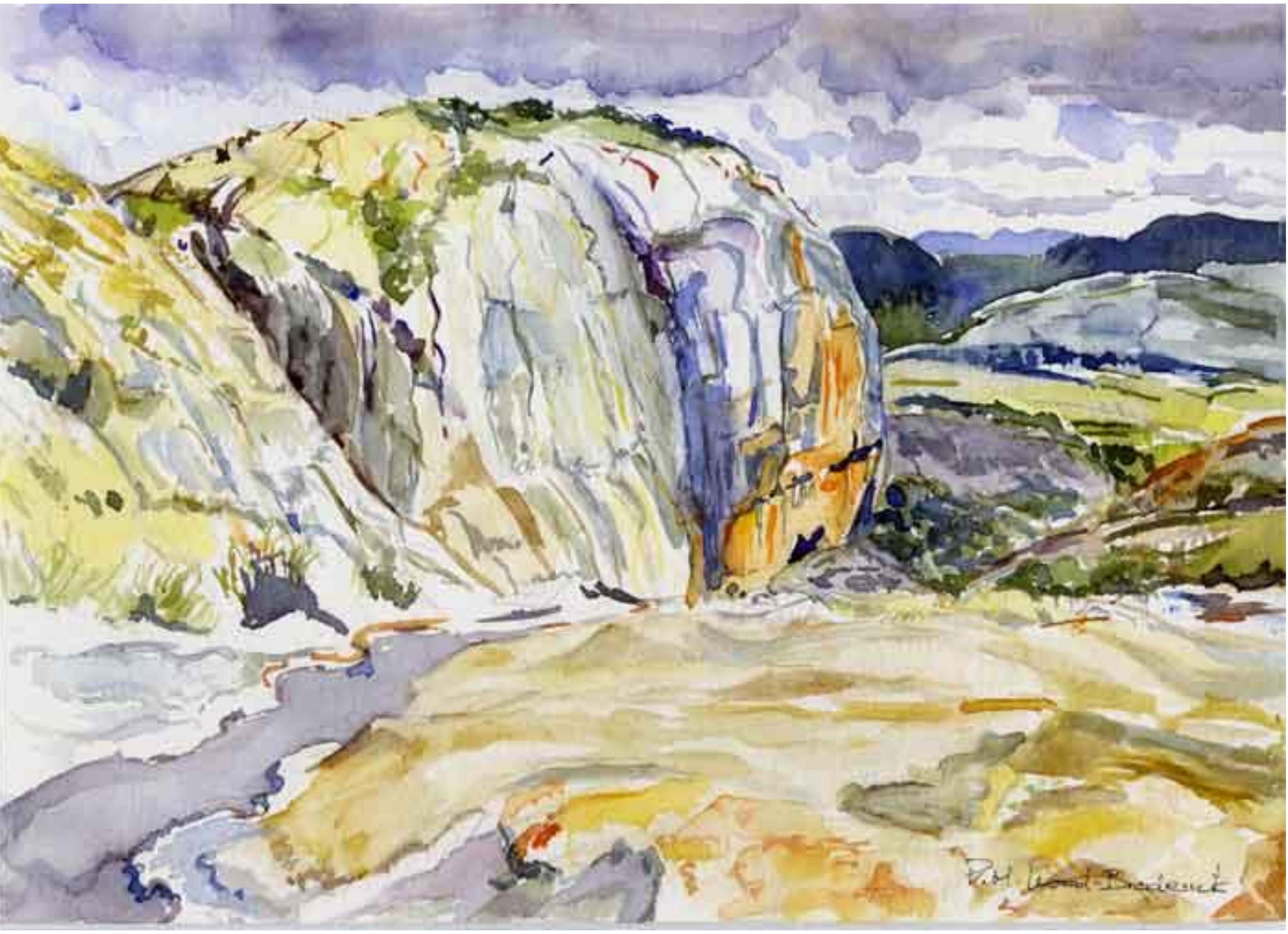
Geological Society of Zimbabwe

Summer Symposium

8am to 5pm, Friday 25th November 2011
Department of Geology
University of Zimbabwe



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Start	Topic	Speaker
7:45	**Registration**	
8:15	Welcome	Houda Bouamar, Society Chairman
8:25	**Opening**	**Allan Mashingaidze, Chamber of Mines Vice President**
8:50	Summary of Geological Society Activities	Bornwell Mapaya
9:10	Strategic considerations for Growth of the Minerals Sector – Vision 2020	David Matyanga
9:30	The evolution of continental crust of the Nuna-Rodinia component: Examples from the Hohewarte complex,	**Ben Mapani (Keynote)**
10:30	Tea	
10:50	On A Roll. Dynamic Evolution of the Central Zimbabwe Watershed	**Andy Moore (Keynote)**
11:50	Integrated Exploration on Coal Project in Southern Zimbabwe	Hilary Gumbo & Peter Bourhill
12:10	Hydrocarbon Exploration in Zambia and Surrounds	Nic J. Money
12:40	Heavy Mineral Sands Exploration Potential in Zimbabwe.	Paul Chimbodza
13:00	Lunch	
14:00	Geological Disturbances On The MSZ , Selukwe Sub Chamber, Great Dyke Of Zimbabwe	Fred Hlasi
14:20	Copper Deposit Types of Zimbabwe: An Exploration Guide	Bornwell Mapaya
14:40	On naturally sculptured granites in Zimbabwe	Forbes Mugumbate
15:00	Tea	
15:20	The Business of Geoscientific Data	Marcia van Aswegen
15:45	Geoscience in Zimbabwe Vs the World	Madeyi Meck
16:05	Perspectives on Geology practice in Zimbabwe	Arimon Ngilazi
16:25	Summary	Ben Mapani

Strategic considerations for Growth of the Minerals Sector – Vision 2020

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The operating environment for the mining industry in Zimbabwe has generally been adverse leading to short term approach in resolving the challenges facing the industry. Since 1980 little has been done to focus and deal decisively with strategic issues that affect the long term development of the industry. The decision to invest in human resources development initiatives is the only strategic development during this period. However, this initiative has been greatly compromised resulting in the need to re-evaluate the sustainability of current efforts to supply labour.

Assuming that the political issues affecting all development efforts are resolved, and the country is once again fully participating in international issues without the current constraints, is the mining industry capable of taking advantage of prevailing conditions and attract capital at the same levels at the best jurisdictions in the world. If not what are the areas that would require the attention of policy makers to place Zimbabwe as a competitive destination for investment? If this environment is availed where will Zimbabwe be as a mining country in 2020?

The paper provides an analysis of how each individual major mineral is expected to grow during the period 2013 to 2020 and the investments required to see these projects through. It will explore the likely constraints to production and the strategies that can be adopted to deal with the constraints.

The evolution of continental crust of the Nuna-Rodinia component : an example from the Hoewarte Complex, central Namibia.

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The Hohewarte complex is a Paleoproterozoic to Neoproterozoic province in Namibia, that records mantle evolutionary trends that may be common to Kalahari Craton characteristics. The evolution of a variety of mafic to ultramafic gneisses, pelitic gneisses and scchists, granitic and felsic gneisses and granites suggests a much more juvenile crust with implications for the crustal evolution of southern Africa

To map the crustal growth processes in light of the geological evolution of Southern Africa we have used both Hf-Lu and U-Pb isotopic systems. Mafic gneisses record ages of 1754±15 Ma, probably showing some oceanic rifting during Nuna times, whereas granitic gneisses record crust forming events at 1826±20; 1286±170; and 1218±120 Ma, that could imply initial amalgamation of Rodinia. Granites record ages of 1058±51 Ma. These correlate with final sutures of the Rodinian accretion as a super continent. The samples we have suggest that the Hohewarte has preserved a juvenile signature from the time of its formation around 1820 through to 1754 Ma. We observe a lot of mafic to ultramafic components in the banded gneisses, suggesting a more complex tectonic origin.

The study has implications for mineral exploration in primitive versus evolved or recycled parts of the crust.

On A Roll. Dynamic Evolution of the Central Zimbabwe Watershed

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The major watershed between the Zambezi and Limpopo Rivers, which traverses central Zimbabwe in a broadly southwest-northeast orientation, has been interpreted to reflect a line of epeirogenic flexure (Maufe, 1927; du Toit, 1933; Moore, 1999), inferred to be of late Palaeogene age (Moore, et al., 2009a). The line of uplift was termed the Kalahari Zimbabwe Axis by du Toit (1933). Moore (1999) subsequently inferred that uplift had occurred on an arcuate line, broadly parallel to the southern African coastline, which he designated the Ovambo-Kalahari-Zimbabwe (OKZ) Axis.

Uplift along this Axis disrupted an earlier northwest flowing drainage system, extant since pre-Karoo times, with headwaters located 200-300km to the southeast of the modern watershed (Lister, 1987; Moore et al (2009b).

During the mid 1990's, Somabula Explorations (Sex) carried out drainage sampling as part of a kimberlite exploration programme in Exclusive Prospecting Orders (EPO's) located to the east of Bulawayo. This work resulted in the recovery of a diffuse spread of kimberlitic picroilmenites in headwaters of south-flowing Limpopo tributaries rising off the central watershed. However, follow-up sampling failed to locate any local kimberlite source rocks, and it was concluded that this unexplained kimberlite pathfinder anomaly is secondary, formed by the remobilization of a diffuse heavy mineral lag associated with the senile surface of the central watershed. The latter has been variously interpreted as a relict of the African Surface (Lister, 1987), or an exhumed pre-Karoo surface (Moore et al., 2009b).

Remarkably, the compositional field (or chemical fingerprint) of the ilmenite population recovered to the ***south*** of the watershed in the Bulawayo EPOs, shows a very strong overlap of the corresponding ilmenite field for the ~500 Ma Colossus-Wessels-Moffat group of kimberlites, located to the ***north*** of the central drainage divide. Further, they differ from the compositional fingerprint of known kimberlites to the south of the watershed. This argues strongly that the ilmenites recovered in the Bulawayo EPOs were ultimately derived from the Colossus kimberlites to the north. However, given the long-lived northwest drainage system, prevailing from pre-Karoo times until initiation of the watershed (Lister, 1987), this raises the question as to how and when the ilmenites might have been dispersed to the south of these kimberlites.

It is proposed that the answer to this conundrum is that the locus of the late Palaeogene uplift that initiated the central watershed was originally located to the *north* of the Colossus-Moffat kimberlites. This would have reversed the original northwest-flowing drainage system that had prevailed since Karoo times, permitting southwards dispersion of ilmenites derived from the Colossus-Moffat kimberlites. We suggest further, that the locus of maximum uplift migrated progressively southwards to its present-day position during the ongoing evolution of the central watershed. This resulted in a progressive southwards remobilization of the ilmenites and associated heavy mineral lag that developed on the watershed.

Such a dynamic "rolling" linear uplift model for the origin of the watershed is difficult to explain in terms of plume-initiated uplift. However, it is consistent with the model of lithospheric buckling linked to stresses caused by reorganizations of the spreading regime at the mid-ocean ridges surrounding southern Africa, as envisaged by Moore et al. (2009b).

On a regional scale, uplift along the OKZ Axis resulted in the formation of the inland Kalahari Basin. Rivers such as the Zambezi and its headwaters were impounded by this basin, resulting in the development of a major wetland system of meandering rivers and ephemeral lakes in which the Kalahari sediments were deposited.

Following, and possibly even initiated by the OKZ uplift, ancient rifts such as the Luangwa-Gwembe were reactivated, leading to south-westward propagation of the East African Rift System into south-central Africa. This rifting disrupted the regional drainage net, resulting in the development of a changing archipelago of wetlands in time and space. Important examples are the Bangweulu Swamps, the Kafue Flats, Palaeo-lake Barotse on the upper Zambezi, a massive inland lake centred on the Makgadikgadi basin in Botswana and the major extant wetland of the Okavango Delta.

Drainage disruption and the dynamic evolution of the wetland archipelago were superimposed on the major climatic swings between aridity and high rainfall pluvial conditions that characterized the Plio-Pleistocene. The interplay between the climatic vicissitudes and the dynamic wetland system provided a potent evolutionary driving force. Thus, for example, severance of the former links between the Upper Chambeshi River and the Kafue, and latter river and the Zambezi, resulted in the isolation of populations of highly water-dependant Lechwe antelope in the Bangweulu wetlands, the Kafue flats and the linked Upper Zambezi – Okavango river system. Isolation of these different populations by tectonically-driven drainage changes resulted in independent speciation in these three isolated wetlands systems. This accounts for the distinctive Black Lechwe (*Kobus smithmani*) of the Bangweulu wetland, the Kafue Lechwe (*Kobus kafuensis*) on the Kafue Flats, and the Red Lechwe (*Kobus leche*) on the Zambezi-Okavango wetland system (Cotterill, 2005).

The dynamically changing archipelago of wetlands provided important refugia for faunal and floral populations during arid Plio-Pleistocene glacials. The result was the evolution of divergent faunal lineages adapted to wetland and arid savanna environments respectively. Recent genetic evidence shows that lions (*Panthera leo*) in the Okavango wetland do not inter-breed with those in the surrounding more arid savanna habitat. This is interpreted to reflect habitat specialization of these two lion populations, and possibly barriers to interbreeding. Fossil and genetic evidence suggest that the ancestral lions were wetland specialists, and that the savanna lions developed from a population that became isolated during an arid Plio-Pleistocene glacial, thus favouring adaptations to exploit the arid savanna environment (Moore, et al., 2011).

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Integrated Exploration on Coal Project in Southern Zimbabwe

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This is a presentation of results and interpretation of both geological and geophysical surveys carried out on a Coal Project in southern Zimbabwe situated on dolerite dyke swarms. The aeromagnetic data maps out surface geology whilst the CSAMT method maps out geology at depth down to 1km. The results of the two techniques as well as surface geology mapping are assembled into a 3D interpretation of the area delineating basin geometry, low conductivity layers (coal and carbonaceous shales), dolerite dykes swarms, sills, faults etc. This makes siting of drill holes a lot easier and targeted to intersect all likely coal horizons in lesser structurally deformed areas. The dykes raise the rank of the coking coal causing it to lose its ability to coke; as a rule of thumb probably within a distance of around two times the intrusive thickness; the geophysics allows the geologist to site holes into coal that has not been affected by dykes.

Prospecting for Oil & Gas in Zambia & Surrounds

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Zambia with an area of some 750,000 square kilometres and surrounded by eight countries is situated in the heart of central southern African plateau that is floored essentially by crystalline basement rocks that are over 400 million years. The surrounds of Zambia that share the plateau include borders of Zimbabwe, Botswana, Namibia, Angola, Democratic Republic of Congo, Tanzania, Malawi and Mozambique.

The crystalline basement core rocks of the plateau are transected by major rift-like grabens, tectonic dislocation zones and sags which extend into some of the surrounding lands and they constitute the sedimentary basins of the region. The rift zones and sags carry younger sediments that range in age from the Ordovician to Recent. The rocks belong to Palaeozoic and Permo-Triassic times, but in western Zambia and parts of the surrounds, Cretaceous rocks occur, in some of which hydrocarbon possibilities have been recorded. It is noteworthy that the bottom sediments of some lakes in the border areas of Zambia have provided oil seeps and gas shows. The substantial sedimentary pile centred on the Okawango-Makarikari-Ethosa basins sitting within the larger framework of the Kalahari basin is extensive and has a long geological history that deserves a detailed study.

Zambia, as with its neighbours, is minerals-rich, but no oil has been found to date despite a sustained prospecting programme with varying intensity since 1970s. The fundamental pre-requisites for hydrocarbon origin, occurrence, migration and entrapment are found in a number of sedimentary basins in the country and surrounds. Zambia has been flown geophysically and substantial records are kept with the Geological Survey Department. Although exploration work by oil companies in the 1980s yielded few positive results despite two wild-cat wells, subsequent evaluation generated renewed interest. In recent years samples for microprobe analysis undertaken by German laboratories have given positive results for gas occurrence. Data packages have been prepared and sold to interested companies by the Geological Survey Department.

The Ministry of Mines and Mineral Resources has demarcated some 41 blocks for issuance under a selective bid, some of which have been granted to a number of Zambian and international bidders. The basic laws for oil search and production have been re-drafted and a new Petroleum Act (2008) issued. A government company, the National Petroleum Company of Zambia has been set-up to spear-head the government's interest and stake.

The finding of hydrocarbons in the rift zones of Uganda and also Sudan has given impetus for the continued work in Zambia for oil exploration as indeed the issuance of oil exploration licence recently to a company in south Rukwa Basin in Tanzania which lies close to the northeastern border of Zambia. Finding oil close to the border of Zambia or within Zambia would trigger a major search in all these areas. The future for oil exploration in the region bodes well.

Heavy Mineral sands Exploration Potential In Zimbabwe

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1. Overview

Heavy Mineral Sands Deposits is a term applied to sands that have a higher specific gravity than your average sands, typically above 4.0.

Heavy Minerals Sand Deposits (HMSDs) are variously referred to as:

*Heavy Mineral Sand Deposits,

* Mineral Sands, or

* Heavy Mineral Deposits

2. Uses

High strength-to-weight ratio and corrosion resistance make titanium a preferred metal for fabrication of alloys for strategic and critical applications in aircraft, military, marine, power generation and ordinance applications. In 2004, demand for titanium metal was soaring due to increased demand by commercial aircraft and military markets.

Due to its lightweight strength and high resistance to corrosion, titanium alloys are used in a wide variety of commercial products replacing heavier and less chemically-resistant metal parts.

Additional applications are being developed based on its fire and shock resistance, favorable cryogenic properties, unique bio-compatibility and non-toxicity characteristics. The lightweight strength, bio-compatibility and non-toxic characteristics make titanium an ideal material in the medical

field for joint replacements including hips, balls and sockets.

Titanium dioxide pigments are used to enhance colors and quality. Titanium oxide has high whiteness, high refractive

index, and light scattering ability. These characteristics make titanium the predominant component of white pigments in paints, paper, plastics, and rubber.

3. Geology of Heavy Mineral Sand Deposits

HMSDs are defined as a loose aggregate of unlithified mineral or rock particles of sand size (generally 0.02 to 2.0 mm) forming an unconsolidated or moderately consolidated sedimentary deposit consisting essentially of medium grained clastics. These are derived from the weathering of pre-existing rocks, and accumulated by wind or water.

HMSDs are syngenetic concentrations of valuable mineral particles with high specific gravity accumulated within the sand deposits. Valuable heavy minerals associated with sand deposits (placer deposits) are primarily **gold, cassiterite, ilmenite, rutile, magnetite, monazite, kyanite, sillimanite, tourmaline, and garnet.**

The origin and concentration of these minerals depends on the disintegrating rocks and landforms from which the rock particles are transported and on which they are deposited.

The transportation mechanism is generally wind or water. A typical scenario would be a source of heavy minerals being eroded and washed out to sea by heavy rains. The sands are carried back to the beach by waves, sometimes even tsunamis. The waves wash back the lighter grains of sand, leaving behind the heaviest grains on the beach. Over geologic time, the shorelines move and some deposits are found well inland.

Titaniferous heavy minerals in HMSDs are generally present as black concentrates composed of:

- **Ilmenite** (4.5 to 5.0 specific gravity),the most abundant mineral of titanium on earth
- **Rutile** (4.25 specific gravity), a high grade titanium mineral
- **Zircon** (4.6 to 4.7 specific gravity),constitutes the main ore for zirconium
- **Monazite** (4.6 to 5.4 specific gravity), with thorium as its principal component, a rare earth phosphate

Other heavy minerals that may occur are magnetite, kyanite, sillimanite, garnets, and tourmaline.

HMSDs are classified in the following two groups:

- Autochthonous or trap placers, and
- Allochthonous or bed placer deposits.

Zimbabwe has no previous known commercial occurrence or production history of HMSDs but recent exploratory investigations from a target geologic area in Zimbabwe has returned high grade HMS concentrations of around 4% and to as high as 55%.

Geological Disturbances On The MSZ , Selukwe Sub Chamber, Great Dyke Of Zimbabwe

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The Great Dyke of Zimbabwe is an early proterozoic intrusion of mafic and ultramafic rocks, cutting across the dominantly archean rocks of the Zimbabwean craton.

The shape of the Shurugwi sub chamber has been controlled by the proximity of the Shurugwi Greenstone belt (on the west), resulting in deflections, constrictions and disturbances to the MSZ.

Mafic rocks (gabbronorite) form a remnant cap, underlain by cyclic ultramafic rocks (pyroxenite, dunite, harzburgite, chromitite), which hosts PGE bearing sulphide zones (MSZ, LSZ) in the top pyroxenite of the first cyclic unit (P1). MSZ is the most economically viable. Amount of sulphides (pyrrhotite, pentlandite, chalcopyrite and pyrite) in both zones varies vertically and laterally from 0.1 – 8% in the MSZ and up to 1.5% in the LSZ.

The MSZ suffered a lot of syn to post mineralization disturbances mostly along the margins and boat ends. The disturbances are somehow related to the size of the magma chamber, level of deformation and country rock dyke is in contact with. This results in disturbances of different forms (border group, alteration, xenoliths, magma mixing, and magmatic erosion). Though some of the disturbances are floating, some penetrate down to the MSZ. Most of the disturbances are on the western side and related to the Shurugwi Greenstone Belt, disturbances related to structures and the granite contact on the east are minimal.

Copper Deposit Types of Zimbabwe: An Exploration Guide

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An important aspect of exploration for copper in Zimbabwe is the wide variety of copper deposit- types throughout the stratigraphy, critical in the search for giant deposits. Therefore, this study implies serious considerations of the genetic controls of ore deposits to direct new discoveries. It is well known that many typical copper deposit-types share common geological characteristics and the model is being demonstrated as a sound exploration tool in Zimbabwe. This knowledge of a wide diversity of copper deposit-types and styles is important in exploration, as it dictates the choice of an exploration programme. Based on the fact that when members of a family of deposits have been discovered, others can be expected or those discovered can be re-evaluated in the light of internationally recognized giant deposit types.

The classification of copper deposit-types studied shows that the integration of geological setting, ore minerals, orebody structures and recorded production in the country from Archaen to Post Karoo can help fingerprint copper deposit-types of interest such as gold-copper deposits in greenstone belts, copper associated with PGMs in the Great Dyke, stratabound copper in the Magondi Proterozoic sedimentary basin, copper-gold deposits in the various granitoids and copper deposits of the post Karoo granophyres. An analysis of these mineral groups suggests that several giant copper deposit-types such as porphyry copper deposits exist in the country but have not been thoroughly explored. Notably, the Mutandahwe Igneous Complex Cu-Mo-W deposits represent post Karoo porphyry copper deposits and a tectonic model suggests formation of such deposits in Archaen and Proterozoic terrains as well. Volcanic Massive Sulphide deposits, which account for a significant amount of copper in the world, have been discovered at the eastern tip of the Shamva Greenstone Belt and exploration in the Midlands Greenstone suggests other new discoveries. It is therefore important to take any group of copper deposits and thoroughly examine the styles and nature of mineralization which generally fit in a particular genetic group in our future exploration targeting.

On naturally sculptured granites in Zimbabwe

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The greatest part of the Zimbabwe craton comprises granitic rocks broadly divided into the vast areas of older granitic gneisses and younger granitoids. Weathering and erosion over millennia have sculptured the granitoids into the most spectacular artistic landscapes such as bornhardts, castle kopjes, and balancing rocks. Marvellous minor weathering forms are also abundant in granite areas.

While the Epworth balancing rocks, the Matobo hills castle kopjes, and the Domboshava batholiths may be the first images of beautiful granite landscapes that come into mind, the truth is that there is an abundance of impressive granite features occurring in other parts of the country. For instance, vast areas of the Harare Granite in Chitungwiza and Mabvuku are strewn with fantastic outcrops that have varieties that could easily surpass the infamous Epworth outcrops in diversity and attractiveness. These areas of rare natural beauty, especially those lying close to urban areas, could be easily turned into tourist attractions in the same fashion as the Lion and Cheater Park and the Epworth Balancing Rocks. The areas are however under threat from urban farmers, illegal sand and aggregate miners, and Apostolic Church groups who are making some these beautiful areas inaccessible by ordinary citizens.

This report is meant to raise an awareness of the existence magnificent granite topographical features in areas including those outside the traditional tourist resorts, the intention being to excite interest in the value of these picturesque features and to promote their preservation and rehabilitation for scientific, educational and recreational purposes. This could be achieved through commercial partnerships between private or public companies and landowners to establish leisure parks that protect the natural scenery as well as protecting flora and fauna.

The Business of Geoscientific Data

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During the last twelve years, requirements for transparency and materiality within geological data sets have been introduced. Credible mineral resource and reserve reporting is based on auditability and accountability within estimation procedures. This cannot be achieved unless relevant primary data sets can be identified and reduced to distinct geoscientific parameters. The descriptors, conventions and constraints governing them must be defined systematically and published as a 'data standard'. Professional work practice and quality assurance methodologies which promote proper geological thinking and understanding can be combined into a practical work procedure for each exploration programme and mine site. These procedures will promote the transfer of skills and identify required competencies. They will support the data standard required for data collection and provide the frame work for a quality management protocol within the data management environment for each data set. Geoscience incorporates many specialisations. Data sharing across related subdisciplines will be possible when common parameters share the data standard. This will improve geological decision making as well as mine planning.

Overview of Geoscience in Zimbabwe Vs the World

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This report provides an overview of the status of geosciences in Zimbabwe viz viz the world. The report is based on data and observation collected over the past 4 years as well as from existing data from other sources, professional membership organizations, and industry.

The reports note that despite being a training ground for SADC countries currently

- There is no geosciences programs at primary and secondary levels
- availability of geoscience education at community colleges is non existent
- geoscience enrollments, degrees conferred, field camp attendance, and funding of geoscience undergraduate and graduate are at an all time low
- department size, faculty numbers, research specialties and funding of geoscience research at the university level decreasing
- Demand for geoscience graduates is on the increase
- productive activity mines are decreasing
- Participation by geologists from Zimbabwe in geological events worldwide is very low

These trends are all antagonistic to the general trends observed in most countries in the world. An analysis of this situation rings an alarm bell and calls for

- Exposure to geosciences in a student's education at primary and high school in order to influence choices they make with regard to college majors.
- Increased direct support for geosciences students.
- Sensetizing the communities about geosciences
- Increased support of Geology dept/s in the country
- Visible participation by Zimbabwean geologists in international affairs
- Recognition that society is currently facing many issues and challenges that require the application of geoscience knowledge and skills by professional geoscientists in a myriad of fields thus producing geologists with full knowledge that they are not meant for the mining related industries only.
- Addressing the decidedly negative flux in the geosciences industry due to skill. shortages and potential economic substitution before they become measurable risks.
- Opening of an IGCP Zimbabwean chapter necessary for participation in international affairs

As a way of concluding it can be safely said unless these trends are addressed its not only the Geology Department at the university that is going down but the whole geosciences profession in Zimbabwe

Perspectives on geology practice in Zimbabwe

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The recent resurgence of interest in the Zimbabwean minerals industry has seen a surge in the demand for geological services both within existing mining companies and new entrants. Irrespective of company size, the requirement for services encompasses a wider range of disciplines from exploration, geological modelling, resource evaluation and mining services among others. Generally, the bigger mining companies require independent and extra resources to achieve their objectives while small and medium companies require to fill the technical void in their operations. This trend seems likely to continue in to the the near future – at least within the next couple of years.

Zimbabwe has qualified college and unversity graduates in all the disciplines to be able to meet this need. However, these skills are now globally dispersed due to emigration and Zimbabweans filling expatriate positions in search of greener pastures. This means that in almost every discipline there is a shortage of the skills to service the demand. Geologists working in the production environment whether in long term (tenement exploration) or short term (mining services) have had to learn quickly on the job to carry out a wider range of services or outsource them to consultants. Either way some opportunities for continuous professional development have been lost as practitioners spread themselves too thinly or have in somes cases abdicated responsibility to third parties.

This is not to suggest every geologist should be able to do everything but there is need to consciously keep up with best practices in a structured manner. It is very important to od so given that the days are gone when internal company practices can remain below internationally accepted standards. As existing companies seek funding from sources other than shareholders and new entrants seek mining assets to invest in, the demand for professional and quality work compliant with prevailing standards both on the ground and in written presentations has become of paramount importance. This is nothing new but is perhaps a wake up call to remind geologists that being a member of institutions like the SAIMM and AusIMM is not a sufficient claim to competency. This as true for professionals employed by exploration or mining companies as it is for consultants.

NOTES

Cover Painting: - Trish Broderick - Ngomakurira looking down the valley towards Makumbi Mission.