneous crustal rocks. The evolved nature of the high-K granites (MgO = 0.20 – 1.30 wt%, SiO_2 = 65.5 – 73.9 wt %, Mg# = 25 – 42, εNd = -3.20 to -4.75) coupled with old TDM ages which are 200-1000 Ma older than their emplacement age requires a higher degree of assimilation of older crustal material by the magma derived from partial melting of the underplated mafic crust.

The close spatial and temporal association of the tonalites, mafic enclaves and the high-K granites and gneisses in the Njombe area provides the first direct evidence of the role of magmatic underplating for the regional thermal anomaly that caused widespread crustal anatexis leading to the generation of the 1.8 – 1.9 Ga granitic rocks and associated felsic volcanism in the Usagaran and Ubendian Belts of SW Tanzania.

GEOLOGISTS IN THE INDUSTRIAL MINERALS AND BUILDING MATERIALS SECTOR: ARE WE DOING ENOUGH?

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Industrial minerals are defined as naturally occurring rocks or minerals of economic value, exclusive of metallic ores, mineral fuels, and gemstones (Bates and Jackson, 1984). Others define industrial minerals as geological materials which are mined for their commercial value, which are not fuel (fuel minerals or mineral fuels) and are not sources of metals (metallic minerals). In fact, there are several definitions of the industrial minerals but all are excluding the fuel minerals and metallic minerals in this group and hence are generally classified as non – metallic minerals and non – fuel minerals. The typical examples of industrial rocks and minerals commonly occurring in Tanzania include: limestone, clays, sand/silica sand, diatomite, kaolin, bentonite, gypsum, granites, graphite, marble, slate, zeolites, pumice, magnesite, asbestos & mica. In the provided examples of the industrial rocks and minerals, the clays, sand, granites, marble & pumice fall in the building materials category by definition of building materials being naturally occurring materials/substances used for construction purposes. In this case then, the speech will cover all materials which fall in the industrial minerals as well as the building materials categories.

Tanzania is endowed with the vast occurrences of industrial minerals and building materials which are mined mainly for domestic use. Rocks and minerals such as limestone, gypsum, kaolin, marble, slates, pumice and granites are known to occur in many parts of the country and are mined and processed for domestic use. Materials such as clays and sand are mined in different places in the country and are used in construction industries. Exploitation of industrial minerals and building materials available in Tanzania has not been done at the level which is related to the demand of the products of industrial minerals and building materials.

For instance, there are high demands of ceramics products which are mainly required in the construction industries. These ceramics products include plates and cups, floor and wall tiles, sanitary wares, glass products just to mentioned a few. Most of these ceramics products can be produced locally

from the kaolin, marble, gypsum, silica sand, granites and slates, but the product available in the market are mainly imported. Though it has been said that the market of the industrial minerals and building materials is dictated by the needs of the population and the performance of the national economy, there is no doubt that the current demand of ceramics, glass and gypsum products leave a challenge to geologists in Tanzania that the need of promoting the industrial minerals and building materials to the local and foreign investors is of paramount important.

GEOTOURISM: AN AREA THAT NEEDS SPECIAL ATTENTION IN TANZANIA

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Tanzania is structured on a granitic nucleus Archaean Craton. Younger crystalline rocks of Proterozoic to Recent age progressively rim the granitic nucleus. The younger sedimentary rocks occupy the coastal plains and inland basins with the volcanics filling the rifted grabens. The Archaean, Proterozoic, Mesozoic, and Cenozoic rocks occur in Tanzania. With respect to Geotourism (nature based tourism), Tanzania is endowed with plentiful natural wonders including the Ngorongoro Crater (largest volcanic crater in the world), the Kilimanjaro (the roof of Africa highest volcanic peak in the world-5895 m a.s.l), the Oldoinyo Lengai (the only active volcano, erupting natro-carbonatite lava on the planet earth), the Oldupai Gorge (a cradle of mankind, home of first hominid), the Wingayongo bituminous sandstone Hill in the Rufiji Basin (signify presence of liquid petroleum along coastal Tanzania), the Tendaguru area (most famous Dinosaur locality in Africa), and many more. Some geosites in Tanzania are ill- protected thus vulnerable to vanishing. Integration of Geotourism in the Tanzania tourism industry with Geosites conservation approach for the benefit of the community close to the Geosites and the General Public is crucial. In Tanzania, publications on Geotourism are scarce. Geoscientists in Tanzania can change this, by conducting various researches/studies (in Tanzania) that are related to Geotourism. Results of such studies will reveal best ways that can be used in conservation of favorite geosites in the country and establishment of Geoparks in Tanzania-to enhance Tourism and Geotourism in the country and contribute to social-economic development.

NEOARCHEAN TO PALEOPROTEROZOIC CRUSTAL EVOLUTION IN THE UBENDIAN BELT, TANZANIA

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To unravel the crustal evolution of the linear Paleoproterozoic Ubendian Belt in Tanzania, we studied the rocks in its NE part geochemically and petrologically and determined their ages by LA-ICP-MS U-Pb zircon and U-Th-total Pb microprobe monazite dating. Internal textures of the zircon crystals in combination with their U-Pb ages indicate that the magmatic crystallization of the protoliths of the orthogneisses and metabasalts occurred in the Neoarchean (ca. 2.71 – 2.64 Ga) but also in the Paleoproterozoic (2.05 – 1.94 Ga). These two intervals are interpreted as active continental margin stages separated for about 600 Ma. The metabasalts, gabbros and orthogneisses are sub-alkaline in composition with a REE and trace element geochemistry akin to those rocks formed in arc settings. HFSE-ratios like Zr/Y, Ta/Yb, Th/Yb, Th/Hf, Ta/Hf and Th/Ta suggest a continental arc setting for the formation of gabbros and the precursor rocks of the metabasalts and orthogneisses. Detrital zircon from the metasediments gave ages ranging between 2.64 and 2.05 Ga, suggesting a Neoarchean and Paleoproterozoic sediment source similar in age to rocks of the Katuma Block of the Ubendian Belt. The time interval is correlated with a passive continental margin stage. During this time, the metabasalts of the Katuma Block experienced a near-isobaric metamorphic cooling history in the deep crust.

Geochronological and petrological data suggest that during the Paleoproterozoic time the Katuma metapelites experienced two metamorphic events at about 1.97 Ga and 1.84 Ga. The first metamorphism reached the kyanite stability field. The second metamorphism was in the sillimanite-garnet/cordierite stability field in the course of a clockwise P-T evolution, correlated with a continent-continent collision after subduction of a oceanic crust at 1.88 – 1.86 Ga. In summary, our new age data point out that the northeastern Paleoproterozoic Ubendian Belt consists of Neoarchean and Paleoproterozoic protolith rocks that experienced their main metamorphic reworking during Paleoproterozoic orogenic events.

OIL AND GAS EXPLORATION BY USING 2D AND 3D SEISMIC REFLECTION DATA AT MNAZI BAY GAS FIELD, TANZANIA

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Seismic interpretation over Mnazi Bay gas field in the South Eastern part of Tanzania was performed by using 2D/3D seismic and well logs data. The main objectives of this study were to map the keys horizons/structures and produce structural maps, to map all possible prospects, assessing and ranking them according to the risk, and lastly to conduct volumetric of proposed prospects and propose for the new drilling targets. Lower sand packages (contains C, D, E tops sand) and Upper sand packages (F, G, I tops sand) both of Mio-Oligocene age, also regional markers such as Pliocene, Lower Oligocene, and Eocene and upper Cretaceous were mapped using 2D/3D seismic data. Fault interpretation was performed utilizing both 2D/3D seismic has identified NNW-SSE listric fault cross-cutting NE-SW which comprises structural traps of Mnazi Bay field, these fault were integrated with horizons maps to produce structural maps.

From this Interpretation several stratigraphical and structural traps were identified and mapped, also Hydrocarbon indications were identified on the seismic section. This interpretation proposed three Prospects to be drilled, Prospect A (GPoS =17 %), Prospect B (GpoS=23 %), Prospect C (GpoS=21 %).Volumetric estimation of these prospects has several uncertainties due to the shortage of well data used. 3.8Mcf was estimated to be recovered for prospect A, 17.5Mcf for prospect B and 8.5Mcf for prospect C, all property used for volumetric was obtained from a single well Mnazi Bay-1. All these prospects are very risks to be drilled, these risks are associated with channelized and discontinuous sands, and sealing property within Mnazi bay channel structures.

Based on the prospect ranking and estimated volumes obtained, prospect B is proposed to be drilled first while prospect A which is located in the south western part of the Mnazi Bay licence is proposed for 3D seismic acquisition in-order to obtain high quality seismic data to image the under explored South Western of the licence, and finally to analyse all risk and propose for

the possibly drilling targets. More wells were recommended to be integrated for further interpretation in the 3D seismic cube, as this interpretation was based only on the extrapolation of the 2D seismic interpretation into 3D seismic cube thus some horizons such as Pliocene, Upper Mnazi Bay (Mio-Oligocene age), and Upper Cretaceous were not interpreted.

PETROLOGICAL RECORDS OF PALEO- AND NEO-PROTEROZOIC SUBDUCTION-ZONE METAMORPHISM IN TANZANIA

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High-pressure metamorphic rocks in the Ubendian-Usagaran Orogenic Belts records fluid-related processes at Paleoproterozoic and Neoproterozoic subduction zones. Recent in-situ zircon and monazite geochronological data, including our own new data, reveals a poly-orogenic nature of the Ubendian-Usagaran Orogenic Belts. Different tectonic terranes in the Ubendian Belt recorded unique tectonometamorphic history during the Proterozoic orogeny. The earliest Pacific-type subduction of basaltic rocks manifested by relics of eclogites of MORB-affinity is recorded in the Paleoproterozoic Ubende Terrane. Lithologic associations of the terrane indicates that the eclogites represent a tectonic slice of a subducted oceanic lithosphere. Eclogite-granulite transitional-facies metabasalts yield U–Pb zircon ages of 1.89 – 1.86 Ga as a subduction event that was followed by a collision of cryptic nature at 1.83 Ga.

The Ufipa Terrane in central Ubendian Belt hosts kyanite-bearing eclogites that were overprinted by a Pan-African granulite-facies reginal metamorphism. Despite the high-temperature overprinting event, eclogite-facies stage kyanite and garnet preserve inclusions of prograde clinozoisite and omphacite. Zoned metamorphic zircons contain fluid inclusion-bearing cores of 1.96 Ga for a prograde eclogite-facies stage and rims of 605 Ma granulite-facies overgrowths. In contrast, kyanite-free eclogite were formed during Neoproterozoic time between 590 and 520 Ma in a Pan-African suture that separated the Tanzania Craton from the Bangweulu Craton. The Neoproterozoic eclogites have also MORB-type geochemistry and contains minor Cl-rich amphiboles. Development of omphacite-rich veins suggest fluid infiltration and consequent mineral precipitations during eclogite-facies metamorphism. In this contribution, we will present new insights, including our on-going project, into the Proterozoic subduction-zone metamorphism and metamorphic evolution of the Ubendian–Usagaran Orogenic Belts.

PETROPHYSICAL EVALUATION OF A SHALY SAND RESERVOIR

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Shaly sands as the name implies refers to sands with a shale component. These shales are a very significant component of shaly sand reservoirs. The increased volumes of shale decrease the effective reservoir capacity. At the same time, the electrical properties i.e. conductivity of shales reduce the formation resistivity hence must be corrected for the evaluations and identification of net pay and reliable assessment of hydrocarbon saturation.

The problem becomes acute in a thin-layered/laminated and shaly sand formation whose beds are thinner than the vertical resolution of the conventional resistivity and porosity measurement tools. The saturation estimated from the conventional resistivity measurements give the cumulative or weighted average of the individual layers response of both shale and sand laminae and are dominated by high conductive shale/clay effects which obscure the presence of more resistive hydrocarbon bearing sands. Direct interpretation of the log reading therefore results in a significant underestimation of hydrocarbon saturation in shaly sand reservoirs. Because one of the common parameter to derive water saturation is from porosity and resistivity and since the conventional resistivity is dominated by high conductivity shales in shaly sand reservoir, then the correct possible formation resistivity must be sought for before evaluating different saturation models related to shaliness effects through petrophysical approach for reliable assessment of hydrocarbon potential.

The effects of resistivity anisotropy on the induction resistivity measurement have been known since the 1950s, but until recently there has been no way to resolve the horizontal and vertical components. By taking the 3D triaxial induction measurement in essence a tensor rather than a scalar approach, these types of ambiguities and errors can be fully resolved. Many of the limitation inherent in induction logging have now been overcome with the Rt Scanner triaxial induction service providing true resistivity in deviated wells and dipping beds (Anderson et al, 2008).

The aim is to propose a petrophysical approach to account for clay and thin laminations effects in shaly sand reservoir and to infer its impacts to the reservoir quality in terms of fluid saturation model and suggest the reliable assessment of hydrocarbon saturation and volume hence the study is expected to deliver plausible petrophysical parameters and saturation calculations to be used in reserve calculation for the particular reservoir under study.

The data for this study comprises of core report for one well, log prints in PDF and in Digital Log Interchange Standards (DLIS) format composed of different curves for various petrophysical measurements and all the work done using the Techlog™ software. Calculation of water saturation using basic Archie equation and shaly sand equations by comparing and discussing the results gives further insights into the variation of hydrocarbon potential under different techniques and petrophysical parameters.

THE ROLE OF GEOLOGISTS IN THE MINERAL BUSINESS

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Introduction

The Minerals Business dates back in early human history of Copper and Bronze Ages in what was relatively small mine diggings in today's rankings. In Tanzania, for example gold prospecting and mining were taking place in today's Lake Victoria, Lupa and Mpanda Goldfields Regions since the early 1900s. It was not until around 1966 when the gold mining industry deteriorated for various reasons, including: 1) low world gold price; 2) sanctions imposition on apartheid South Africa; 3) lack of funding for exploration and existing gold mines; and 4) lack of enough geologists and mining engineers. We are currently in presence of items 1 and 3!

Following the 1970-1980s global economic reforms, the government encouraged companies to invest in the country. Faced with limited financing, but equipped with sense of purpose, business strategies and sound geological knowledge and experience, geologist-led Junior Companies (i.e. Samax, Cluff, Pangea Minerals, among others) embarked on systematic exploration programs that led to a number of re-discoveries including ~130t Au Golden Pride (BHP/Samax), ~900t Au Sanza-Geita and Kukuluma-Matandani Gold Camps (Cluff and Samax); ~550 t Au Bulyanhulu (Sutton) and 150t Au Nyabirama, Nyabigena prospects (Afrika Mashariki), from among other historical goldfields. Professionalism through which geological assessments and resource evaluations were conducted by Junior Companies attracted large-scale mining companies such as AngloGold Ashanti, BHP Minerals, Barrick, who in addition to acquiring their mineral properties pouched their best local Tanzanian Geologists. These geologists have never looked back since then. They are still making contributions to new discoveries wherever they are. They are still young! We need them back!

Apart from Junior Companies' geologists, Government (MADINI DODOMA) and STAMICO geologists highlighted the geological attractiveness pertaining to the Bulyanhulu Gold Deposit. Through protracted drilling programs over 1.5km strike-length and >200m deep gold-hosting

multiple shear zones was drill-outlined (in the late 1970s the Geological Survey of Tanzania under the late Prof. Nanyaro were first to dril before a follow up drilling by STAMICO (Mzee Kissae) from early 1980s), prior to Placer Dome's 1989's first move onto the property.

Technical Uncertainties

Given inherently risks typical of exploration investment (i.e. monetary and time: Fig. 1), the Industry still embark on programs targeting for economic mineral deposits! In this process, geologists identify technical uncertainties and mitigate them from the onset of exploration process (Fig. 1). Commonly encountered ones include: 1) geological uncertainties on deposit type and geometries (will deposit develop into an open pit or under-ground mine); 2) estimation of endowment (inferred to proven resource); 3) metallurgical characteristics (provide management enough time to strategize extraction methodologies and plant designs); 4) proximity to key infrastructural set ups (e.g. power, accessibility, and water critical from the onset of the project such as Kabanga Nickel).

Financial and Market Uncertainties

Although geologists can predict with certain degree of confidence whether a project would be commercially profitable (technical risks), those predictions are likely to be compromised by fluctuations in metal prices, unstable interest rates, exchange rates, inflation/deflation of US$ as well as global supply and demand of metals. Other risks such as political-economic and inconsistent government policies and regulations can be controlled by government.

All stakeholders are aware of the current market downturn facing the precious metals, energy and industrial minerals, which is probably due to the strengthening of the US$ and/or slowing down of economic growth in China, among other consumers. Among other stakeholders geologists in the Minerals Business are going through worst times in their careers' history. As a key stakeholder, Government should think of policy changes to improve attractiveness for the exploration investment and the mining business as a whole

Summary and Recommendations

Successful minerals business relies on relationships between Government and Industry Stakeholders. Government and Community Stakeholders through capacity building programs understand the how the Mineral Industry as a Stakeholder operates (LSM/ASM). This is because the Mineral Industry mainly LSM, require commercial and social licenses to operate, not only in the country but more importantly on the ground. As well, Government must react on the current slump in exploration investment, which is affecting the Mineral Supply Chain (Kabete and Ntungicimpaye, 2014), an important driver to our national economy.

The future of the Minerals Business in the context of the Mineral Supply Chain lies within geologist's readiness to change the trend (Fig. 2). For example, GST is rightfully busy planning and collecting new data, mostly at regional to terrane scale. However, given the growing maturity of terranes, a unified approach incorporating prospect to regional scale datasets would be required to accomplish scientific targeting for new deposits. GST's abundant regional-province scale datasets, should be complimented with prospect-camp scale drilling results, geochemistry, geophysical imagery, detailed geological maps, and tenement information, held by exploration and mining companies. The entire data packages could be merged and blended to form an integrated product that together with GST dataset system could contribute to discovery-driven scientific targeting for companies wishing to have a re-look at areas previously explored by others (Fig. 2). As we all know discoveries have been made to areas that have had more than one round of exploration by different companies.

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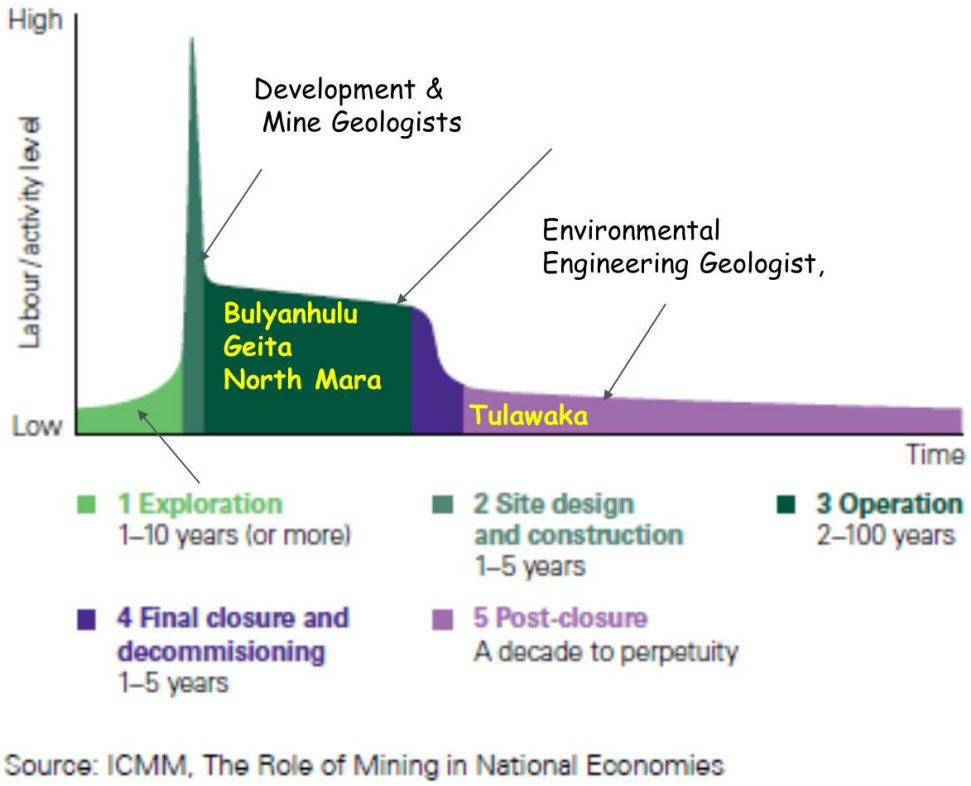

Source: ICMM, The Role of Mining in National Economies

Fig.1 Geologist's best case scenario: Their involvement from targeting to mine closure

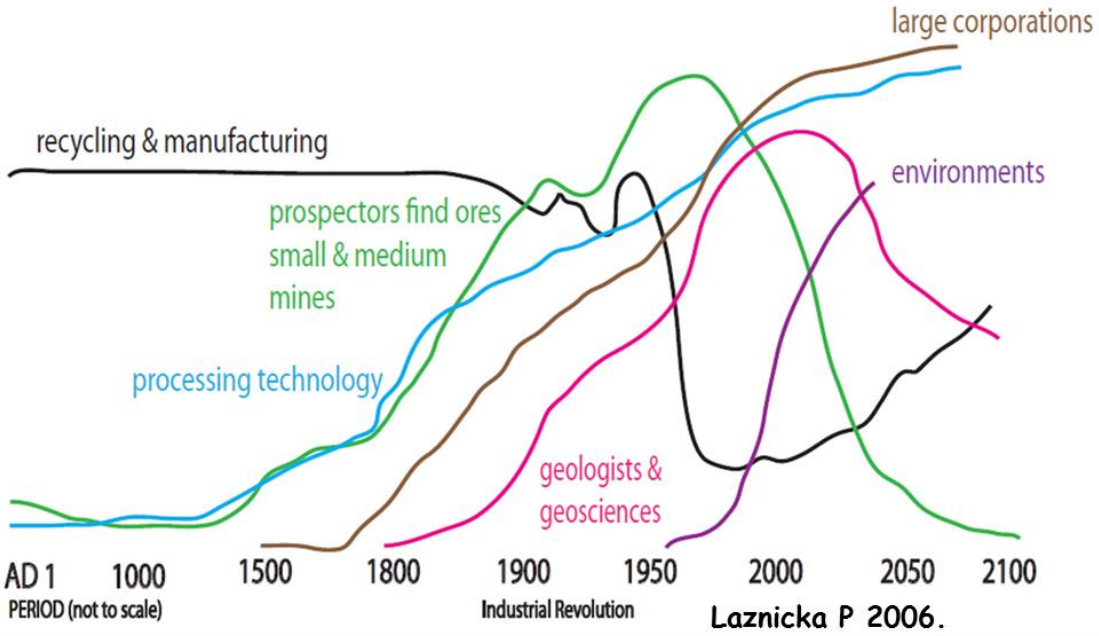

Fig. 2 Is this where geologists' future is in the 21st Century? NO: Geologists must be ready to learn, unlearn, and relearn (Alvin Toffle) to avoid these predictions.

THE ROLE OF GEOSCIENTISTS IN TANZANIAN SOCIO-ECONOMIC DEVELOPMENT

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Despite the fast growth of mining industries in Tanzania, which contributes to the economy of the country, the field of geosciences have still a lot of roles to do to overcome some of the top challenges that impact the mining industry. In order to discover, quantify and qualify also maintain the quality of the estimated ore body to ensure high recovery of the grade for the future benefits of the company and socio-economic development of the country, geoscientist is a steward to facilitate this process. This abstract covers some of the most important aspects of geoscientist in the mining industries; Geological and geotechnical mapping to understand type and nature of lithologies available, different structures, which help to control mineralization and any ground controls that can impact the operations.

Grade Control, this start from the planning of close spaced drill holes to help intercept the ore body, ensuring quality of samples recovered from drilling, geological interpretation of lithologies, structures and assays data for better understanding of geological controls and grade continuity in the deposit to develop useful models, mining operations and selective mining to maximize ore recovery and reduce ore dilution. Another important aspect of grade control is the monitoring of ore movement after blast to determine the distances and directions of horizontal and vertical movements.

Geological and geotechnical logging to identify lithologies, lithological contacts, structures and their natures, types of alterations and mineralization available, degree of jointing or fractures (RQD) and the measure of strength of the rock (UCS). Performance monitoring – reconciliations are carried out to highlight performances of reserve and grade control models. The Mine Call Factor (MCF) being the ratio of actual recovered plus tails to that estimated grade using samples and models is monitored regularly.

REMOTE SENSING APPLICATION IN EARTH RESOURCES EXPLORATION: AN ALTERNATIVE APPROACH TO RESTORE THE TANZANIA MINERAL SECTOR

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Mineral sector is one of the main backbones of the Tanzania economy. However, in recent years the Tanzania mineral sector has been observed to slow down. Major gold mines are depleted (e.g. Tulawaka, Golden Pride-Resolute and Buhemba) and at the same time there are no reported potential deposit discoveries, those of the likes of Bulyanhulu and Geita gold mines. This is the indication that the Tanzania mineral sector is declining. The observed problem will have a negative impact in the economy, taking into account that mineral sector contribution is around 50% of the total foreign income in Tanzania. The geology of Tanzania supports the presence of different mineral resources. But why there are no potential discoveries? We need to find solution.

Exploration techniques of recent technologies would be the best option to be included in the approaches that have been used in exploration. Recent technologies, for example remote sensing, are reported to have a positive impact in the discovery of mineral deposits in different areas of the world. Remote sensing data have been increasingly used in mineral exploration in the last two decades and have contributed to a large extent in revolutionizing the exploration industry. Their use in mineral exploration has played a big role in the discovery of a large number of world-class mineral deposits e.g. in South America and Australia. However, remote sensing has not been applied effectively in the mineral exploration industry in Tanzania, and so far its potential is not well known.

Recent studies have revealed positive results of remote sensing approach if employed in Tanzania. Innovative use of the data, for example, the multispectral remote sensing data, can depict precisely the hydrothermal related gold deposits. The designed method has mapped potential targets in the Bulyanhulu Mining district including the Bulyanhulu Gold Mine itself. The advantage with the remote sensing data is that most of them cover large areas when compared to other data sets; this makes the data useful in studying mineralization trends. Remote sensing data are also relatively cheap and some can be downloaded for free from different sources.

STRATEGIC EXTRACTION AND UTILIZATION OF COAL RESOURCES OF TANZANIA FOR SUSTAINABLE ECONOMIC DEVELOPMENT

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Economic coal seams in the South West Tanzania occur in the Mchuchuma Formation (Semkiwa 1992) with indicated resources of 1.5 billion metric tonnes of coal. The seams occur in two distinct facies; the sandstone-coal facies (SCF) and shale-coal-sandstone facies (ShCF). The ShCF is found in all ten coalfields namely: Songwe-Kiwira, Keteweka-Mchuchuma, Ngaka, Njuga, Mhukuru, Mbamba Bay, Galula, Muze, Namwele-Mkomolo and Liweta; while the SCF have been observed in Mchuchuma and Ngaka coalfields only.

Currently mining work is at Ngaka Mine only. As this work progress, it is of a paramount importance to embark on conducting characterization studies for coals in different coalfields geared at delineating different coals for different utilization potential, hence, ensure guided licensing, extraction and utilization of these resources. Bearing in mind that coal is a complex heterogeneous material composed of a number of distinctive entities called macerals (> 50 wt %) and lesser amount of inorganic substances called minerals. Characterization of the macerals and the mineral content in coals provide insight into expected systematic deviations of coal properties. Characterization of coal after different treatments gives a theoretical behavior of coal in treatment plants and the possible end uses.

A database of coal composition (petrography, mineral content and major and trace elements content in each coalfield, individual seam and associated lithotypes) including coal properties and beneficiation characteristics for individual coal seams; will provide a guidance to investors and decision makers on the best possible use of these resources. Depending on the intended use (power generation, metallurgical, cement making, gasification, liquefaction, petrochemical etc) the investors will be able to predict how coal from different locations will respond to cleaning and will derive an effective and environmentally friendly way of utilizing the resources.

TECTONICS OF THE TRIASSIC-JURASSIC MANDAWA BASIN OF COASTAL TANZANIA: IMPLICATION FOR GONDWANA RIFTING AND DRIFTING

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Our new field structural observations, digital elevation modal (DEM), seismic and magnetic data from the Triassic-Jurassic Mandawa Basin of coastal Tanzania demonstrate tectonic results of Gondwana rifting and dextral strike slip movements associated with the rifting and drifting of Madagascar from East Africa in Jurassic time. The results reveal two major deformation events, in the history of Mandawa Basin formation, named D1 and D2 in this study. The D1 event generated the NNW-SSE trending deep-seated normal faults, and T-fractures. The geometry of these structures suggests that, the ENE-WSW extensional movements, probably associated with the rifting of Gondwanaland during Permo-Triassic time, generated them. The D2 event was the most important deformation episode, which is widely distributed on regional scale as well as on outcrop scale. The NNE-SSW, NNW-SSE and ENE-WSW Riedal shears, dextral strike slip faults, sinistral faults, normal faults and T-fractures characterize D2 event. The D2 event is probably related with the NNW dextral shear zone with NW-SE extensional movements, probably generated during the drifting of Madagascar along the Davie transform fault during the Jurassic time. The geometry of Mandawa Basin suggests pull-apart origin, generated by transtensional event, followed by successful reactivations.

TEM AND ELECTRICAL SOUNDINGS FOR THE INVESTIGATION OF GROUNDWATER IN VOLCANIC ROCKS OF THE MT. KILIMAJARO, NORTHERN TANZANIA

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The Kilimanjaro Plantation Ltd (KPL) farms, located on the slopes of Mt Kilimanjaro consist of 8 farms. The farms were investigated for the presence of groundwater using the Transient Electromagnetic Method (TEM) and Vertical Electrical Soundings. The geology of the area is dominated by volcanic rocks that consist of rhomb poryphyrs overlying the agglomerate. The drainage is mainly towards the south along the slopes of Mt. Kilimanjaro.

A total of 53TEM soundings were conducted covering all the farms owned by KPL. The square cable of 40 m by 40 m was able to reach a depth of investigation ranging from 80 to 200 m. Interpretation of the sounding points revealed a potential aquifers located beneath the highly resistive volcanics below a depth of 100 m and with thickness greater than 30 m. This depth is in agreement with the productive borehole drilled to a depth 130 m of which the TEM sounding revealed an aquifer at a depth of 125 m with resistivity of 17 Ohm-m. Based on the results, the aquifers in the area are characterised by resistivity ranging from 10- 100 Ohm-m.

The TEM sounding studies were complimented by 7 vertical electrical soundings that was conducted with current electrode separation ranging from 1- 1.5 km. The study revealed presence of potential aquifers at depths below 100 m. Previous VES studies using current electrode separation of 400 m was not enough to reach the deep aquifers as rocks above the aquifers have very high resistivity. The TEM survey was found to be more effective in this environment as compared to other geophysical surveys conducted in the area such as NMR and VES, which failed to reach the deep-seated aquifers.

THE MINERALOGY OF GRAPHITE-BEARING METASEDIMENTARY ROCKS OF CHUNYU-MIHEWE, SOUTH EAST TANZANIA

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Graphite is a rare mineral that has unique chemical and physical properties, which makes it important in high technology applications and green energy initiatives. The process of forming graphite in rocks, from carbonaceous rocks, is of importance as it leads to formation of different array of carbon structures that are of industrial interest. In this study the mineralogy of graphite-bearing siliceous marbles from Chunyu-Mihewe area, south east Tanzania has been investigated in order to determine the conditions for the formation of the rocks and the graphite. The Chunyu-Mihewe siliceous marbles are composed of 75 wt. % quartz and 7 wt. % talc and tremolite and 3 wt. % graphite. A more silica rich marble contains in addition to above minerals olivine and clinopyroxene. The presence of olivine and clinopyroxene in this rock suggests that the siliceous marbles has been under granulite facies conditions. The retrograde rims of tremolite and talc around olivine and clinopyroxene indicate subsequent to granulite facies conditions the rocks were exposed to greenschist facies metamorphic conditions. The graphite in graphite-bearing siliceous marbles has been formed together with the graphite marble under granulite facies metaporphic conditions (>700 ^{o}C), at which all poorly ordered, non-graphitizable carbon were transformed into graphite.

THE ROLE OF GEOSCIENTISTS IN THE SOCIAL DEVELOPMENT OF TANZANIA: PERSPECTIVES FROM THE GOLD EXPLORATION AND MINING INDUSTRY

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One of the key roles of geoscientists in a nation and indeed around the world is to search, discover, and help in the exploitation of natural resources and mineral wealth for the benefit of that nation's citizens and humanity at large. In our presentation, we have used the case of the gold exploration and mining industry perspectives and its recent trends, to examine the roles geoscientists could impact, in the full realization of benefits from exploration and mining. We have attempted to propose a medium scale, exploration and mining projects as a future way for our country (Tanzania) in the case of ensuring benefits and sustainable development are maximized. The recent and indeed cyclic nature of the gold industry, driven by commodity demand–supply and gold price fluctuations, leave small room for under developed countries to benefit most during periods of boom and positive markets sentiment. While large scale gold mining operations are significant and usually positive, the small and medium scale operations could greatly benefit from appropriate policies and exchanges of skills, capital and knowhow, which would allow them expand economic opportunities along their value chains. As a way of shielding economies and their sustaining institutions against such uncertainties and potential negative impact, we propose the embracing of a mid-way form of industries where indigenous entrepreneurs take charge of running medium scale mining and exploration companies. These companies will ideally focus on exploration and development of small size deposits, in the range of 50 K to 500 K ounces total reserves. They will have their major ownership under Tanzanians entrepreneurs, utilize local skills and expertise in ensuring they are productive and sustainable, assisting in minimizing impacts to the environment while equitably dealing and assisting stakeholder's development agendas in areas they work. Depending on the magnitude of investment (concession to be explored or resources to be developed) some form of public-private partnership would be a catalyst to enable tapping into efficiencies of collaboration in terms of capacity building

and governance support costs. Tanzania's vast mineral wealth will then be more beneficial to the country through maximization of profits retained in country, supporting other sectors and industries, while continuing to benefit from exchanges of skills, technology and capital from equitable partners. We see also the benefit of such projects in confidence building and ensuring organic growth with later trends being the export of skills and experiences to other African countries. In conclusion we challenge geoscientists in private practice, mining companies and institutions to seriously consider our proposition, with the aim of increasing our share of contribution to the country social economic development.

2D SEISMIC INTERPRETATION, BASIN AND PETROLEUM SYSTEM MODELLING OF THE OFFSHORE SOUTHERN TANZANIA

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2D seismic reflection data have been used to map the lithology horizons and the associated structures within the project area in offshore of southern Tanzania. Two major unconformities are recognized from the interpreted seismic lines. These unconformity surfaces are related to the Mid Jurassic and Albian erosion events. The Albian erosion event was followed by the deposition of Cenomanian shale, which is sealing the Albian sandstone reservoir.

The study area has all essential elements for hydrocarbon generation and accumulation. For the purpose of this study, the Campanian black shale and Jurassic source rocks are taken into consideration. Eocene, Paleocene, Santonian, Albian and Triassic sandstones have been identified as the potential reservoir units. An events chart has been constructed in order to summarize the petroleum system in the area.

1D and 2D petroleum system modeling of one well have been used to assess the source rock maturity, estimate timing of hydrocarbon generation and predict the accumulated volumes of oil and gas within the area. 1D modelling is done by reconstructing the burial and thermal histories by utilizing the age of horizons, layer thicknesses and other relevant parameters. The well geochemical data and bottom hole temperature (BHT) are used to calibrate the 1D model.

It is found that main oil and gas generation for the Jurassic source rocks began in the Early Cretaceous and Late Cretaceous respectively, which is compatible with the start of hydrocarbon generation according to the transformation ratio (TR). The Early Jurassic source rocks have been completely transformed. The Middle Jurassic (Bajocian) source rocks continue to generate dry gas to present day along with late oil. The Campanian black shales are immature to begin hydrocarbon generation.

3D PETROLEUM SYSTEM MODELLING OF THE SONGOSONGO SOURCE ROCKS, SOUTHERN COASTAL OFFSHORE TANZANIA

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3D petroleum system modelling of the SongoSongo area, located southern coastal offshore Tanzania, has been constructed with PetroMod software using surfaces interpreted from 2D seismic lines. 1D modelling, in combination with measured temperature and vitrinite reflectance values, was used for model calibration. The modelling results have improved the understanding of the maturity and transformation of the source rocks in the study area. The subsidence history plots from the model indicate the basin has experienced several periods of subsidence, uplift and erosion which have affected sediment deposition, trap formation, hydrocarbon generation, migration and entrapment. A high subsidence rate was recorded in Middle Jurassic which corresponds to the period of active rifting in the East African coastal basin.

Maturity modelling indicates that the Mtumbei Formation (source rock) is at different levels of maturity ranging from immature to mature, and is potentially the main source rock in the area which has generated both oil and gas. The hydrocarbon generation started in the Early Cretaceous in the deepest part of the basin and peak oil generation began in the Early Eocene. The predicted hydrocarbon accumulations are trapped mainly in the Kipatimu Formation which is in direct contact with the Mtumbei Formation (source rock) and is sealed by the top Albian Formation which lies direct above. However, the only gas accumulation to date in SongoSongo could be accounted for by cracking of early formed oil to gas or an increase in terrestrial gas prone source rock in the main 'kitchens', as well as light hydrocarbons migrating vertically from deeper and more mature source rocks.

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