Geological Society of Zimbabwe

ABSTRACTS

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Summer Symposium

8am to 5pm, Friday 25th November 2016
Department of Geology
University of Zimbabwe

Start	Topic	Speaker
07:45	**Registration**	
08:00	Welcome	Andrew du Toit - Summer Symposium Sub-committee Chairman
08:20	Official Opening	Isaac Kwesu - CEO of Chamber of Mines
08:50	Zimbabwe Geological Survey's Japanese assisted project	Temba Hawadi - Director of the Zimbabwe Geological Survey
09:10	**Tea**	
09:25	Adrift again: recent geochronology and paleomagnetics undermine a Neoarchean collision model for the Limpopo Belt	Jan Kramers (Keynote Speaker)
10:25	Geology of the Pongola Greenstone Belt	Tony Martin
11:05	Framing Himalayan-Tibetan style indenter-escape style collision for a Neoarchean Limpopo orogen and Zimbabwe craton since 2.75-2.74Ga	Mark Tsomondo
11:40	On the distribution, morphology, chemistry and mineralogy of global laterites: Cuban and Zimbabwean scenarios	Tendai Njila
12:00	Mineral Resource estimation techniques for shallow dipping ore bodies – a case on the Great Dyke	Farirai Kambanje
12:20	Geomythology: Zimbabwean examples	Forbes Mugumbate
12:40	**Lunch**	
14:00	Groundmagnetics and gold-camp scale structural controls at Mazowe Mine	Hilary Gumbo & Mark Tsomondo
14:30	The relevance of GIS techniques to resources evaluation - A project on archive data from Zimbabwe	Tenyears Gumede
14:50	Drones - the big picture for Geology	Mike Kirstein
15:10	**Tea**	
15:25	Condition driven operating and planning standards at medium sized gold mine	Renias Tirivabaya
15:45	What to Expect as an Exploration Geologist	Nhamo Manenji
16:05	Summary	Tony Martin

Zimbabwe Geological Survey's Japanese assisted project

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On 10 September, 2015, the Government of Zimbabwe, represented by the Ministry of Mines & Mining Development, and Japan Oil, Gas, and Metals National Corporation [JOGMEC] signed a Memorandum of Understanding on cooperation in Mineral Resources.

The MOU provides for the joint conduct of geological analysis with Geological Survey Department of Zimbabwe by applying Remote Sensing, GIS techniques and field surveys; the training and transfer of Remote Sensing and GIS skills to Zimbabwe trainees; and the enhancement of geological information on Zimbabwe for the purpose of attracting mining investors, including Japanese companies.

Remote sensing is that art of deriving information about the Earth's surface using images that register reflected and emitted electromagnetic radiation in one or more regions of the electromagnetic spectrum. Reflectance varies with wavelength for most materials because energy at certain wavelengths is scattered or absorbed to different degrees. These reflectance variations are evident when spectral reflectance curves (plots of reflectance versus wavelength) for different materials are compared to each other.

Remote Sensing (RS) data captured by earth orbiting satellites with mounted Multispectral Sensors is used in geological mapping and mineral exploration by identifying structural features potentially controlling mineralisation. Such Sensors include Landsat (one of the first sensors to be developed) and ASTER (Advanced Spaceborne Thermal Emission Radiometer).Subsequently RS data can be used in an integrated study with regional geophysics, geochemical data and expert knowledge to delineate potential target areas.

Some of our geoscientists from the Department of Geological Survey are currently being trained in Remote Sensing and Satellite Image analysis under the supervision of experts from JOGMEC Remote Sensing Facility in Botswana.

Adrift again: recent geochronology and paleomagnetics undermine a Neoarchean collision model for the Limpopo Belt

Jan Kramers (Keynote Speaker)

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Some of the first radiometric age determinations from Africa were carried out on metamorphic minerals from the Limpopo Belt and yielded ages around 2000 Ma. Subsequently, whole rock Rb-Sr as well as zircon U-Pb on granitoid intrusions, mainly in the Central Zone (CZ), were used as time markers. These included the Singelele suite of S-type granites occurring interlayered with metasedimentary rocks. Neo-Archean ages between 2600 and 2700 Ma dominated the data. High grade metamorphism, observed throughout the Central Zone as well as in the Northern (NMZ) and (patchily) the Southern marginal (SMZ) zones, was then naturally linked to this evidence of crustal melting and thereby also dated to the Neoarchean. Throughout the 1980’s the concept of a Neoarchean Limpopo Orogeny was built and consolidated, with structural, metamorphic and geochronological studies mainly carried out or coordinated by the geology Department at Rand Afrikaans University in Johannesburg, and seismic studies by the University of the Witwatersrand. It was based to a large extent on work in the CZ and SMZ, with the NMZ receiving relatively little attention. The model that emerged was essentially one of a continental collision between the Zimbabwe and Kaapvaal Cratons, producing a mountain Belt of Himalayan proportions[1]. From crustal structures, a south-dipping subduction zone was envisaged to have preceded the collision.

Then from the mid-1990’s on, ages around 2030 Ma obtained from metamorphic mineral assemblages (lead isotope dates mainly on garnet, and argon dates on amphibole and micas) accumulated. These were mainly from the CZ, and in most cases associated with shear zones, but were also found in the Northern Marginal Zone[2], and further research in the CZ revealed many such young metamorphic zircon ages[3] as well: clearly two episodes of high grade metamorphism had occurred there, and research groups groups were divided into two camps regarding which of these two events was associated with the amalgamation of the two cratons; the 2000 Ma camp proposing a dextral transpressive orogeny at that time[4,5]. Nevertheless the Neoarchean Himalayan model continued to dominate mainstream thinking, while later major strike-slip movements along the belt, possibly associated with the Kheis-Magondi orogeny, were acknowledged to exist.

The picture has now changed again. Since 2000, a great deal of hafnium isotope work on zircons from the Central Zone[6] and the Francistown region[7], combined with neodymium isotope work on the NMZ and Zimbabwe Craton[8] has suggested that there was northwards subduction underneath the NMZ and the Craton Margin, which fitted with the idea that the CZ could be a leading continental edge. But now the chronology did not fit with the collision model any more: This subduction zone should have existed at around 2600 Ma. However, more recent geochronological work[9,10] (mainly U-Pb on zircon, but also Ar/Ar on amphibole) in the Southern Marginal Zone has shown that peak metamorphism there occurred at around 2730 Ma. If the collision followed on subduction of an ocean crust, then the metamorphism in the SMZ should postdate it, not predate it by >100 Ma. In addition, a palaeomagnetic and regional facies reconstruction[11] places the Pilbara Craton only several 100 km north of the

Kaapvaal margin at 2700 Ma, a position overlapping with the present position of the Zimbabwe Craton.

It follows that the Neoarchean tectonometamorphic event in the SMZ must be considered separately from those in the CZ and the NMZ. One possible suggestion for the latter could be that they represent an Andean-type continental margin; the regionally rather high concentrations of U and Th mean that no excessive crustal thickening or heat advection from below is necessary to generate high grade metamorphism and even melting in the lower crust[12]. The SMZ on the other hand is, like the Kaapvaal Craton, a province of low U and Th content[13], and here considerable crustal thickening and/or anomalous heat flow is required to cause the high grade metamorphism. If a continental collision occurred here at around 2.73 Ma ago, the resulting assembly has been broken up since and we do not know where the other part is.

Regarding the c. 2030 Ma event, this has now been detected in Ar/Ar dates on amphiboles and micas in the SMZ as well[10] . The rather sharp isochronism of this event over a very large area, and its close coincidence with the age of the Bushveld Igneous Complex, possibly suggests magmatic underplating of the crust during this igneous event. With the crust weakened, strain from large scale tectonic forces could have been focused in the Limpopo Belt, leading to extensive shearing and at least a repositioning of the two cratons relative to each other.

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Geology of the Pongola Greenstone Belt

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The Pongola Supergroup is exposed along the southeastern comer of Kaapvaal Craton and south of the Paleoarchaean Barberton Greenstone Belt.

Deeply-incised rivers cut the land surface in northern KwaZulu-Natal and the exceptional well-preserved Pongola exposures form inliers within Karoo strata.

The Pongola sequence was deposited around 3 Ga ago in an epicratonic basin that developed on a thick and stable crustal fragment. Along with other basins it represents one of the earliest and largest intracratonic assemblages in the world. It also provides evidence of a transition between the highly-deformed volcanic-dominated and steeply-dipping Palaeoarchaean greenstone belts and the less-deformed Mesoarchaean sedimentary-volcanic successions that followed. It is also interesting to note that typical Archaean greenstone belts continued to form elsewhere (such as on the Zimbabwe Craton) long after stabilisation of the Kaapvaal fragment.

There are three main areas of Pongola exposures stretching over 270 km: the Nkandla Basin in the south, the central White Mfolozi Inlier and the much larger Hartland Area in the north.

The Pongola Supergroup is divided into a lower, volcanic succession known as the Nsuze Group, and an upper, sedimentary Mozaan Group, but both contain lesser sedimentary and volcanic components respectively. The Nsuze Group is folded into a series of anticlines and synclines in the southern Nkandla basin whereas the dominant Mozaan in the north is less deformed.

An extraordinary feature of the Pongola is the exceptional state of preservation of the rocks. The volcanic sequences display practically every compositional type and structure from rhyolitic pillows and lava domes to basaltic/andesitic pahoehoe, pillowed and pyroclastic flows, and some unusual spinifex-textured units. The sedimentary sequences show marked thickness variations along strike and contain stromatolites, desiccation cracks, ripple marks, dewatering structures and the earliest known glacial diamictites – all of which are beautifully preserved and allow an accurate reconstruction of the epicratonic depositional environment.

Framing Himalayan-Tibetan style indenter-escape style collision for a Neoarchean Limpopo orogen and Zimbabwe craton since 2.75-2.74Ga.

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The high grade Limpopo belt comprising the Northern and Southern Marginal Zones and a larger near-axial Central Zone has been the subject of multidisciplinary research based on an integration of geological-geophysical and P-T-t path studies. Yet there are at least five contrasting models for parts of or the entire Limpopo belt and several workers increasingly cast doubt on uniformitarian analogues for the belt. Early versions of the Himalayan-Tibetan indenter-escape style collisional tectonics were regarded as largely ‘untenable’ on shear-sense evidence or ignored in models of complex thrust-stacked granite-greenstones. Elsewhere, a postulated westward, lateral ramp-like tectonic escape of the Central Zone on sinistral and dextral shears in the Archean was also rejected in favour of Paleoproterozoic age of dextral transpressive motions on the zone-bounding ductile crustal-scale shears (Triangle and Palala-Tshipise). Thus a coherent and predictive global geotectonic framework for a collisional Limpopo orogen between the Zimbabwe and Kaapvaal cratons has hitherto remained elusive, including other reasons such as, (1) the unresolved structural/tectonic issues on the nature of convexity of the southern margin of the Zimbabwe craton with the Limpopo orogen and (2) model-driven assumptions on hinterland-foreland relationships, plate and plate boundary definitions and width and (3) failure to define asymmetrical tectonic escape structures, such as an east-tapered Central Zone, ‘the smoking gun’ of Neoarchean oblique convergence, as defined in this paper.

By extending studies on corner-indentation by 3.35Ga Mont d’Or granite in the Shurugwe belt and conjugate faulting together with detailed consideration of results of pertinent analogue modelling, this study frames indenter-escape tectonics for a Limpopo orogen during a Neoarchean dextral oblique convergence between a stationary Tokwe protocraton and a NNW-directed subduction-driven Kaapvaal protocraton of the Kalahari Craton, since 2.75-2.74Ga. Such an older start to the entire Limpopo orogeny (ending c.2.50Ga) has far-reaching geodynamic consequences for not only the subzones of the entire Limpopo orogen, but also the evolution of (1) the c 2700Ma Ngezi Group of the well-known Belingwe greenstone belt (2) intrusion of the 2.75-2.74Ga komatiitic Mashaba Ultramafic Suite and (3) older >2.74Ga komatiite-dominated Mutare greenstone belt as indentation-linked rather than mantle-plume induced. Yet most researchers have divorced the origin and deformation of the Belingwe belt from a Limpopo hinterland, despite (1) its proximity and high angle trend (hence a strain gradient marker) to the ENE-trending Limpopo orogen, (2) a postulated NNW-directed foreland-type (topmost) Cheshire Formation of the Belingwe belt, (3) location of the belt within the very frontal domain of a Tokwe indenter of this study. Did rotational strains assist in the preservation of kernels of low strain? Is the Mtshingwe Fault a domain of ductile dextral trishear fault-fold propagation, pre-Great Dyke? Is it part of a distributed dextral ductile shearing including Jenya Fault? What is the link between such distributed dextral strike-slip and the convergent thrusting on the North Limpopo Thrust Zone?

In sum, the fundamental weaknesses in applying uniformitarian and mechanical analogue models to block kinematics and tectonic reconstructions based on indentation-extrusion in the Archean of both the Zimbabwe and Kaapvaal cratons are a general lack of definition of the archetypal shape, size and convergence directions of the initial protocraton indenters and subsequent effective indenters.

On the distribution, morphology, chemistry and mineralogy of global laterites: Cuban and Zimbabwean scenarios

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A comparison of the distribution, morphology, chemistry and mineralogical composition of the global weathering crusts in the world, commonly referred to as laterites, taking into account the examples of Cuban oxide-type nickel and non-nickeliferous laterites in the North Eastern part and the Zimbabwean Ni-laterites in the North Dyke. The similarities and differences will be highlighted and a discussion on the characteristics of these geologic objects will be presented. Problems related to the terminology and classifications will also be highlighted and aspects of these will be discussed. The different interpretations of the term laterite has made it difficult to reach a consensus on its rightful use mainly due to the existent contradictions related to the laterite aspects and adopted definitions. These discrepancies have not yet been overcome although in the past few decades various investigations have contributed to a better understanding of the term laterite. The similarities and differences in the morphology and mineralogy of the 2 examples will be a major topic of discussion, in view of the economic potential these weathering profiles present.

Mineral Resource estimation techniques for shallow dipping ore bodies – A case on the Great Dyke

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Mineral Resource estimation forms the basis for evaluation of an ore deposit and the viability of a mining project. The Mineral Resources estimation process entails the definition of mineralisation inside specific geological domains, the statistical and geostatistical analysis of sample data inside each target domain and the application of a suitable grade interpolation technique on the data. The geological model is a crucial pre-cursor in the resource estimation process, as it generates an explanation of the arrangement of lithological and mineralogical domains. Houlding (1994) rightly notes that ‘no matter what prediction technique we apply to a variable we are unlikely to achieve an acceptable result unless we take geological effects into account.’ The domains derived from the geological model form the basis for geostatistical processes of statistical analysis, variography and grade interpolation. The final stage of the Mineral Resource Estimation process is the classification of the resource according to the relevant international standard like the JORC or SAMREC Code, based primarily on geological interpretation and wide spaced drilling.

The Great Dyke is a shallow dipping ore body with dips ranging from 0° to 21° degrees with considerable consistency of mineralisation throughout the ore body allowing for application of standard Kriging methodology to interpolate metal grades and densities within geo structural zones. This article discusses some of the salient geological and geostatistical issues in Mineral Resource estimation as applied on the shallow dipping PGE hosting ore body of the Great Dyke.

Geomythology: Zimbabwean examples

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Man has since time immemorial sought to meticulously describe unusual features of his environment. Pre-scientific cultures have invoked traditional stories to explain the evolution of some poorly understood characters of the natural world. Some of these mythical accounts have been handed down generations through oral history.

The study of myths concerning the development of certain geological elements such as volcanoes, earthquakes, fossils and certain landscapes is known as Geomythology. Two kinds of geologic folklore can be identified; a distorted explanation of some actual geologic event; and a geologic feature or phenomenon which has inspired a legendary explanation. An example of the first category might be the Biblical story of Noah's flood, which some geologists argue that the flooding of the Black Sea area around 5 600 BCE inspired the story in local cultures whereas the second example can be illustrated by the Epworth weathering etch marks that resemble human foot marks on granite pavement which locals believe are God's foot prints made when He walked on soft granite.

Although most of these phenomena or mythical accounts can now be explained by science, documentation of geomyths has become important not only for preservation of heritage for the purposes of amusement, but also because scientists and historians have often missed truths and rational concepts embedded in geomythological narratives owing to the legendary language of oral traditional beliefs. A few geomyths observed in the pre-scientific past are being found to have roots in real geological events.

This presentation that describes local examples of the two types of geomyths is an attempt to stimulate interest among local geoscientists on the subject and to initiate the process of documentation of Zimbabwean cases. There are few known examples which are mostly entrenched in local oral folklores. These should be identified for publication on the Geological Society of Zimbabwe website for sharing and preservation.

Groundmagnetics and gold-camp scale structural controls at Mazowe Mine

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During the period March to September 2016, 3D Earth Exploration (Pty) Ltd conducted a high resolution ground magnetic survey over the entire Mazowe Mining Lease. The survey area is characterized by thick undergrowth, dangerous artisanal workings and hilly terrain which slowed the survey progress. Cultural interference from residential and mining infrastructure had to be taken into consideration in data quality control. Over 93800 stations were read.

The high resolution ground magnetics has mapped a major alteration and shear system hosted in and around a large granodiorite body. It not only defines the controls to the known Mazowe Group of Mines gold mineralization but also opens up whole new target areas for exploration of undiscovered gold mineralization.

The relevance of GIS techniques to resources evaluation - A project on archive data from Zimbabwe

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Zimbabwe covers some 39,190,000Ha of land on a perimeter of 3,036 kilometers and is covered by lots of geo-scientific data. A total area of 19, 416,710Ha has been geologically mapped and published as geological bulletins and short reports (SR) while some 1,096,930Ha has been mapped but not published. The remainder, some 18,676,360Ha either lies covered by sand not suitable for traditional hammer and boot mapping or is within granite and was perceived to be territory with little economic minerals.

On the other end, a total of 413,817 line kilometers of airborne magnetics by Kenting Earth Sciences Ltd, Sanders Geophysics Ltd and Intera-Kenting Ltd at 1km line spacing covering the entire country except a strip in the Eastern Highlands was flown for the government of Zimbabwe in the period 1983 to 1992. In addition, a further 20000 line kilometers of airborne aeromagnetics and electromagnetics, known as INPUT (Induced Pulse Transient) was flown by Geoterrex Ltd at 250m line spacing on selected greenstones.

Furthermore, the British Geological Survey generated a further 12464 stream sediment samples in which multi-element analysis was conducted in Rushinga and Nyamapanda areas. This data, when integrated with Exclusive Prospecting Orders (EPOs) exploration data generated by exploration companies and archived at the Geological Survey produces enormous baseline stream sediment database.

Geological maps are base maps to understanding a variety of resources including mineral potential, groundwater and soils maps and a four dimensional data systems, and in the fourth dimension of time, they are crucial to assessing natural hazards and environmental risks. Against this background, Knowledge Factory/NIOM, embarked on a program to make the digital geological maps, that area interactive electronic documents that put earth science issues into a geospatial framework. To date, some 9,553,490Ha of geological bulletins and Short Reports (SR) maps have been vectorized using open source software QGIS and ILWIS and are usable as ArcGIS shape files and can be integrated to available panchromatic SPOT images that cover the whole country. The attribute tables include litho-code, litho-name, age, formation, series, Supergroup, member, area and perimeter, the latter two being computed from the polygons. These attribute tables can be queried to produce several varieties of the same geology maps including hydrogeology maps showing distribution of unconfined ground-water aquifers.

Also vectorized is; the tectonic map of Zimbabwe that has been integrated with interpretation of aeromagnetic data; spatial distribution of base and precious metals, topographic maps (digital elevation models) essential for surface and flood monitoring.

Drones - The Big Picture for Geology

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Remotely Piloted Aircraft Systems (RPAS), otherwise known as Drones or unmanned aerial vehicles; are high tech aerial systems controlled from a remote location. Scout Aerial Africa is a Zimbabwean company specialising in the use of RPAS for a variety of solutions. With over 6 years of complex operational experience in the mining, infrastructure and oil and gas industries in Australia, Asia Pacific and Africa; they have been exploring unique and novel ways to provide solutions for geology and mining operations across the globe.

Regulatory environments, workflow integration, safety and data processing are key considerations that need to be made when implementing new processes into any work environment. This presentation shall explore the opportunities, limitations and specific applications for the use of RPA systems for geology, exploration and general mining activities in remote areas.

Condition Driven Operating And Planning Standards, From Instability To Stability At A Medium Sized Gold Mine In Zimbabwe

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A business improvement project was implemented at a medium sized gold mine in Zimbabwe. The mine was facing perennial challenges with attaining its key performance indicators as measured in terms of grade, milled tonnes, gold produced and the cost per ounce of gold produced. The principal objective was to bring the operation to stability, predictability and profitability. A three step gap analysis was used to analyze the current environment through the following questions, what to change, what to change to and how to cause the change?

The findings were that there existed a mismatch between the planning assumptions and the operating standards at the mine resulting in poor mine plan compliance, a highly fluctuating run of mine grade. Stopping was identified as the constraint though it was difficult to pin a constraint with all resources performing well below capacity. The findings were that due to the instability in the operation, management thrived on crisis management acts such as overtime, increased production machines, deviation from the mine plan and all these strategies failed to bring stability and predictability to the operation. The implemented none capital interventions resulted in some notable improvements in the KPI performances.

What To Expect As An Exploration Geologist

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Being an exploration geologist takes a lot of courage. You are supposed to be very quick to adapt to different kinds of environments. You will face a lot of resistance and challenges. Once you are in the field you sometimes have very little support from the head office but you have to make things work.

Before you go to the field, plan your requirements and expectations. Take all the necessary legal documents with all your maps, reports and camping stuff. Don't forget your food and water requirements.

Once you have challenges do not let people take advantage of you. Stand your ground and have confidence in yourself.

Once in the field the first exploration point is around your camp then you move out. Once in the area, do not restrict yourself to your known boundaries, this is your chance to explore.