Geological Society of Zimbabwe

Summer Symposium

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University of Zimbabwe

Final

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Start	Topic	Speaker
07:45	**Registration**	
08:15	Welcome & Atlas Project Demonstration	Andrew du Toit, Society Chairman
08:35	Official Openning	Deputy Minister of Mines and Mining Development, the Hon. Fred Moyo MP
09:00	Overview of Zimbabwe's Mineral Resource Potential - Tip of the Iceberg?	Forbes Mugumbate
09:25	**Tea**	
09:40	Policy Development and its effects on mineral resource rich countries: from potential to actualization	Ben Mapane (Keynote Speaker)
10:30	Sustainable Geology: Enhancing geosciences education practical foci and independent development of geological skills from elementary to tertiary levels	Tendai Njila
10:50	Hydrocarbon Potential in Zimbabwe	Brent Barber
11:25	A snapshot of PGE resources of the Great Dyke	Collins Mwatawa
11:45	Comparison between Sulphide ores and Oxide ores on the Wedza Complex of the Great Dyke of Zimbabwe	Freddy Chikwiri
12:05	The Waterberg Platinum Discovery	Gordon Chunnett
12:25	Determination Of Optimal Combination Of Recovery Rate (Rom) And Level (Cut-Off Grade) Based On The Polygon Method Of Reserve Estimation	Lyman Mlambo
12:45	**Lunch**	
14:00	Merits of multi-spacing Gradient Induced Polarisation (GIP) and its applications	Tenyears Gumede
14:20	Exploitation of gangue minerals and their contribution towards a country's economic development	Kennedy Magomo
14:40	The History of Mica Mining in Zimbabwe	Tim Broderick
15:00	**Tea**	
15:15	The Geomorphology of southwest Uganda	Andy Pahwaringira
15:35	SRK's perspective on new mining business for the past 5 Years	Arimon Ngilazi
15:55	A Discussion On Quality Assurance-Quality Control (QAQC) In Mineral Exploration	Jones Bishi
16:15	Summary	Ben Mapane

Overview of Zimbabwe's Mineral Resource Potential - Tip of the Iceberg?

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With a heterogeneous geological environment spanning a period from the present era to the Archaean, Zimbabwe is favourable for occurrences of a variety of mineral deposits and ore body types. Projection of this rich mineral endowment was first made by Arab and Portuguese visitors in the 10th and 16th centuries respectively when they recognised extensive ancient workings in many parts of the present day Zimbabwe. Corroboration of these observations by adventurers and hunters such as Karl Mauch, Thomas Baines, Henry Hartley and Frederick Selous who visited the country in early in the 19th century inspired Cecil John Rhodes to conquer the country to secure the mineral riches. Zimbabwe is therefore perhaps the only country whose colonization by Europeans can be attributed to its perceived mineral riches.

Although not as per expectations of discovering huge mineral deposits at colonization, the mining industry gradually grew to become an important sector of the economy. Over 40 different economic minerals have been mined from more than 6 000 prospects, making Zimbabwe one of the best-known mineral-rich countries. World-class deposits of gold, platinum, chromite, coal, coal-bed methane, diamonds, nickel, and pegmatite minerals have now been recognized in Zimbabwe's geological environments.

Despite the projected rich mineral endowment and the long history of mining activities, various technical and political reasons have hindered full realization of the mineral potential. Available information suggests that only a small surface of the huge 'iceberg' of mineral resource has been identified. Arguments supporting the existence of a huge mineral resource are as follows:

- The country's laws do not compel companies to delineate certain resources before mining, and as a result, resources at many mineral deposits are not known. Majority of mines operate at zero reserves or usually only calculate reserves a few months ahead of production. Small-scale producers who dominate the industry do not have capacity to delineate reserves. However many mines have been intermittently worked for nearly 100 years on this basis without being exhausted. This suggests that there are substantial mineral reserves at many deposits, most of which have only been sporadically worked.
- Political and economic challenges faced by the country at various stages of its development have hampered the usage of modern equipment and technology such as high resolution geophysics and geochemistry, remote sensing, and manipulation of large datasets in Geographical Information Systems (GIS) that have contributed immensely to the discovery of mineral deposits in other countries. Systematic green-field exploration in Zimbabwe has virtually stopped.
- The post-independence influx of mining companies with requisite capital, technology and innovative ideas resulted in recognition of world-class mineral deposits at several mines including Ayrshire, Connemara, Eureka, Giant, Freda-Rebecca, Indarama, Isabella, Pickstone, Royal Family, Turkey, and Vubachikwe,

previously considered to be small deposits. New discoveries were also made at Maligreen, Ipanema and Hungwe gold deposits. This period also coincides with the discovery of Kanyemba uranium deposit and the commissioning of the Hartley Platinum mine. This exploration window that lasted less than ten years clearly demonstrates that given an environment that encourages exploration, this country has unlimited opportunities for mineral discoveries.

- Although small scale mining for which Zimbabwe is renowned often point to possible significant mineralization, the partitioning of ore bodies by small-scale mining claims belonging to different owners have presented challenges to modern scientific exploration. The potential of these areas remain obscured although consolidation of some of these claims has occasionally led to major mineral discoveries, e.g. the Vubachikwe deposit.
- The structure of the mining industry in Zimbabwe is highly skewed. There is a gap between hundreds of small scale mines and a few large mines. The apparent missing link bridging the simply indicates that there are many small mines with potential to develop into medium and large-scale.
- Majority of mines re-discovered at colonization of this country have ceased operations with only a few having been mined to significant depths from the surface. The greater numbers of these have never been scientifically investigated. Reasons for the closure of the majority of the mines are unknown. Technical data on many of these dormant workings is clearly suggestive of the need for further investigations. Thus with hundreds of old mines dotted across the country, opportunities for re-discovering some of them as large deposits are enormous.
- Large areas that traditionally have not been considered for mineral exploration simply because they do not have a glaring history of mining are proving to be valuable. These include minor greenstone belts such as Mount Darwin (Ruia and Mukaradzi), Dindi (Ball mine area), Makaha (Chipenguli Hill), Mutare-Odzi (Penhalonga), Beatrice (Beatrice-Roma) , Felixburg and Lower Gwanda (Antelope and Legion areas), Limpopo Mobile Zone (Ngundu area), and Umkondo basins (Tarka Forest gold, Marange and Chimanimani placer diamonds).
- Zimbabwe has similar geology to some great mineral producers such as Australia and Canada. There are no geological reasons to explain the current differences in the nature and sizes of mineral deposits in Zimbabwe and these countries. Current studies of Large Igneous Provinces and super continents are not only suggesting dichrous evolution of these geological provinces, but that some of them formed as a unit in space and time and later separated, and thus should share many similarities including mineral potential.

Just like the tip of the iceberg, Zimbabwe's known mineral resources are therefore undisputedly representing a tiny part of the possible resource. That the country remains under-explored despite the overwhelming mineral potential has more to do with policy issues than geological limitations. In the same way appreciation of the full size of an iceberg can only be achieved by probing the protruding tip below the surface of water, realization of the full mineral resource of the country will be accomplished by comprehensive exploration and research. Systematic exploration has virtually stopped. Policy intervention and research are necessary to promote exploration to reveal the nature of the mineral 'iceberg'.

Sustainable Geology: Enhancing geosciences education practical foci and independent development of geological skills from elementary to tertiary levels

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The dynamics of educational perspectives in relation to changing societal demands requires a more practical approach in teaching and equipping geoscience students and professionals with the relevant skills through observations and application. Sustainable geology is the ability of a geoscience student to be innovative and apply the independent geological skills in adding value to geological resources at any given scale of national development. This requires students to learn with minimal supervision, be innovative, and acquire critical thinking perspectives which will help them to development independent of geological skills from elementary to professional level. Global perspectives on societal demands are having major impacts on many scientific disciplines, including the geosciences. Examples of such changes are population growth and urbanization, pollution and land degradation, global change, and, the 'new materials society,' shifting economies away from traditional high-growth consumption of primary metals through technological advances. This will drive earth science disciplines in the direction of environmental, sociogeociences and urban applications. The Industrial Attachment component in the penultimate year of the new geology undergraduate programme at the Department of Geology at the University of Zimbabwe is geared to enhance the coupling of geoscience theory and practice, but does not entirely cover the whole spectrum of geoscience applications, which needs to be further addressed as a growing concern. The attachment is also meant to provide a platform to interact with geoscience industry. However, collaboration with various geoscience industries is still at birth stage and this paper aims at highlighting the importance of such a mutual approach in finding, creating and producing better professionals capable of spearheading innovative and development measures much needed in present day scenario.

Policy Development and its effects on mineral resource rich countries: from potential to actualization.

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A global survey on exploration budgets around the world from 2000 to 2012 reveals that while a general increase is observed, however the increase is affected by results of inflation, currency fluctuations and a marginal real value increase. A critical analysis shows that mineral policies in various countries around the world have a direct bearing on the foreign direct investment stemming from mineral exploration.

One country that seems not to follow the trend is investment sourced from China, which has consistently grown regardless of the perceived risk factors in certain countries. In market driven economies, it is clear that countries such as Canada saw a lower rate of increase between 2011 and 2012 because of new changes in the mining law in the province of Ontario. European countries that were most affected by policy changes include Poland, which increases taxes on processing and Bulgaria, which could no longer process its ore due to EU environmental requirements. African exploration activity varied greatly according to country specific fundamentals. The issues that affected African countries were (i) mineral supply concerns due to changes in mineral regulations; (ii) labour issues; (iii) issues concerning artisanal mining, e.g., copper artisanal miners in DRC; (iv) conflict minerals; (v) government pressures and political instability. Increases in mine taxes in Burkina Faso, Congo D.R., Guinea, and Senegal affected rate of investment flow. Changes in mineral regulations in Namibia affected direct capital investment in 2010-2012 and proposed tax increases in Ghana and Cote d'Ivoire in 2012 ensured that investors had to wait and see what the margins of increase would amount to before investing. Latin America continued to be the preferred continent for major mineral investment projects. A total of US$20.53 billion was invested in metals and coal exploration (non-oil and gas) in 2012; this went mainly to gold (54%); base metals (17%); uranium (5%); diamonds (2%) and coal, iron ore and all other commodities accounted for 22%. This amount is shared as follows by continent/country: Latin America 25%; Africa 17%; Canada 16%; Rest of the world 15%; Australia 12%; United States of America 8% and the Asia Pacific region obtained 7%. Junior companies continue to raise more funds for exploration across the globe, and accounted for 57% of the budget share in 2012. Australian companies had a total of 650 exploration projects in 37 African countries. It looks increasingly certain that more exploration is poised to continue in Africa, the question is which countries will benefit from this capital inflow? The countries with the least risk are currently attracting a lot more money.

Hydrocarbon Potential Zimbabwe

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The possibility of discovering oil or natural gas in Zimbabwe is one that has frequently been raised and, due to the costs in foreign currency of purchasing petroleum products, remains an intriguing question.

Decades ago it was believed that hydrocarbons formed virtually exclusively from the decay of micro-organisms under anaerobic conditions within marine sediments of Cainozoic to Mesozoic age. In Zimbabwe, as life did not proliferate until the Phanerozoic, the prospects of finding oil were considered relatively meagre, with sediments possessing the potential to possibly generate and host hydrocarbons restricted to the Zambezi and Save-Limpopo Rift Trends.

Contrary to malformed rumour Mobil Exploration Zimbabwe did not discover oil during the investigations undertaken along the Mid-Zambezi Valley in the early 1990's. What the exploration completed did confirm was the presence of very thick sedimentary piles of Karoo and younger strata which, in the Cabora Bassa Basin, are over 10 kilometres thick. At this time the source rocks sampled were determined to be predominantly gas prone and, as insufficient interests in joint venture drilling a well could be generated, the prospect was judged to be too high risk and exploration discontinued.

Some 20 years later exploration concepts, proven by the discovery of oil in similar depositional environments as close as the Albertine Graben in Uganda and Lokichar Basin in Kenya, have evolved and the hydrocarbon potential of the sedimentary basins in the Mid-Zambezi and Save-Limpopo areas merit reappraisal.

A snapshot of PGE resources of the Great Dyke

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The Great Dyke of Zimbabwe is a major repository of world class Platinum Group elements (PGE) resources which are also associated with Nickel, Copper and Cobalt mineralization. The Great Dyke is layered mafic-ultramafic intrusion that transects the Zimbabwe Archaean Craton for some 550km. It is an elongate body with a maximum width of 12km and in traverse section is trumpet shaped. The Great Dyke is divided into two major successions, an upper sequence of mafic rocks consisting of gabbros and norites and lower succession of ultramafic rocks made up of dunites, harzburgites, olivine pyroxenites and pyroxenites.
Several occurrences of PGEs in different stratigraphic and structural positions have been identified within the layered sequence of the Great Dyke and marginal rocks. The PGEs are associated with the Main Sulphide Zone (MSZ), Lower Sulphide Zone (LSZ), chromite layers, the marginal sequence and gabbroic rocks. The MSZ is the most important source of world class PGE resources and quantification of the resources in light of ongoing exploration is the focus of this presentation.
It is believed that the MSZ was originally a continuous layer over most of the length of the Dyke. Erosion has subsequently removed much of the cover mafic sequence and the MSZ, leaving remnants portions with preserved mafic cover rocks in the Musengezi, Darwendale, Sebakwe, Shurugwi and Wedza sub chambers. The economic PGE resources are confined to a 2-3m zone of the MSZ within the Wedza, Shurugwi, Sebakwe and Darwendale sub chambers. The MSZ mineralization is uniform over the Great Dyke, subtle vertical variations in distributions of the PGEs occur within the sub chamber.

The resources stated in this report a result of concerted exploration work that has been carried over the past decade by mining companies on the Great Dyke whose resources are audited and verified by independent third parties before publication in their annual reports. The resources as published by the mining companies follow SAMREC or JORC reporting guidelines and are compiled by competent persons on PGE mineralization.

A total inclusive sulphide resource of 3.2Bt have been reported by mining companies operating on the Great Dyke with a total 4E content of 373.6Moz which reflect increased exploration and understanding of the MSZ PGE mineralization. The Pt resources of the great Dyke had been estimated at 143Moz by Grant Cawthorn in 2009. The 4E average grades at resource cuts of 180cm to 250cm range from 3.6g/t to 3.3g/t. The Darwendale and Sebakwe sub chambers have the largest PGE resources followed by Shurugwi sub chamber and Wedza Complex with 86%, 10% and 4% respectively in terms of resource tonnes and 84%, 11%, 4% respectively in terms of 4E ounces. Oxide resources approximate 3-4% of the total sulphide resource.

A Comparison Between the PGM Mineralogy of the Pristine Sulphide and Oxidised Ores of the Wedza Complex of the Great Dyke, Zimbabwe

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This presentation will give a qualitative and quantitative overview of platinum-group minerals (PGM) composition in the pristine sulphide and in the oxidised ores in order to establish how weathering affects PGE distribution in the rather complex surface oxidised ore. Estimated value and potential for future mining will also be discussed.

The Great Dyke, striking NNE and approximately 550 km long and 4-11 km wide, is an Archaean (2575.4 ± 0.7 Ma) linear layered intrusion which comprises an upper mafic sequence and a lower ultramafic sequence. The Great Dyke is the second largest reserve of PGE after the Bushveld Complex in South Africa and its oxidised ores represent a treasure chest for future mining. Recent attempts at mining oxidised ore have been hampered by the low recoveries of PGE. Economic concentrations of PGE in the Great Dyke are hosted in the Main Sulphide Zone (MSZ) which is a 2.5 m thick PGE rich layer located at the base of websterite and orthopyroxenite contact. The pyroxenite comprises comprise cumulus opx altered to hydrous silicates, intercumulus plagioclase, cpx and a late stage high temperature assemblage of quartz and K-feldspar. In the oxidised ores, base metal sulphides (BMS) are replaced by iron hydroxides. PGMs were identified using a Mineral Liberation Analyser which is an automated FEI Quanta 600 Scanning Electron Microscope (SEM) and also using a Scanning Electron Microscope (SEM) Jeol5610 at IGEM RAS.

PGM in sulphide ore have been found to exist as magmatic primary PGM mainly PGE bismuth tellurides, sperrylite and cooperite/braggite all mainly associated with BMS. Weathering of the pristine sulphide ore has changed the PGM proportions, distribution and textural setting. In the oxidised ore PGM exist as:

i. Relict primary PGM mainly sperrylite, minor Pt_3Fe as well as rare laurite, Pt-Ir sulphoarsenides and Pt-Pd bismuth tellurides.
ii. Secondary PGM neoformation (e.g. Pt- complex alloys with Bi and Te admixtures, Pt-Fe alloys with Cu and Pd admixture, Pd-Hg compounds and Au-Ag alloys)
iii. PGE oxides and hydroxides either in altered primary PGM or representing neoformations (e.g. PdO and PdO_2).

All these species in oxidised ore are associated with iron oxides, silicates (mainly bronzite) and hydrous silicates.In the samples studied, $PtAs_2$ is the most stable PGM in the supergene environment and is occurs as fresh grains or grains with altered surfaces coated by low reflectance Pt oxides/hydroxides. There is a significant Pd loss during weathering and its fate at this time is unknown. There is also a conspicuous gain in Cu and Au which might be due to a secondary supergene concentration process which concentrates the metals in narrow newly forming cementation zones.

The redistribution of PGE in oxidised ore creates metallurgical complications as the ore cannot be upgraded by conventional metallurgical methods. Suggested possible pyrometallurgical and hydrometallurgical methods by Evans (2002) require large scale technical equipment and expensive equipment and are hence uneconomical to use in the present day. Further research is needed to develop novel metallurgical methods in order to convert this sitting resource into a mineable reserve.

The Waterberg Platinum Discovery

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The art of exploration is seldom more thrilling than when turning over a stone, done so many times before, but this time looking differently and finding treasure. The Waterberg Platinum Discovery continues to amaze even our own pundits with so far a continuing strike and dip projection we can't wait to bring this new deposit to account. The team were set a task and have steadfastly opened up new ground and new mineralised units of unimaginable geological astonishment, like the recent 80m at 4g/t (32,000cmg/t) which has yet to be added to the already announced 29Moz Pd, Pt, Au deposit.

The mineralization is atypical of the known platinum horizons including the Platreef so direct lateral comparisons are avoided, suffice to say that with what metallurgical work is to hand the recoverability is at levels of at least Platreef style deposits.

Cunningly this deposit is masked by variable thicknesses of Waterberg Sedimentary material in a relationship yet to be confirmed but intriguingly atypical, with sniffs of the textbook rewrite type. The PTM team is commended for a great piece of work concluded so far with wide open horizons ahead.

Determination of optimal combination of recovery rate (ROM) and level (cut-off grade) based on the polygon method of reserve estimation

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This presentation demonstrates how optimal rates of recovery and recovery levels can be determined assuming the polygon method is used in defining reserves. The presentation is a summary of a case study on "Optimizing a depletable mine design, Rio Blanco lateritic nickel deposit" presented in detail in Rudawsky, O (1986) (*Mineral Economics - Development and Management of Natural Resources*, Developments in Economic Geology 20, Elsevier, Amsterdam). The presentation shows that once some minimum level of ore grade is determined, there are several combinations of levels (grades) and production rates that can be considered depending on technology available. Assuming some recovery rates in mining and in concentration, mining costs, concentration costs, concentrate level (marketed product), hence concentration ratios, mining costs per ton of concentrate produced for each combination of grade and ROM are computed. Combining this information with the revenue side, annual and life –time profits are computed, which give an accounting basis for decision on optimal combination. Further consideration of the time-value of money, depreciation and depletion allowances, royalty and income tax (abstracting from the other fiscal charges, for simplicity), leads to the determination of an optimal combination on the basis of the net present value (NPV) or the internal rate of return (IRR).

Merits of multi-spacing Gradient Induced Polarisation (GIP) and its applications

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Multi-gradient Induced Polarisation (IP) method consists in plotting gradient IP profiles read with increasing current electrode spacing one under the other on a depth scale. Evidently no inversion is performed to build a real-section and is more of a plotting convention. As a result real-sections, are not different to other IP Survey arrays, and are not true depth sections, but pseudo-sections.

Once classified as pseudo-section, multi-gradient sections suffer the same limitation as pseudo-section obtained with pole-dipole (PD) and dipole-dipole (DPDP). They suffer the same surface effects inherent in other IP arrays.

As illustrated in IP surveys in Figure 1, multi-gradient IP cannot distinguish a source at depth from near surface effects. There is no pant leg anomaly because the highest contribution comes beneath the potential dipole and the pattern does not change whatever the current electrode spacing. As a result, a vertical body will give a narrow vertical anomaly synonymous with a flat lying one. It is therefore recommended to model and incorporate geological evidence.

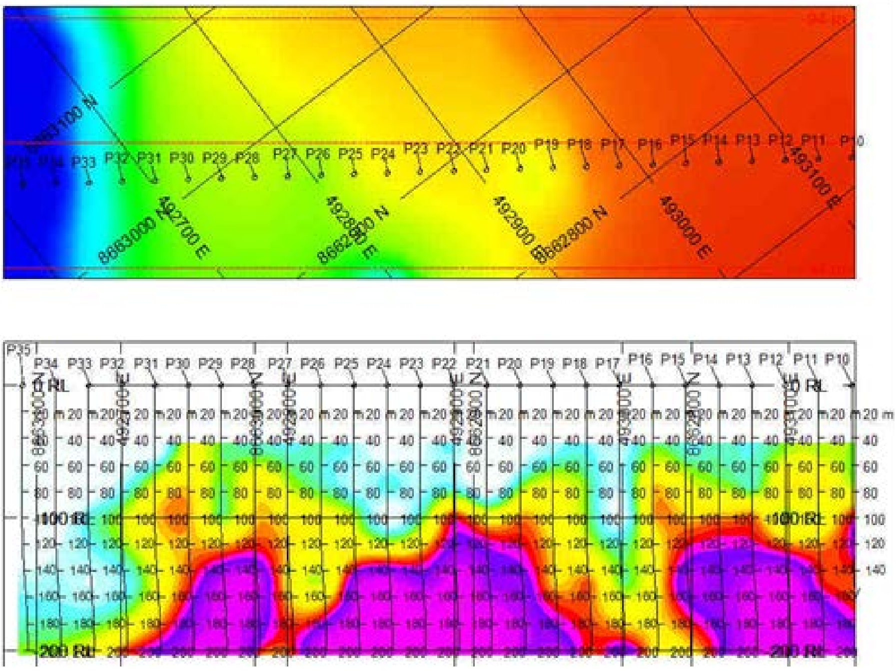

Figure 1 – Real Section Image showing the plotting convention

For a definitive interpretation, inversion algorithms are available although the process remains subjective especially if geological constraints are lacking. The input into the inversion routine calls for user selectable variables whose adjustments can seriously influence the output. The resultant converted surface IP/Resistivity measurement is a more realistic depth section. In areas where conventional gradient array surveys have limitations due to currents being channeled in major geological structures, moving multi-gradient IP methods have been employed successfully with normal IP power requirements. Anomalous zones can then be confirmed by conventional IP arrays.

Exploitation of gangue minerals and their contribution towards a country's economic development

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Gangue minerals are commonly defined as, "that portion of an ore deposit which is of no commercial value but which cannot be avoided during mining; it is removed during processing as waste."
These gangue minerals occur in all rock classes and geological environments so can be found everywhere. However it is when these gangue minerals become highly concentrated through various geological processes (igneous, metamorphic or sedimentary), in sufficient quantities at highest levels of purity do they become industrial minerals. Industrial minerals are therefore geological materials which are mined for their commercial value, which are not fuel minerals and are not sources of metals (metallic minerals). They are used in their natural state or after beneficiation either as raw materials or as additives in a wide range of applications. These industrial minerals are processed to optimize their intrinsic properties in order to obtain the required characteristics and specifications such as strength, conductivity, electrical and heat resistance, etc. These properties are then used in various applications that are linked to human standards of living and to the level of economic development of a country. It is proven that countries that make full use of industrial minerals are more developed as compared to those who make little use of these resources. Zimbabwe is endowed with a variety of these, and this paper will seek to highlight what Zimbabwe can do to optimise the use of its "gangue"/industrial minerals.

The History of Mica Mining in Zimbabwe

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Muscovite is the common 'book' mica mined from pegmatites associated with high-grade metamorphic terranes in Zimbabwe. This discussion does not include the mining of lepidolite, vermiculite or any other mineral with a phyllosilicate structure. There is little or no evidence for the fascination or use of 'Lapis Specularis' (stone mirror) in the prehistoric record of Zimbabwe. The early Mbara people of Hurungwe were known for their skill in metalworking and trade in iron and copper. A police post was established near Hurungwe Hill in 1898, and the 'fly-ridden' area attracted an interest in gold prospecting, being beyond the Angwa diggings. Adventurer Jack Carruthers pegged a mica claim in 1901 near what was to become the Catkin Mine when he was investigating the road and rail routes across the Zambezi to Kafue. Announcing the presence of workable mica, it was not until 1919 that the first sales came from the Zonkosi and Miami claims in what was to become the Miami Mica Field. This was first visited and reported on by H.B. Maufe for the Geological Survey in 1920. Being post-WWI it was not long before a rush for claims took place, but workings were all open-pit and did not exceed a depth of 10 metres. Some of the first shipments of high quality cut mica sent to London were valued at £500 per ton. Government assigned mining engineer C.A.B. Colvile to the field, and Maufe visited mica mines in India to assess mining methods and tools. He introduced the mica gradeograph as a template to standardize cut mica sizes for the market.

The Grand Parade Mine at Mwami was pegged by W.R. Small in 1919 and acquired by Jack Goldberg, owner of the Grand Hotels in Harare and Kadoma, in August 1920. Setting up a trading store, Jack became the 'Mica King' in Miami, accepting cut mica as currency for goods from prospectors. A hotel, competing stores (Isaac Levy, Sam's father), a butchery, administrative and police posts became established and by 1925 10 to 11 tons of cut mica were shipped monthly. The Grand Parade and Catkin in the East Urungwe Field produced ruby mica, but brown, green and spotted grades were mined from a host of claims. More than 360 people were employed on the Grand Parade, which had ventured underground to a developed depth of 70 metres. Based on an estimate of £400 per ton of cut mica representing 6% of the mined volume, the Grand Parade Mine was valued at £200,000.

However, after 1928 the effects of the Great Depression were felt and by 1931 mica prices had plummeted, causing insolvency and all production on the Goldberg mines ceased, as was the case across the mica fields. The Idol Mine near Rusambo was discovered in 1927, but it too ceased mica production in 1931. A total of 1418 tons of saleable mica from 9686 claims had realized a declared value of £304,907 between 1919 and the end of 1929.

Renewed interest, following the introduction of Government support, took place from 1937 and the years of WW II saw an upsurge in mica production with new mines opening north of the Mukwishe River, and in the West Urungwe Field west of the Catkin Mine. Hugh Trevis took over the old Goldberg stable of mines, and sold to G. Paterson and Sons in June 1945 when Newby Tatham, a mining engineer, started his long association with the Mica Fields to become the next ‘Mica King’. He worked closely with John Wiles of the Geological Survey during his 1950’s regional mapping of the area. Wiles established the increase of metamorphism in the Piriwiri Group from greenschist to granulite grade, and noted the association of mica-bearing pegmatites with sillimanite-rich schists and gneisses in the upper amphibolite grade of regional metamorphism. He also showed that the pegmatites had assimilated these aluminous metasediments in which mica development is controlled according to zoning in these bodies, notably the wall zones. Mica close to the quartz core is invariably distorted, striated or fishtailed. This understanding greatly facilitated the economics of mining mica pegmatites.

F.F. Chrestian and Co. bought the Paterson mica mines in 1955, when Tatham returned to manage them. The company, with Indian and London roots, were the World’s leading mica buyers, and they opened a subsidiary, the Rhodesia Mica Mining Company, with mica buying and grading centres based at Grand Parade and at Madadzi south-east of Karoi. With no new discoveries mica production was from existing mines, with a decreasing availability of ruby-grade mica being realized. All mica production from the Chrestian mines had ceased by the end of 1958 and the company confined itself to mica buying until it was dissolved in October 1959. Their Idol Mine in Chimanda, associated with sillimanite-bearing gneiss of the Rushinga Group, had not fared well during the 1940’s. Another well-known mining engineer, Arthur Bensusan with John Wiles, revived production at the Idol between 1955 and 1959, but insufficient reserves were proven resulting in closure.

The 1950’s saw a proliferation of claims for beryl, the new space-age ore mineral. Not all mica mines were beryl-bearing but at some, dump discards were hand-cobbed to supplement income. Miami-type pegmatites were estimated to contain 29% of the potential beryl reserve across the country.

Mica mining continued at a slow rate into the 1960’s, with much of the mining activity taking place in the West Urungwe Mica Field, notably at Turner’s Nzoe Group and Nairn’s Gil Gil Mine, the latter having sold over 100 tons of cut product up to 1968. A Mica Research Centre was established at Mwami in 1961 as Government tried to perpetuate interest in the commodity. The Ubique Mine in the Dete Inlier produced over 100 tons of saleable mica between 1959 and its closure in 1974. The Nyaodza Mica Mining Company made an attempt to open new prospects east of Kariba in 1969 but by 1972, when the writer was mapping in the West Urungwe, there was no mica production. Most mica sold in the 1960’s was scrap, available from old dumps. By the end of 1965 a total of 7593 metric tones of cut mica produced since 1919 had been sold for a declared value of Rh$3,435,356.

It was Henry Martin who recognized the value of scrap and waste mica, of which he harvested many thousands of tones through the 1970s and into the 1980s, using the Turning Point Mine near Mwami as his base. It was Wiles’ contention that the full potential for mica production from many mines, including the Grand Parade, had not been realized by the time of closure, and he believed that the Gil Gil Mine in particular could be developed significantly on strike. Indigenous mica miners were encouraged from 1961, and a renewal of small-worker interest could be fostered given the advent of the new Mining Promotion Corporation initiative by Government.

The Geomorphology of S.W. Uganda

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The rift tectonics, cycles of deep weathering from ground water and stripping, helped shape the striking geomorphic features of S. W. Uganda.
Tectonism induced cycles of stripping, while tectonic quiescence brought about cycles of deep weathering. Drainage reversal in Western Uganda changed drainage from West to South.

Broadly speaking, geomorphic provinces can be classified into three categories based on (i) morphology (ii) relief horizons (iii) tectonic evolution.

Some of the geological events of note are:
Palaeproterozoic era
2 deformational phases termed the Ubendian orogeny.
2100-2025Ma characterized by E-W to WNW –ESE foliation and granulite facies.
The 2nd phase occurred between 1950-1850Ma-and the so called Ubendian belt, was formed.
Kibaran (1.4-0.9Ma) Orogeny. Rift tectonics recorded here.
1375Ga the Kibaran event was coined. Here bimodal volcanism under intra-cratonic, regional scale extension stress regime took place.
Neoproterozoic: Pan African Orogeny 725-500Ma
2 phases –The early phase of oblique collision between E and W Gondwana.
At the end of the Pre Cambrian there was a collision of East Gondwana and West Gondwana. Then subsequently the Mozambique mobile belt was formed. In Uganda it is recognised as the Karasuk group of metasedimentary rocks over-thrust onto the Aruan.
Pleistocene
Western branch of EARS with grabens bordered by high angle normal faults**.**

- After glaciation, in the Palaezoic, warmer and more humid conditions prevailed in the Mesozoic, this in turn led to weathering of Jurassic/mid-Cretaceous terrains during a period of tectonic quiescence.
- Opening of the South Atlantic Ocean terminated the weathering cycle above and instigated a cycle of stripping between mid-Cretaceous and early Miocene. This gave rise to the “African” surface which has persisted from the Miocene to the present day.
- Rifting in S. Uganda separated the Tanzanian craton from the rest of Uganda. Rifting induced sedimentation and volcanism, then convergence of the Kasai and Tanzanian cratons

SRK's prospective on new mining business for the past 5 Years

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SRK Consulting Zimbabwe was established in 1982 as a subsidiary of SRK Consulting South Africa and has been almost exclusively active in the environmental, geology and mining fields. The current year activity has been heavily focused on exploration and mining while the previous three to four years have been focusing on advanced project geology, resource evaluation and technical reports. It is possible to see the impact of the international and local economic climate on the work that SRK has been able to bid for and win. Large mining businesses remain the mainstay for SRK and other consulting practices, while new entrants both external and internal have livened activity on the lower end of the scale. The challenge is working with a new type of client – national governments. SRK has had some experience advising an African government concerning exploitation of its natural resources which will be beneficial to the country's economy in the end. This is new ground for both SRK and the government concerned but is nevertheless a step in the right direction to marry the interests of the nation and business. It is SRK's view such work will increasingly become an important component of work where resource nationalism is increasingly become an issue. Governments tend to be stronger in their views than consultants and other participants while the may be weaker in technical aspects that serve the intended goal best. Therein lies the case for collaborative efforts between consultants and governments.

A Discussion On Quality Assurance-Quality Control (QAQC) In Mineral Exploration

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Although most companies carryout QAQC programmes as an integral part of their exploration projects, the approach for most is usually one of half measures and quite often reactive rather than pro-active and holistic. Results of numerous recent audits and due diligence jobs conducted on exploration and mining projects in South and North America, Asia, Africa and Europe indicate that comprehensive geological quality control programs are still relatively infrequent (Mendez , 2011). A review of a number of exploration projects in Zimbabwe particularly those carried out prior to 2000 show a similar trend. As a result of new regulations governing the reporting of exploration results, most companies are now increasingly keen on implementing such programmes as they are crucial in attracting project investment and/or financing and better asset valuation. Analysis of QAQC systems and results form the first critical step in the validation of exploration results which forms a firm foundation for the estimation of mineral resources and resource classification. Lack of comprehensive QAQC systems and results can result in the downgrading of a project's mineral resources with far reaching consequences on the competitiveness of the mineral asset. This is despite the fact that that in most cases QAQC programmes generally cost less than 2% of the overall project cost. The best project is one that integrates a wholesome, best practice quality management system at all stages of the project value chain from the formulation stage, through implementation to the reporting of results.

The purpose of this paper is to discuss the various facets of this very crucial yet often overlooked component of a successful exploration project with a special emphasis on practical, field based aspects that help the Project Geologist successfully manage investor funds from a quality standpoint thereby guaranteeing valid, accurate, representative and reliable results.