Geological Society of Zimbabwe

ABSTRACTS

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Summer Symposium

8am to 5pm, Friday 29th November 2019

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Notes

Cover Photo
Walwyn Conglomerate - Tony Martin

Start	Topic	Speaker
07:45	**Registration**	
08:00	Welcome	Nevison Chikandiwa- Geological Society Chair
08:20	Official Opening	Forbes Mugumbate - Director of the Geological Survey
08:40	Summary Of The Petroleum Exploration Completed In The Mzarabani Project By Invictus Energy	Brent Barber
09:00	**Tea**	
09:20	Sijarira surprise! Preliminary age data on detrital zircons from the Sijarira Group, western Zimbabwe, reveals an unexpected Antarctica connection	Sharad Master
10:15	Superplume versus far-field stress as geodynamic controls on Witwatersrand sedimentation and Ventersdorp LIP magmatism: new insights from south-retreating and north-advancing orogens of 3.1-2.5Ga Kalahari Supercontinent .	Mark Tsomondo
11:00	The Great Dyke of Great Treasures and Great Mysteries.	Forbes Mugumbate
11:20	A new Late Triassic fossil vertebrate assemblage from Zimbabwe - Key to the understanding of the origin of Dinosaurs.	Chris Griffin as read by Tim Broderick
11:50	The Geology and Historical Importance of the Abanab Vanadium Mine in the Otavi MountainLand (Namibia).	Mark Watts
12:10	Some Observations on Pegmatites.	Tony Martin
12:40	Structural Footprint of Gold Mineralisation in Zimbabwe Greenstone Belts; A case study of Pickstone Peerless Deposit.	George Rusike
13:00	**Lunch**	
14:00	Tantalite Production in Post Colonial Zimbabwe, 1980 – 2018: Challenges and Prospects.	Tafadzwa Gwini
14:20	The Geo-Metallurgy of the Arcadia Pegmatite Swarm.	Adam Moodley
14:40	An Interpretation Of Magnetic, Gravity And Magnetotelluric Measurements Over The Magondi Circular Magnetic Anomaly Of Zimbabwe.	Tenyears Gumede
15:00	**Tea**	
15:15	ScanIT – Optimizing core logging data acquisition.	Megan du Plooy
15:35	Microseismic monitoring based approach to effective ground control management in unstable underground mines.	Paul Matshona
15:55	Summary.	Tony Martin

Overview Of The Petroleum Exploration Completed And Planned By Invictus Energy In Its Muzarabani Prospect (Special Grant 4571) In The Cabora Bassa Basin, Northern Zimbabwe

Brent Barber

bbarber@invictusenergy.com

In the limited time available Brent will present a summary of the petroleum exploration completed and planned by Invictus Energy in its Muzarabani Prospect (Special Grant 4571) in the Cabora Bassa Basin, northern Zimbabwe.

To-date this has included the capture and reprocessing of gravity and aeromagnetic data covering all of Zimbabwe and the seismic lines shot by Mobil Exploration Zimbabwe in the Cabora Bassa Basin in the north of the country in the early 1990s and, following the acquisition of additional and re-evaluation of legacy source rock analyses, petroleum basin modelling. Copies of the gravity and aeromagnetic data will shortly be presented to the Ministry of Mines and Mining Development for the benefit of the geoscientific community and mineral exploration in Zimbabwe.

A brief synopsis of the Profit Sharing Agreement drafted by Invictus Energy and presented to Government for consideration will also be presented. This agreement, which draws heavily on that negotiated with Mobil Exploration Zimbabwe, could form the legal platform for the creation of a Petroleum Act.

The talk will conclude with an overview of the petroleum exploration planned by Invictus Energy within the Project area in the coming year. This work will include the acquisition of additional seismic lines designed to delineate the position of exploration wells.

Sijarira surprise! Preliminary age data on detrital zircons from the Sijarira Group, western Zimbabwe, reveals an unexpected Antarctica connection.

Sharad Master
S.M. Glynn, M. Wiedenbeck, M. Ntsoane

sharad.master@wits.ac.za

The Sijarira Group is a Precambrian unfossiliferous, unmeta¬morphosed redbed sequence, which unconformably overlies the Palaeoproterozoic Magondi Belt in western Zimbabwe. It outcrops in the Chizarira Hills (where it is up to 660 m thick) and in the Hurungwe area (where it is overthrust by the “Urungwe klippe”, which contains carbonate rocks and a glacial diamictite, of Neoproterozoic age). Although the unmetamorphosed Sijarira Group has not been dated, it overlies the Badze granite which has a (reset) Rb-Sr muscovite age of c. 1211 Ma. It is aligned with, and has been regarded as a continuation of, the Tsumis- Ghanzi belt of early Neoproterozoic redbeds extending across Namibia and northern Botswana.

During our initial reconnaissance study, we collected a sample of coarse-grained trough crossbedded sandstone at 17° 39’ 04.0” S; 27° 51’ 21.0” E, in the Chizarira Hills. Our sample

ZMB13/2 comes from the Ruziruhuru Formation of the Lubu Subgroup, overlying the basal conglomerates of the Sijarira Group (Humphreys, 1969). We performed U-Pb isotope dating of detrital zircons from the Sijarira sample using the Cameca 1280-HR SIMS instrument at the Helmholtz Zentrum Potsdam. The age spectrum that is obtained from the detrital zircons is very surprising- there are almost no zircons from the underlying Magondi Belt, and none from the Archaean Zimbabwe Craton, despite an easterly sediment source (as shown by the palaeocurrent data of Chappell, 1969; Humphreys, 1969, and Mann, 1970, 1979, 1982). Furthermore, the Sijarira sandstones contain abundant detrital garnets, sphene, and epidote (confirmed by our new petrographic studies), indicating provenance from a metamorphic terrain (Mann, 1970, 1982). The obvious source of these metamorphic detrital mineral components would appear to be the underlying Magondi Belt, but the lack of detrital zircons of Magondi age seems to rule this out completely.

Our data indicate that the Sijarira Group is derived from erosion of a distant late Mesoproterozoic (c. 1.05 Ga) terrain, with minor provenance from Neo¬proterozoic rocks. The vast majority (80%) of the zircons record ages between 1075 Ma and 835 Ma. The Sijarira Group cannot be regarded as a molasse of the nearby Pan-African Zambezi Belt, since it contains very few Neo¬proterozoic zircons, and the palaeocurrents were in general from E to W. We suggest that its provenance is from the erosion of a late Neoproterozoic collisional zone of the southern Mozambique Belt (Manhica et al., 2001) and Maud Belt of West Dronning Maud Land, Antarctica, to the east of the Zimbabwe Craton. The c. 1075 to 1000 Ma detrital zircon population in the Sijarira sample could have been sourced from the HU Sverdrupfjella region, in the Maud Belt, where there are gneisses of that age range formed by late Mesoproterozoic arc collisions (Board et al., 2005). The youngest Sijarira zircons may be derived from Neoproterozoic intrusive rocks from the Maud Belt, or they may be related to a 615 ± 30 Ma tectonic event recorded in eastern Zimbabwe. The lack of Pan-African zircons is due to a relative lack of Pan-African aged magmatism in West Dronning Maud Land and in the southern Mozambique Belt. Our new maximum age for the Sijarira Group of c. 632 Ma indicates an Ediacaran depositional age. The Sijarira Group thus correlates in terms of age with other late Neoproterozoic to Palaeozoic post-Pan-African molasse basins surrounding the Kalahari Craton, such as the Okwa Group of central Botswana and the Nama basins of southwestern Africa. Its former correlation with the Ghanzi Group of Botswana cannot be sustained, since the Ghanzi Group has no glacial diamictites, and is probably between 1050 and 980 Ma in age (Hall, 2017), while the Sijarira Group is constrained to be < c. 632 Ma.

Our original reconnaissance study has now expanded to include samples from other parts of the Sijarira Group, including from areas that were mapped by Chappell (1969), and Harper (1970). We will be obtaining more detrital zircon ages in sufficiently large numbers to be totally representative of the source terrains. We also plan a study of Hf isotopes in the zircons, in order to better characterize the provenance. We also will attempt to compare the mineral chemistry of detrital metamorphic mineral grains from the Sijarira Group with heavy mineral concentrates obtained from the postulated source terrains (Southern Mozambique and Maud Belts).

Acknowledgments:
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Superplume versus far-field stress as geodynamic controls on Witwatersrand sedimentation and Ventersdorp LIP magmatism: new insights from south-retreating and north-advancing orogens of 3.1-2.5Ga Kalahari Supercontinent

Mark J Tsomondo

tsomondom@gmail.com

A longstanding debate on tectono-thermal evolution of the Kaapvaal and Zimbabwe granite-greenstone belts involves plume-dominated (2.7Ga Ventersdorp-style Large Igneous Province (LIP) or c2.7Ga Upper Bulawayan) vertical tectonics versus far-field stress (horizontal tectonics) such as impactogenal rifting emanating from a putative convergent plate boundary. Yet this dichotomy misses potential plume-lithosphere geodynamic interactions that are implicit in global tectonic frameworks such as the recently proposed 3.1-2.5Ga novel Kalahari supercontinent cycle (Tsomondo, 2018, in prep.) that replaces Valbarra or Zimgarn paleoreconstructions and others. Remarkably, the 600Myr periodicity of Kalahari supercontinent cycle corresponds exactly to the well-documented intracratonic/intraplate Dominion-Witwatersrand-Pongola-Ventersdorp-Transvaal Supergroups-giving glimpses of evolving geosphere-hydrosphere-atmosphere, earliest glaciation and life on Earth-and onset of modern plate tectonics. These assemblages provide both compelling evidence and constraints to the new hypothesis that seeks to link their formation to subduction zone-driven 1) south-retreating orogen ($V_{Retreat}>V_{Convergence}$) with large crustal extension/flow, transforming into 2) north-advancing rigid plate-like (Swazi ribbon) interactions since at least 2894Ma-the age of north-ward thrusting in Pietersberg belt (ref) and subsequent (India or Adria microplate-style) continent-continent collision ($V_{Convergene}>V_{Retreat}$) across the Limpopo belt from 2.75-2.74Ga. Like the Limpopo orogen (Ranganai et al., 2003), the southern Kaapvaal margin is south-convex and analogous to the Aegean-arc (Stanistreet and McCarthy, 1991), the latter having formed through subduction zone segmentation, rapid slab retreat and rollback in $V_{Retreat}>V_{Convergence}$ (Rosebaum, 2014). The Kaapvaal craton is an ear-shaped Orocline that is attached in the east to a 400km wide x c.700km long Swazi ribbon, a plate-like, hinterland driver of modern plate tectonics (Tsomondo, 2018) in the form of a north-advancing Limpopo oceanic subduction, continental subduction of leading Murchison North Kaapvaal (MNK) terrane and exhumation of the granulite-grade Southern Marginal Zone (SMZ) (e.g. Smit et al.. 2011).

Roughly along latitude 29^0E, the Swazi ribbon's west margin uniquely demarcates the preserved extremities of both 1) the Witwatersrand basin in the Evander Goldfield corner-region and 2) the western extent of the 2.72Ga Southern Marginal Zone, and 3) apparently bisects the 2.05Ga Bushveld Complex into its eastern and western lobes. Phenomenologically, the yorked- or triangular-shaped Witwatersrand basin occupied a NW corner in the 3.6-3.2Ga protoKaapvaal quadrangle whereas the time-correlative Pongola Supergroup, the opposite SE corner with rather unique 2.99-2.96Ga Usushwana Complex and SE-trending dykes, being the oldest stable cratonic sequence. Both basins covolved with 2.97-2.88Ga accretion of northern MNK and western Cordilleran Kimberley arcs onto a recently (c3.0) cratonised protoKaapvaal. The Moho-depth profiles show remarkable evidence for a nearly semi-circular arc of thinned/extended crust in the south that embraces both protoKaapvaal-margin Witwatersrand and Pongola basins (Youssof et al., 2013;references therein). The foreland-directed, east-convexity of the Colesberg linear domain forms part of a major Cordilleran intracontinental dextral transform (interplate) margin that formed the ear-shaped Kaapvaal Orocline under oblique convergence. Significantly, it forms framework for intraplate transtensional and transrotational basins formation through complex vertical axis block rotations driven by a differential, south-directed back-arc crustal extension in south-retreating orogen. Pinned deformation in the Evander east domain caused transrotation or Witwatersrand pull-apart by widening the basin southwards along the `bounding western Colesberg domain during counter-clockwise rotation along the trace of a complex southeastern basin-margin bounding faults (oblique dextral-normal fault). Sediment transport was expectedly mostly southwards into a depocentre of gross synformal geometry.

The evolving and heterogeneous crust-mantle (lithospheric) strength profiles and transient crust mantle coupling and decoupling played major role in the subsidence history of both the Witwatersrand and Pongola basin given the interplay between NE-directed oblique convergence, conjugate system of (ENE-WSW), sinistral Thabazimbi Murchison lineament and (NNW-SSW trending), dextral Colesburg strike-slip (Stanistreet and McCarthy, 1991). Northward motion on the Colesberg fault probably induced or re-activated the sinistral displacement on east-west trending (TML-related) northern basin faults and caused, initially, clockwise block rotation that may have under-thrusted the enigmatic >3.2Ga protoKaapvaal basement over 200km west beneath <3.1Ga young arc rocks in the Kimberley and Finsch diamond mines. The N-S retroarc flexural model of the Witwatersrand basin (Catuneanu, 2001) however understates 1) the basins volcanicity (e.g. Winter, 1987) 2) role of major strike-slip motions and 2) regional crustal extension southwards in the form of max 200km of regressive hinge migration of the southern Orocline along the Colesberg detachment or **S**ubduction-**T**ransform **E**dge **P**ropagator (STEP) (e.g.Gowers and Wortel, 2005) fault. Such pinned displacement is mirrored by the 200km length of the west margin of the yorked Witwatersrand basin (Pretorius, 1974) showing that the first-order control of the Witwatersrand basin is a southern Orocline syntax of ccw vertical axis rotation. From analog and geodynamical modelling results (e.g. Schellart and Moresi, 2013) and geophysical proxies for surface deformation (Silver et al. 2004), we infer north-south poloidal flow associated with back arc extension and back arc spreading. The asymmetrical subduction retreat and slab rollback in the south triggered ascending quasi-toroidal counter-clockwise mantle flow (spin or distributed sinistral strike-slip at surface on N to NW-trending faults) at the edge of the slab. The mantle flow at asthenospheric levels possibly entrained the southern edge of a tectospheric Swazi ribbon keel to induce northwards transformations of this rigid plate. From the SE-trending 2.99-2.96Ga Usushwana complex and later 2.86Ga complexes, dykes & NW-trending folds (after tectonic inversion), the Pongola basin was a zone of sinistral transtensional deformation along curved sinistral shears (e.g. Hunter and Good,), then, dextral transformations northwards of the Swazi ribbon-consistent with a hinterland indenter motions. The study of the transition from south-retreating orogen of distributed intracontinental deformation to a north-advancing orogen has far-reaching consequences on the initiation of subduction and transference of such subduction boundaries in a geodynamically self-sustaining mantle flow process. Along that flow path, the back arc spreading possibly formed the 2.78?-2.71Ga Ventersdorp LIP that can be linked in time and space, across transform-like faults to cotemporaneous N-S shortening of the Swazi ribbon domain. The closest analogue is the spreading Mid-Atlantic Ridge that terminates in the (shortened) Verkhoyansk Mountains (Wilson, 1965). To the question (e.g. Rajesh et al., 2014), can regional shortening associated with Southern Marginal Zone be coeval with NW-SE extension of the Ventersdorp LIP domain and collinear with Kaapvaal Orocline regional extension direction, the answer is ‘Yes’ as controlled by coeval transpression and

transtension (Fossen, 2016). It appears, the Upper Bulawayan magmatism of the Zimbabwe craton since 2.75-2.74Ga includes syn-collisional back-arcs, rifts and extensional basins (Belingwe, Shurugwi, Mashaba Ultramafic Complex, Masvingo, Mutare, Wedza and others), -caused by the Swazi ribbon collision-indentation and vertical axis rotation.
In summary; *$V_R>V_C$ Rate of subduction (retreat) exceeds overall (Kimberley) plate convergence velocity (Royden, 1993). The negative buoyancy of c. 500Myr old oceanic crust is an efficient driver of plate tectonics of south-retreating orogen that formed back-arc Witwatersrand and Pongola basins by rather unique *transrotation* requiring counter-clockwise vertical axis of rotation of ocean-continent domain in southern margin of the protoKaapvaal craton. The model is predictive of the main structural trends in Swaziland and the southern Orocline syntax that is mimicked by Wits basin geometry.

The Great Dyke of Great Treasures and Great Mysteries

Forbes Mugumbate

fmugumbate@gmail.com

The existence of Archaean age Great Dyke of Zimbabwe, which is possibly one of the most extraordinary rock formations on earth, has for a long time puzzled geoscientists. This extraordinary layered igneous complex, is clearly discernible from space as intruding nearly the whole north-south length of the Zimbabwe craton, has attracted considerable research since the first major geological investigations of the 1920s. The investigations are inexhaustible. A number of questions regarding, in particular, the source and nature of the magma, emplacement mechanisms, the layering and genesis of constituent rock types, economic mineralization, morphology, regional setting, and relationships to surrounding rocks, remain insufficiently answered.

The Great Dyke has an unusual structure. It is not, as its name implies, a true dyke at present erosional surface, but the remains of four lopolithic complexes arranged in a straight line and down-faulted in a graben. Each of the four complexes comprises layered igneous cumulates that define both in cross section and longitudinal section a synclinal structure that can be subdivided into an upper mafic zone and a lower ultramafic zone.

No particular hypothesis has been universally accepted to explain the origin of this remarkable body. Theories on the evolution include suggestions that the Great Dyke is a remnant of an Archaean Large Igneous Province (LIP) related to the processes of the evolution of the Earth's crust that involved accretion and destruction of continents from as far back as the early Archaean. In this hypothesis the Great Dyke is a manifestation of a plume related LIP associated with rifting and breaking up of an Archaean supercontinent.

There are also suggestions that such igneous bodies were caused by huge meteorite impacts. For instance, the gigantic Vredford meteorite impact in South Africa has been astonishingly believed by some researchers to be the reason for the evolution of the Great Dyke and other complexes despite the huge differences in ages. The current belief is that the Dyke together with associated satellite dykes were emplaced as a result of fracturing caused by collision between the Kaapvaal and Zimbabwe cratons during the late Archaean, although this hypothesis is also being questioned.

Interesting debate about the Great Dyke thus continues, which is presenting endless research opportunities on various topics essential for understanding evolution of this body and that of the young Earth. This significance is buttressed by the vast resources of chrome ore, Platinum Group Metals and other economic mineral deposits, and also by the majestic topography displayed by the Dyke. The Great Dyke often heads the list of things to see for any geologist visiting Zimbabwe. Non geologists are also beginning to appreciate the greatness of the Great Dyke. The unique flora whose distribution is controlled by different rock types in the layered complex and the naturally heavy mineral contaminated soils over serpentinized horizons, present further prospects for tourism. The structure certainly deserves to be designated a national heritage, and one of the geological wonders of the world.

A new Late Triassic Fossil Vertebrate Assemblage from Zimbabwe Key to the Understanding of the Origin of Dinosaurs

Chris Griffin as read by Tim Broderick

ctgriff@vt.edu makari@zol.co.zw

In a Pangaea setting 230Ma ago Carnian-aged dinosaurs had been found in only three places worldwide, and these in association with hyperodapedontid rhynchosaurs, traversodontid cynodonts and armoured archosaurs referred to as aetosaurs, all of which were herbiverous. That is these genera have been documented in Brazil, Argentina and India. The question is, why are they found at a certain palaeolatitude under humid conditions? And why not in the Carnian of southern Africa? Oesterlen's discovery of rhynchosaur dentition from the Pebbly Arkose of the western Cabora Bassa Basin of the Zambezi Valley in 1988 was followed up by Raath and Kitching (1992), who confirmed the presence of Hyperodapedon remains in association with an apparently early dinosaur bone. In a quest to find the missing link, Chris Griffin earned a young scientist's grant and staged the 2017 Expedition in association with the National Museums and Monuments of Zimbabwe. Homing in on badland topography west of Mashumbi Pools and north of the Zambezi Escarpment, we discovered a host of fossil bone material associated with the Pebbly Arkose Formation as mapped by Oesterlen, 1998. Confirming the rhynchosaur and cynodont association, in 2019 we extended the bone-bearing locations as far west as the Angwa River. The significance of the rhynchosaur association is that these archosaurs hold a very restricted worldwide stratigraphic record within the Carnian stage of the Late Triassic. The cynodont and aetosaur combination makes the situation more significant in that we also recovered the near full skeletal remains of a small early sauropodomorph dinosaur in 2017 backed up by more convincing material in 2019. On preparation and examination classic dinosaur bone features are present, which have been compared with similar Brazilian material including that of Saturnalia, the early saurpopodomorph from the similarly aged Santa Maria Formation of Brazil. Then bones from a larger theropod dinosaur were discovered in 2019, which are akin to the Argentinian-named carnosaur, Herrerasaur, making the transcontinental vertebrate association complete. Only later and at higher stratigraphic levels did sauropodomorphs appear as fossils from the corresponding climatic band north of the palaeo-equator. It may be fair to hypothesize that the earliest dinosaurs were restricted in their range due to palaeoclimatic and latitudinal restraints.

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The Geology and Historical Importance of the Abanab Vanadium Mine in the Otavi MountainLand (Namibia)

Mark Watts

mark@shango.co.za

The Otavi Mountain Land (OML) is a 10 000 km^2 Neoproterozoic (730 – 530 Ma) mineral province located at the eastern extremity of the Damara Pan African Orogenic Belt in Namibia.Three mineralising styles are present in the OML. The first developed from low-temperature and high-salinity basinal fluids and produced Zn-Pb deposits with a Mississippi Valley-Type (MVT) affinity (Berg Aukas-type). The second episode (~600 Ma) involved higher temperature, lower salinity, Cu-rich, possibly metamorphic fluids. These formed the Cu-Pb-Zn-Ag Tsumeb-type deposits, locally accompanied by Fe-Mn oxides and silicates. The third episode is related to recent (~25 Ma) weathering and produced V-rich deposits which are spatially associated with the MVT/Sedex Berg Aukas type of mineralisation.

The Pb-Zn-V deposits of Abenab were exploited between 1921 and 1958 during which period the mine reportedly produced 1.85Mt @ 1.03% V2O5 to yield 56 600t of concentrate at a grade of 18.5% V2O5, 13% Zn and 42% Pb. For the first 18 years, mining took place exclusively on the Abenab pipe deposit which was exploited initially from an open pit operation. Upon reaching the water table at a depth of 60 metres below surface (mbs), further mining took place from eleven underground levels driven beneath the pit to a final depth of 215 mbs.

In 1924, shortly after commencement of mining at the Abenab pipe, prospecting was carried out on the narrower orebody at Abenab West. Although the deposit is located only 200 m south of the Abenab pipe at its closest point, mining did not commence there until 1939 when global vanadium prices improved and the somewhat lower grades could be exploited commercially. For eight years, mining took place intermittently until new reduction installations rendered the systematic concentration of the ore possible.

The Abenab pit and underground workings were exhausted in 1947. Abenab West was mined until 1958, by which time the easily accessible near-surface ore was depleted.

All three styles of mineralisation are represented in the Abenab-Abenab West area:

1. Primary MVT/Sedex ore (dominated by galena, sphalerite, pyrite, tennantite, bournonite)

The pink laminated dolomite at Abenab West forms a marker horizon in which low grade disseminated Pb-Zn sulphide mineralisation is common and which locally is associated with lenses of massive Pb-Zn-Fe sulphide.

2. Late Hydrothermal Zinc Reef (largely ferruginous willemite)

The Zinc Reef is a metasomatic replacement product of the pink dolomite and platy limestone by willemite along the Christiana Fault.

Some Observations on Pegmatites

Tony Martin

anthony.martin2107@gmail.com

There are two geological domains that host pegmatites in Zimbabwe: the Archaean ones which have a close spatial association with the Chilimanzi suite of potash granites and those of the Mesoproterozoic Magondi Supergroup. Both result from crustal re-melts and the volatiles generated from this process.

This talk will focus mainly on Archaean examples and textural and mineralogical variability that have been observed in some of these bodies, which indicate a complex history of emplacement.

Classical pegmatites have been subdivided into four zones, The Border, Wall, Intermediate and Core Zones based originally on North American examples in the 1950s. Although most large pegmatites show these zones, they are far from concentric and in particular the Intermediate Zones are mostly very complex suggesting multiple injections of fluids of different compositions. The main evidence for this is seen in breccias, dykes of different mineral compositions and alteration of pre-existing mineral assemblages.

Other observations include the shallow dip of large pegmatites which is very different to the mostly steep dips of hydrothermal veins, indicating a different mode of emplacement and different fluid properties.

Structural Footprint of Gold Mineralisation in Zimbabwe Greenstone Belts; A case study of Pickstone Peerless Deposit

George Rusike

georgemrusike@gmail.com

The Pickstone Peerless system locates within a narrow corridor of carbonated greenstones and pillowed basalts of basic composition. Gold bearing structures impress, from a bird's eye view, lozenge shaped complexes bound to the foot- and hanging wall by steeply dipping metapelitic 'black shales'. The shear zone is bound by three major granitic plutons, the Mupfure, Shumavale and Mombi batholiths to the NW, NE and S respectively. Pickstone Peerless mine lies in the middle of a major indentational flexure which apparently coincides with the regional foliation trajectory of the northern fringes of the Mombi intrusive.

The three granitic plutons apparently acted as the heat engines that mobilized gold bearing fluids along the margins. Gold mineralisation exhibits a 'warp-about' geometric profile sympathetic to the margins of the Mombi granite. The Peerless trend strikes E-W. Lithotypes in the mineralization envelope of the Peerless trend shows a basinal cyclicity with pillowed basalts on the outer fringes, auriferous carbonated, metabasaltic stockwork reefs in the middle, with a weakly mineralized halo of sheared dolomites that are bound to the foot- and hanging wall by a thin layer of impevious metapelitic 'black shales' (mine parlance). The Pickstone trend strikes NW-SE and coalesces with the Peerless trend to the west. The Pickstone trend reef is typically a banded ironstone bound by Fe-rich and talcose-chlorite schists to the north and south. The Duchess Hill to the SE is an eastward appendage of the Pickstone trend, displaced to the south by the Mombi river fault. The petrogenesis of the Pickstone Peerless shear zone was initiated by truncation of greenstone crustal mass (paleobasin) due to synchronous diapiritic upwelling of the granites which resulted in E-W elongation of the volcanic and sedimentary successions, which further deformed by translational forces, causing formation of lenticular slivers of basaltic composition. These lenticular 'duplexes' exhibit predictable dimensions and can be used to infer recurrence of structural traps along strikes where gold mineralization is high and the reef widths are as generous as 20 to 25m for +/-20m of strike. This observation has afforded Geologists to predictively model the payshoot and save on exploration expenditure by zooming in on structural flexures that are likely to result in formation of wide pods of highly mineralized stretches.

The westerly plunge observed on longitudinal sections is likely to be coincident with the Cromer Porphyry thrust vector.

Tantalite Production in Post Colonial Zimbabwe, 1980 – 2018: Challenges and Prospects

Tafadzwa Gwini

etgwini@gmail.com

Tantalum containing minerals have been known to exist in Zimbabwe since 1911. By 1962, the country (then Southern Rhodesia) became the fourth largest producer of tantalite in the world. In the post-independence period, tantalite became the most sought after mineral by small-scale miners in Zimbabwe after gold, superseding emerald that the geologist A. Mamuse speculated that with the increasing inquiries about the mineral at the Geological Survey, tantalite could even overtake gold in terms of small miner demand in the near future. Since then, increased uses of tantalum, resulting from the global digital and technological revolution has increased the demand of the mineral on the world market. This is supposed to be good news to Zimbabwe since there are at least 300 known occurrences of tantalite deposits in the country thus "positively suggesting a wealth of reserves (Mlambo and Mugoni, 2011). Unfortunately, despite significant booms and high prices of tantalite on the world market, production in Zimbabwe has remained relatively poor. The presentation analyses shifts in the global production since 1980, production trends since independence, and some of the challenges the industry is facing will be discussed. It then closes with the prospects of the industry and solutions to make the best out of the rare earth element in light of sovereign national development projects, given the nature of extraction methods of the mineral. Of importance to the discussion will be the historical approach taken to assess the prospects of the industry in the globalized 21st Century.

The Geo-Metallurgy of the Arcadia Pegmatite Swarm

Adam Moodley

adammoodley85@gmail.com

Mineralized pegmatites found in Zimbabwe have been subdivided into two main groups. The first group is the Miami type, which is confined to high-grade metamorphic derivations and have ages estimated between 477 and 680 million years. The second group is the older Bikita type, which is associated with granite-greenstone terranes, and range in age from 2 100 to 2 865 million years. The Arcadia pegmatite swarm is located within the Harare granite-greenstone terrane and thereby fall into the Bikita type category.

The economic significance of Bikita type pegmatites in Zimbabwe is that they are the prime repositories of lithium minerals. The Arcadia pegmatites contain economically significant proportions of petalite and spodumene, along with some eucryptite and trace amounts of lepidolite, which are rarely observed. Petalite phenocrysts are largely coarse-grained (<10mm - >100mm), while most spodumene comprises fine-grained (<1mm) quartz-spodumene assemblages sometimes with graphic intergrowths.

At Arcadia, the difference in mineral properties and textural variations, between petalite and spodumene have required a high level of ingenuity to develop a minerals beneficiation

process plan. A series of crushers, HPGR (High-Pressure Grinding), DMS (Dense Media Separation), and froth floatation have been used in the minerals plant to produce both petalite and spodumene products. Magnetic separation tables have also been incorporated into the process map in order to recover a tantalum by-product.

The lithium market requires that final petalite and spodumene products achieve specific lithium, Iron, and alkali pro for them to be used in the various applications. Therefore, the geology of the plant feed has a direct impact on the specifications of the final saleable product.

An Interpretation Of Magnetic, Gravity And Magnetotelluric Measurements Over The Magondi Circular Magnetic Anomaly Of Zimbabwe

Tenyears Gumede

tenyearsgumede@gmail.com

The Magondi "Magnetic" anomaly centered approximately 17˚ 45' S, 29˚ 52' E consists of a deep seated circular to ellipsoidal magnetic low, 15km in diameter, with a small magnetic high to the north and northeast. The qualitative depth of the anomaly is interpreted from the constituting wave forms which are smooth. The anomaly is in or below the Proterozoic Lomagundi or Deweras group at the possible edge of the Zimbabwean craton. The data indicates that the causative body has a large remanently magnetized component and consequently it is expected that the magnetic material probably has large magnetic crystals. Among the outcropping rock types, no explanation for the magnetic anomaly can be construed.

The deep negative magnetic anomaly is modelled as an unknown intrusion that dips to the north. The depth of the anomaly is as much as 2000m and the thickness varies from 500m to as much as 2000m. The deeper body has an extremely high magnetic susceptibility of 0.1 cgs units. The r remanent inclination was taken at the reverse of southern Africa's present magnetic field direction namely declination is +65° and inclination at +20°. The Konigsberger ratio is 1.5.

The second group of models is represented by a highly magnetic diapiric/plug like body. The modelled depth to the top of the body is in the order of 2000m. The remanent inclination direction is taken at +93° and declination at +17° with a Konigsberger ratio of 1.5.

Substantial gravity anomalies at the southern and northerly perimeter of the magnetic anomaly were mapped and generated a lot of exploration interest leading to drilling of 1094m drill hole located near a medium grained gabbro similar to that observed in the first fresh rock encountered in the core below the weathered zone.

Of the six magnetotelluric soundings undertaken, four can be fairly well represented by a north dipping sheet like conductor with a resistivity of 60ohm.m confined above by material with a resistivity of 5K Ohm.m and below approximately 20K Ohm.m material. The conductive layer may be discontinuous and block faulted. The average dip of the conductor is in the region of 22˚. The conductor's most southern boundary coincides roughly with the central part of the magnetic body. Modelling indicates the depth to the conductor to be in the region of 600m. Sounding to the east indicate the presence of a moderate (600 Ohm.m) conductor present under an outcropping granite sheet. The conductor is expected to be greenstone material.

ScanIT – Optimizing core logging data acquisition

Megan du Plooy

megan@ucpafrica.com

ScanIT is a data acquisition tool that has been developed to increase core logging efficiencies and precision – to speed up the process and collect meaningful data.

We at UCP Africa believe with a swift change in methodology more can be achieved in a shorter time frame, keeping projects within time schedules and budgets.

With the rise of Industry 4.0, ScanIT will assist the early adaptors to get ahead of the curve with data acquisition, allowing the geologists to spend more time on other important aspects of their projects too.

By simply photographing the core with our simple photography system, the project's photographic archive is created before core is logged. ScanIT users log their core on their screens, with Optical Character Recognition improving meter-marking precision, as well as dip and dip direction for each structure measured with just with three clicks. Borehole data can be viewed in a stereonet, an orthographic projection, and in a composite view.

ScanIT produces comprehensive lithological, structural, and geotechnical logs, easily importable to geoscientific information management systems and modelling software. RQD is calculated in the background and exported in 1, 2, 3m intervals or per run. ScanIT is taking borehole data collection to a whole new level.

Microseismic monitoring based approach to effective ground control management in unstable underground mines

Paul Matshona

paul.matshona001@gmail.com

Fall of ground is a mining hazard that is inherent with underground mining operations. The hazard is exacerbated by increasing mining induced stresses as mining operations progresses. Stope sequencing has a major influence of the local and global stability of the mining environment. Rapid sequencing results in increased stress regimes which in most instances leads to stress relaxation and rock bursts. In sublevel open stoping mining operations, stope sequencing is characterised by primary stoping and secondary stoping which involves mining of pillars. Mine depillaring can cause mine instability and to cater for this, the open stopes left during primary stoping are usually backfilled to provide support during secondary stoping. On a mine set up where there is no backfill equipment secondary stoping may be a challenge due to increased stress and extent of deformation around the mining void which can interrupt production, due to stope loss, damage to equipment and injuries to mine workers An effective ground control management system is necessary to ensure that stoping can be achieved in a safe manner. The purpose of this research was to preliminarily design a microseismic monitoring system for effective ground control management at mine X. The design of the microseismic monitoring system was based on the monitoring objectives that we determined during rock mass characterisation and numerical modelling. The results of rock mass characterisation indicated that the mine area is characterised by two major shear zones intersecting in the district under consideration for secondary stoping, there are two major lithologies in the area. Results of Numerical modelling indicated that the area around the open stopes are unstable, the lithologies contact zones and the shear zones provide areas of instability.