Geological Society of Zimbabwe

Summer Symposium

8am to 5pm, Friday 1st December 2006
Department of Geology
University of Zimbabwe

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Zimbabwe Geological Society Summer Symposium 2006 1st December 2006, Department of Geology, University of Zimbabwe Registration and Lunch $2500 ($5500 for non members)		
Start	**Topic**	**Speaker**
08:00	Registration	
08:15	Welcome	Hilary Gumbo, Chairman Geological Society
08:25	Opening	Jack Murehwa, President Chamber of Mines
08:45	Summary of Geol Soc Activities	Collins Mwatahwa
09:05		Forbes Mugumbate, Geological Survey
09:25	The paragenesis of the basal conglomerates of the Umkondo	Martin Roberts, Debeers
09:45	**Tea**	
10:05	Great Dyke Today	Edgar Chiteka, Zimplats
10:25	First geological results of Ruschrome platinum exploration at Darwendale	Yuri Telegin, Ruschrome
10:45	The occurrence of Coarse Grained Bronzitite at Ngezi and Its effects on the Main Sulphide Zone	Cliff Mademutsa, Zimplats
11:05	Hardrock sources for platinum placers related to Alaskan-type intrusions in the Urals (Russia)	Yuri Telegin, Ruschrome
11:25	Challenges for environmental management in the mining sector in Zimbabwe	Cuthbert Gambara & Dominic Mazvimavi
11:45	Fractures, Stresses, Weathering and Groundwater in Crystalline Rocks	Richard Owen, Abel Maziti and Torleif Dahlin
12:05	Some geological hazards, geotechnical implications, mitigation and maintenance.	Andrew Pahwaringira, ZMDC
12:25	Potential impacts of mining alkaline rocks on Save River water quality in Zimbabwe	M Meck, Dept Geology UZ
12:45	**Lunch**	
14:00	Geophysics and Remote Sensing in Mineral Exploration	Tenyears Gumede, Angloplats
14:20	Free and open source Sofware (FOSS) for spatial data	M Meck, Dept Geology UZ
14:40	Resource Modelling -Current Trends in Gold Deposits	Vlad Trashliev,Pan African Mining
15:00	The Geology of the Hwange Coal Deposit	Oliver Maponga
15:20	**Tea**	
15:40	Microbial prospecting for Oil and Gas - case studies and implications for Zimbabwe	Paul Chimbodza, Geo Associates (Pvt) Ltd
16:00	Diamonds – the Exploration context	Joseph Hwata, Debeers
16:20	Life on Mars? A review of the evidence	David Love,
16:40	Summary	Martin Roberts

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF ZIMBABWE

COLLINS MWATAHWA

The Geological Society of Zimbabwe was formed in 1981. It used to operate as a sub branch of the Geological Society of South African from 1962 until a resolution was passed which enable it to operate as an independent body.

The primary objectives are to promote geological research, teaching, exploration and mining in Zimbabwe. It acts as a forum for geological talks and field trips.

The society has 4 categories of Membership namely Honorary, Ordinary, Associate and Institutional Membership. The society welcomes new members to enhance and increase the diversity of our science.

The Society sponsors research activitities through the GSZ Research and Development Fund and awarding of the Phaup Award. It also awards scholarships to Honours Students from the Geology Department when the honours programme is running. The best student from the School of Mines is awarded the Mike Vinyu award.

The Geological Society is actively engaging various stakeholders in the Mining Industry through the Geology Lecture Fund Project to ensure that the earth sciences departments meet their objectives in the teaching of the science amid the lack of resources.

The Society is actively involved with the Geological Survey of Zimbabwe in a 1:1 000 000 Zimbabwe Map project. The Project involves updating the current map with information acquired recently. A project known as Atlas was commenced last year aimed at producing a compilation of interesting geological sites or outcrops which will be field guide for any one interested in Zimbabwean Geology.

Field trips were held to Chimanimani and Marange areas, which are hotspots for Gold and Diamonds. Geological talks were held in both Bulawayo and Harare.

The Summer Symposium organised by the Society is an annual event run in December either in Harare or Bulawayo. The Symposium is normally the last event of the year organised by the Society.

FORBES MUGUMBATE

Geological Survey

THE PARAGENESIS OF THE BASAL CONGLOMERATES OF THE UMKONDO

MARTIN ROBERTS

Debeers

The discovery of diamonds found within basal sediments of the Umkondo Group (~1.1 Ga) when following up a reconnaissance garnet in Eastern Zimbabwe, has provoked considerable interest. It was felt that the understanding of these basal sediments could assist in understanding the primary source of the diamonds, and the understanding of the diamonds and their conglomerate host could provide insight on the development of the Umkondo basin.

The basal sediments are dominated by thin arkoses and rare coarser conglomerates that are overlain by limestone. Coarse conglomerate units are located in zones 300m-1000m wide along strike. Clasts are generally sub-rounded to well-rounded and are dominated by vein quartz pebbles. Typically rare, but locally common basement lithic clasts tend to be more angular and in places appear to have been very locally derived. Bedding in the conglomerates is poorly developed and manifests itself by coarse planar bedding and low angle cross bedding. The conglomerates grade laterally and vertically into arkosic grits. Type localities for these basal conglomerates include the Makodzi and Kondo outcrops, which are described in detail and compared.

The diamonds from the basal conglomerates at Makodzi are often fractured and broken, with the unabraded breakage surfaces suggesting that diamond breakage took place within the conglomerate during burial and subsequent exhumation. The diamonds appear to be sitting within the Makodzi conglomerate as true hydraulic equivalents. Extreme abrasion may be explained by very high diamond concentrations in a well worked conglomerate lag that remained active for a significant period of time. Brown spots on the diamonds indicate a heating event experienced by originally irradiated diamonds. This heating is typically pegged at ~500^{o}C, although encasing sediments suggest a lower temperature of metamorphism/recrystallization, as seen by greenschist facies overprint. Age of basal conglomerates is probably slightly > 1.1 Ga (date of syn/post Umkondo dolerites), and this long period of time may have been sufficient for green spots to revert to brown under burial conditions. Nitrogen contents and Infra Red characteristics of the Makodzi diamonds defines an almost unique population by global standard, suggesting that they are derived from the same high-nitrogen, possibly eclogitic mantle source.

A multiphase model for the tectonostratigraphy of the western margin of the Umkondo basin is presented, and is believed to account for most if not all the features observed within the basin. The basal conglomerates are modeled as having been formed at the basin margin on an initially stable craton margin. Diamond input appears to be discrete and related to direct, low-sediment content, fluvial inputs into the basin margin, with little or no longshore dispersion. Long duration wave action winnowed the conglomerates and resulted in significant rounding of the clasts including the highly concentrated diamonds at Makodzi. Diamonds appear to have been concentrated in basal most portions of the Makodzi conglomerate due to the jigging action conglomerate in the shore environment. An initial transgression is believed to have remobilized the conglomerate as a transgressive lag that

eroded local basement lithologies and incorporated these more angular clasts. This developed into a major transgression with the low sediment input maintained, resulting in the limestones overlying the basal arkoses. Sediment input subsequently increased to produce the argillaceous and arenaceous sediments which dominate the Umkondo Group. The Umkondo Group sedimentation was concluded with a major regression and possibly uplift of the basin associated with impact of buoyant mantle material. The decompression melting of this anomalously buoyant mantle produced widespread asthenospheric melting in the spinel zone, suggesting lithospheric thickness at 1.1 Ga of ~90-100km. Melts migrated towards the surface to form dolerite sills and dykes and more rarely preserved basaltic flows that cap the Umkondo sediments.

The observed sequence of basin events that occurred during the formation of the western margin of the Umkondo basin has been incorporated into a regional tectonic model for the period of the Umkondo basin formation. The accretion of a volcanic arc terrain associated with the possible docking of Antarctica during Rhodinian assembly, may have resulted in the loading of the Zimbabwean Craton margin. This in turn produced the foreland basin in which the majority of the Umkondo sediments were deposited. The initial Umkondo basal transgression was associated with the subsidence of the foreland basin. Subsequent increase in sediment input from the Zimbabwean Craton is suggested to have been a result of the development of a forebulge on the Zimbabwean Craton in response to the loading of the craton margin. As the accretion of the arc terrain stalled, the rising of buoyant mantle material along the Zimbabwean Craton margin resulted in widespread melting and injection of basaltic melt.

GREAT DYKE TODAY

EDGAR CHITEKA

Zimplats

Today the Great Dyke is believed to be a layered intrusion, 2575.4 + 0.7^{-} Ma old (Oberthür et al..2002) which cuts the archean greenstone and granites , is of a linear shape and strikes NNE for over 550km with a maximum width of 11km. The answers to the emplacement of this geological wonder might seem quite simple but yet so hard. Structural and stratigraphic data indicate that there was a major fault across the craton which was then intruded by the great ‘dyke’. Over the period spanning over a century there has been different theories about what it is, how it formed and its mineralization. To date there still exist some grey areas exposed by many exploration and mining activities that are taking shape on this feature. However it is difficult to come up with a true picture of how this feature was formed because of denudation activities which affected it up to now. Nevertheless it is important that we highlight some of the grey areas and promote further research as the answers will go a long way in helping the mining industry that is booming in this area. The occurrence of silicified intrusion in the P1 layer, varied grade distribution from the eastern margin to the western margin, occurrence of large greenstone ‘xenothiths’ in the top mafic layers, the believed existence of a large space in the granites that would accommodate an intrusion of 550km in length are among some of the burning areas to be looked at.

FIRST GEOLOGICAL RESULTS OF RUSCHROME'S PLATINUM EXPLORATION AT DARWENDALE

TELEGIN YURI

Ruschrome Mining (Pvt) Ltd

Russian-Zimbabwean JV "Ruschrome Mining (Pvt) Ltd" was established for the purpose of exploration and development of mineral resources of Zimbabwe. Since May of 2006 Ruschrome owns the group of base metal claims covering Darwendale area, the northern portion of Hartley mafic-ultramafic Complex of Great Dike. PGM and base metals resources within Ruschrome's claims exceed the amount of 35 Moz of conditional platinum.

At first Ruschrome is planning exploration of open pit able ore reserves within the western portion of the area with development of the trial open pit and construction of small concentrator.

Exploration drilling at Darwendale was commenced in August 2006. Drill holes located eastern of MSZ outcrop intersected sulphide mineralization at the open pit depth (20-50 m). Sulphide content runs up to 4-5% in some holes. The base of MSZ occurs 5.0-10.0 m deeper of the footwall of websterite layer. The zone dips to the east at maximum of 10-12^0, which enables the open pit and further mechanized underground ore production.

The latter hydrothermal alteration and veining (chlorite, carbonate, some quartz) are widespread within the exploration area. This caused general deeper (up to 35-40 m) oxidation of MSZ compared to Ngezi area.

THE OCCURRENCE OF COARSE GRAINED BRONZITITE IN PORTAL 2, AND IT'S EFFECTS ON THE MAIN SULPHIDE ZONE.

CLIFF MADEMUTSA

Zimplats

In the Portal 2 mine at Ngezi, mining has intercepted a coarse grained rock variety; from hand specimen the mineralogy of this rock is consistent with that of our host lithology a medium grained Bronzitite. This rock variety has been classified as a coarse grained bronzitite (BRC).

Typically, the MSZ consists of a 2-10m thick zone of visible sulphides called the base metal sub-zone. The base of this layer coincides with a 1 to 5m thick zone of elevated precious metal values (Pt, Pd, Au, and Rh) called the PGE sub-zone. The BRC has disrupted the MSZ in Portal 2, the metal distribution profiles in the affected areas show low metal concentrations. The significance of this disruption is that the BRC, though mineralized, the mineralization is at sub-economic levels. Hence the BRC is barren and classified as waste. The BRC is made up of subhedral bronzite crystals enclosed by plagioclase. The augite in BRC occurs as megacrysts in the BRC, and no visible sulphide mineralogy has been observed. The BRC occurs in the South Section of Portal 2, from mapping, the extent of the BRC has been traced from 17S53 to 21S53 extending south and also 37S40W and 40S40E extending south to panel 42E and W and also in 48S. The metal distribution profiles in the areas disrupted by the BRC have been disrupted and assay results have yielded low metal concentrations for 4E. The characteristics of the BRC described i.e. the mineralogy of the BRC is consistent with that of the host lithology, medium grained bronzitite, and that the BRC is mineralized to sub-economic levels, can be compared to the Bastard Reef in the Bushveld Complex of South Africa. In terms of the paragenesis of the BRC several hypotheses are being considered, these are an origin from the differentiation at slower rates of a trapped liquid in the magma chamber, a post genetic intrusion and an origin from textural coarsening that took place during differentiation in the magma chamber. The low grades in the BRC were caused by depletion of chalcophile elements in the magma that evolved at a slower rate.

HARDROCK SOURCES FOR PLATINUM PLACERS RELATED TO ALASKAN-TYPE INTRUSIONS IN THE URALS (RUSSIA)

TELEGIN YURI

Ruschrome Mining (Pvt) Ltd

Alaskan-type zoned ultramafic intrusions (complexes) are composed of "dunite core" surrounded by "clinopyroxenite rim". These complexes represent quite another style of platinum mineralization as compared to the layered intrusions. Over 99% of platinum at the areas of Alaskan-type intrusions has been produced from alluvial placers.

The world-greatest trend of Alaskan-type intrusions (650 km in length) is related to the Urals mobile belt. It is called "Urals Platinum Belt" because its intrusions are the sources of the world largest platinum placers. Over 15 Moz of placer platinum have been produced in the Urals since 1824. In the late 19th-early 20th centuries Urals contributed 95-98% of global platinum production.

The only known style of platinum mineralization within Alaskan-type intrusions is a "native" platinum (Fe-Pt alloys) associated with chromite dissemination and massive chromitite ("schlieren") in dunite. This is the source of platinum placers, but none significant hardrock platinum deposit of such style has been discovered.

Single small chromitite occurrences were the targets of primitive small-scale platinum production. One of them was a "chromitite pipe" discovered in 1909 and mined out to the depth of 180 m (around 1.0 t of platinum). This deposit can be parallelized with platiniferous dunite pipes of the Eastern Bushveld (Onverwacht, Driekop and Mooihoek), but any analogous of Merensky style of mineralization still were not discovered in the Urals.

CHALLENGES FOR ENVIRONMENTAL MANAGEMENT IN THE MINING SECTOR IN ZIMBABWE

CUTHBERT GAMBARA & DOMINIC MAZVIMAVI

FRACTURES, STRESSES, WEATHERING AND GROUNDWATER IN CRYSTALLINE ROCKS

RICHARD OWEN[1], ABEL MAZITI[1] AND TORLEIF DAHLIN[2].

[1] Mineral Resources Centre, University of Zimbabwe,

[2] Engineering Geology, Lund University, Sweden.

In a granite terrain, lineaments oriented parallel to the maximum regional compressive stress orientation exhibited the thickest regolith development, while lineaments oriented perpendicular to the maximum compressive stress showed the shallowest development of weathered regolith.

Low groundwater yields are common in crystalline rock terrains. The study investigates the possibility of using readily available data from satellite imagery and stress field maps to identify optimal groundwater targets based on fracture orientation.

The fracture pattern was digitized from aerial imagery and the principal fracture set orientations identified. The regional stress field, estimated fom global stress maps, was used to determine the stresses acting on each principal lineament orientation. Multi-electrode resistivity profiling was carried out to determine the subsurface regolith conditions associated with different lineament orientations.

The results indicate that the 360º and 060º lineaments sub-parallel to the principal compressive stress orientation (s_1) exhibit maximum development of the regolith, while 130º lineaments perpendicular to s_1 do not exhibit significant regolith development. Regolith development has been linked to groundwater condition.

It is concluded that knowledge of the regional stress field and fracture set orientations can be used as an effective tool for locating potentially higher yielding boreholes in crystalline rock terrains.

SOME GEOLOGICAL HAZARDS , GEOTECHNICAL IMPLICATIONS, MITIGATION AND MAINTENANCE

ANDREW PAHWARINGIRA

ZMDC

Quarried and mined locations often develop geological hazards which are a function of the geological setting, mining methods and other environmental factors.

The geologist often has a difficult task of classifying the hazard before recommending an appropriate mitigatory measure.

The common hazards identified are, faults, shear zones, geological contacts, rockfalls, slabfalls, toppling and blocky ground. Others like raveling, karstification, flaking, debris flows are also associated with quarrying.

Mitigatory measures that are common in underground workings are shotcreting, roof bolting, wire-meshing, fencing, pillars and barricading.

In quarries mitigation takes the form of rocktrap ditches, crib walling, fencing, drainage installations, access restrictions, slope flattening, backfilling and vegetation establishment.

A summary of deterioration modes in relation to rock mass types is given. For instance, a combination of grain raveling and a weak massive rock is extremely likely to occur.

POTENTIAL IMPACTS OF MINING ALKALINE ROCKS ON SAVE RIVER WATER QUALITY IN ZIMBABWE

M MECK

Department of Geology, University of Zimbabwe

Alkaline rocks (phosphate deposits in particular) of igneous origin are currently being mined in Zimbabwe. Exploitation of these deposits which are associated with metals and non-metals provides a potential for changing the river water quality in the surrounding areas by increasing metal and phosphates levels thereby endangering the beneficial use of the river. Previous work has concentrated on acidic environments where most pollutants are known to be mobile. Alkaline environments were left out on the basis that most pollutants precipitate out of the water and usually do not migrate but get deposited on the sediment. Never the less Malinovsky et al (2002) have shown that apatite mining on the Khibiny apatite–nepheline ore deposits have affected various waters near the mines through elevated concentrations of total dissolved solids and metals.

The aim and objectives of this paper are to enumerate the current and potential impacts associated with mining alkaline rocks on Save River water quality in Zimbabwe. Though there are several impacts associated with the mining of alkaline rocks, this paper only deals with impacts on water quality. The discussions in the paper are based on a preliminary study of one ring complex .This paper discusses the noted impacts as well as the potential impact of mining alkaline rocks in terms of phosphate (and associated pollutants) release from the sediments in the Save. The study will in particular analyze the potential release of phosphate and associated pollutants from the Save River through analysis of physio chemical mechanisms taking place around the alkaline ring complex.

A preliminary assessment of the water quality in the Save River downstream of Dorowa phosphate mines showed an increase in conductivity, iron content, manganese content, nitrates and hardness when compared to those taken before the mine. However there was no notable increase in phosphate and metals except for Fe and Mn. A plausible explanation for the low phosphate in the water is that the phosphates are sinking down to the sediments. Phosphate is known to effectively remove metals from the surface water through the formation of metal–phosphate minerals. Thus various pollutants may be adsorbed to the sediments accumulated on the bottom of the river. These sediments may accumulate pollutants over long periods and act as new pollutant sources to the overlying water when phosphate desorbs from sediments due to change in water conditions. Therefore the sediments can act as a source of water pollution in the future. The preliminary results in the study area demonstrated sediments as potential pollutant source associated with mining of alkaline rocks. The paper recommends proactive measures to address the potential threat to water as well as more investigations to understand the waters around alkaline ring complexes

GEOPHYSICS AND REMOTE SENSING IN MINERAL EXPLORATION

TENYEARS GUMEDE

Platinum Exploration Ventures

The use geophysical methods have been useful on the detection of covered mineral deposits or their extension. Gravity, magnetics have been used extensively in the search of podiform type chromite deposit in the Inyala mine area and the Chirumanzu greenstone remanence and in the evaluation of remanently magnetised magnetic source NW of Zimbabwe for base metal exploration. The Airstrip deposit at Inyala Mine was used as the model to execute the gravity survey for podiform type chromite deposit as it was mapped clearly from the analytical signal reduction.

43 strips of (96 channels) Hyperspectral data has been used to aid in the mapping of mineralogical variations 40km south of Inyala Mine followed by extensive ground magnetics to map ultramafic units. The airborne imaging spectrometer over Fort Rixon/Shangani Mine expanded on existing mineralization models in addition to the generation of further areas of interest for base and precious metals.

Pole-dipole induced polarisation (IP) has mapped the extensions of Hunters road deposit in KweKwe. The initial results over the evaluated deposit have been extrapolated north and south of the deposit using the IP method and tested by a single diamond drillhole. The regional airborne electromagnetic/magnetic data acquired using a Barringer System for the government by Canadian International Development Agency (CIDA) identified potential targets south of Broomrigg Laurana deposit 20km west of Hunter Road deposit. Late channel electromagnetic anomalies were identified and recommended for follow up.

Airborne magnetic survey over the Gwampa Valley Area north of Turk Mine covering part of the Peter Pan area identified the greenstone extension beneath the Kalahari Cover. Seismic Refraction soundings and electrical resistivity methods identified the Kalahari cover to be as deep as 138m west of Nkai area. A single diamond drill hole targeted at the mapped shear zone confirmed the geophysical results.

IKONOS 4m spatial resolution has been used within Unki Mine Environs, Shurugwi to aid in the geological mapping. East west lineaments interpreted as faults have been identified around Paarl Winze area 4km north of Unki shaft. A circular feature interpreted as an autolith is also visible from the image

FREE OPEN SOURCE SOFTWARE

M MECK

Department of Geology, University of Zimbabwe

Free open source software (FOSS) is a program whose licenses give users the freedom to run the program for any purpose. This can be used for study, research, commercial and private uses. FOSS programs can be modified and redistributed. The advantage of using FOSS is that one is not locked into products and services from a single vendor and one has an opportunity to modify an existing program to suit a particular task because the software codes are accessible. Most mining ventures are site specific and in most cases may require approaching problems in a different. Quite often when one is using proprietary software there are lots areas where the software does not suffice for particular purposes. Using FOSS can overcome this hurdle as one has an opportunity of modifying software to suit what one really wants to do. Once one has evaluated how well a FOSS can meet most of one's needs, adjusting it to suit minor changes is usually easy if a programmer is available

The other advantage of using FOSS is that in most cases they are free from virus infection thus can reduce cost to users. However though defined as free FOSS is not totally free as it has its own costs in terms of time and human resources. Nevertheless studies show that the total cost for FOSS is often far less than proprietary software. Thus in these hyper-inflationary situations currently being experienced by Zimbabwe use of FOSS may be beneficially as they have many strong cost advantages which result smallest total cost of ownership. Two FOSS softwares (TerraView and Geonetwork) were demonstrated at the 9th International Conference of Global Spatial Data Infrastructure held in Santiago Chile and showed that that building a customized geographical applications can be achieved with relatively less effort

RESOURCE MODELLING -CURRENT TRENDS IN GOLD DEPOSITS

V S TRASHLIEV –

Consultant Geologist

Successful mining operation is a combination of understanding the geology, practical mining, sound metallurgy and good management. During the last two decades the general trend has been towards large tonnage, low grade, and high throughput mines. Consequently, the precision and confidence in the ore reserve estimate together with rigorous grade control formed the foundation of a profitable operation.

Sophisticated and powerful mining software packages are presently available and used in the development of mineral resources, mine designs, and scheduling making the resource estimation a specialized field. The use of statistical and geostatistical analysis are now commonly applied throughout the industry. With the technological advances of the past thirty years, manual methods of reserve estimation (such as polygon and section-based grade estimation) are being replaced by more complex mathematical techniques (such as the various variations of kriging).

Despite the fact that unique geologic environments and local conditions must result in a variety of interpretations and resource estimation methods, many gold deposits throughout the world apply common techniques to estimate mineral resources. Therefore the presented most common parameters and methods can be considered a standard industry approaches. Those that employ novel or unusual techniques relative to the norm may be considered non-standard and require special scrutiny to validate.

Each mineral deposit presents unique geologic characteristics, therefore the careful and correct interpretation of the deposit's geologic boundaries remains the single most important aspect of any resource estimation. This requires that the geology of the deposit be reasonably delineated allowing for a realistic geologic interpretation.

35 gold deposits worldwide were surveyed from open sources and public information posted on: www..sedar.com; www.infomine.com;

Here is a summary of the modelling techniques and parameters at predicting tonnage and grade within generally acceptable limits developed worldwide:

THE GEOLOGY OF THE HWANGE COAL DEPOSIT

OLIVER MAPONGA

Hwange Colliery

Situated some 335km by road to the northwest of Bulawayo, the Hwange coal deposit is hosted in the Hwange portion (hereinafter referred to as the Hwange Coal Basin) of the Mlibizi intrabasin. The Hwange Coal Basin itself is dichotomuous, being divided into the Entuba-Lukosi branch to the south and the Hwange Concession and Western Areas coalfields to the north by an inlier of crystalline rocks called the Entuba Range.

The stratigraphy of the basin has been studied in detail and sufficient is now known of the broad features of the succession of the sedimentary deposits within the basin to justify the Hwange Basin being considered as a type area of the Karroo system.The succession spans the Lower and Upper Karroo.

Sedimentation within the basin was controlled by a combination of factors the main ones of which were:

- Climatic conditions which ranged from glacial to warm temperate, to hot and arid, and finally tropical conditions;
- The geography of the period; and
- Vertical movements (subsidence and/or uplift) affecting relief between source areas and depository.

Karroo sedimentation was initiated with the deposition of tillites mainly in the bed-rock depressions in the pre-Karroo floor. These glacial beds exhibit wide variations in width, pointing to an uneven pre-Karroo floor. The beds attain maximum thickness in troughs and wedge over the relatively higher basement topography. Deposition during the Karroo is terminated by the outpouring of volcanic lava, known as the Batoka Basalts, during the Jurassic. Between the glacial beds and the volcanic lava were deposited genuine sediments which range from pelitic, arenaceuos to rudaceous.

The southwest-trending sedimentary basin is bounded to the south by the Kamativi-Dete Inlier and to the north by the Deka Fault. The latter is of a regional magnitude, extending from the Botswana border to Kariba, contributing to the formation of the half-graben feature that characterises the mid-Zambezi Basin. Between the Kamativi-Dete Inlier and the Deka Fault occur several faults of variable magnitudes and trends, the chief of which is the Entuba Fault whose magnitude approaches that of the Deka itself which it merges with in the extreme southwest. Underground and in-pit mapping in the production areas at Hwange Colliery indicates that most of the faults within these areas are listric in profile.

Two coal seams occur at Hwange, viz., the Madumabisa and Hwange Main Seam. Only the Hwange Main Seam (hereinafter referred to the Hwange Coal Deposit) is currently of economic value and has been the sole source of solid fossil fuel for the nation. The geological seam has a thickness of up to 30m. Its thickness varies widely, pointing to an uneven seam floor: ranging from 30m, shelving over and pinching out against the topographic highs.

The Hwange Main Seam deteriorates in quality with distance above footwall, with the exception of sulphur which decreases upwards. The ash and phosphorus contents increase while the volatile content decreases with height above footwall. Petrographic analyses also reveal a vertical variation in the macerals. The basal, usually bright portion, is rich in reactive macerals which are dominated by vitrinite. Towards the top, the coal is dull and composed mainly of inert macerals, the chief of which is the inert semi-fusinite.

On the basis of the afore-mentioned, the Hwange coal deposit is modelled into:

- A basal high quality coking coal horizon;
- A middle relatively higher ash coal used for power generation; and
- A high ash carbonaceous mudstone (waste) at the top.

The basal Hwange coking coal (HCC) and the overlying Hwange power coal (HPS) constitute the commercial seam whose thickness averages 11m and is generally split into 5m of HCC and 5m of HPS.

The commercial seam is mined by Hwange Colliery from two opencast mines and and one underground mine at a rate of 400 000 tonnes per months, split into 200 000 tonnes of HPS and 200 000 tonnes of HCC.

MICROBIAL PROSPECTING FOR OIL AND GAS - CASE STUDIES AND IMPLICATIONS FOR ZIMBABWE

PAUL CHIMBODZA

Geo Associates (Pvt) Ltd

Microbial Prospecting for Oil and Gas (MPOG) is a surface exploration technology based on detection of anomalies in microbial distribution and biochemical activity in soil samples.

Microbial Prospecting is a unique, stand-alone method which has proved itself effective even in complex geological reservoir conditions.

Its effective application and the high level of accuracy attained is the direct result of many years of practical experience.

The use of specialised microbiological techniques to detect the presence of various groups of methane-, propane- and butane-oxidising micro organisms can reliably differentiate between prospective and non-prospective areas, as well as between oil and gas reservoirs!

The process is inexpensive and before any intensive seismic exploration is undertaken, MPOG should be carried out over the whole exploration area on the basis of a minimum of two (2) test per kilometre.

The reservoirs detected by the MPOG microbial method have been both sandstones and carbonates down to a maximum depth of 3,500 m.

The success rate of the MPOG microbial method of surface prospecting already exceeds 90 %!

International onshore and offshore case studies are sited and similar work programmes are being undertaken on Geo Associates' two Special Grants in the Zambezi valley and the Gonarezhou area in Zimbabwe.

DIAMONDS – THE EXPLORATION CONTEXT

JOSEPH HWATA

Debeers

Less than 1% of the global kimberlite pipes are sufficiently diamondiferous to be economic. Fewer than 50 can be considered to be economic and of these only around 15 are major producers. This makes diamond exploration not only a risky business but a high capital investment. Companies venturing into diamond exploration are always keen to shorten the exploration cycle whilst at the same time not compromising on the quality of the results. Economic kimberlites are characterized by several criteria that, when combined with general physical and chemical features in an integrated exploration model, may lead to significant discoveries.

The basic diamond exploration cycle can be divided into four main stages namely; targeting, exploring, evaluating and mining. A basic overview of exploration strategy, targeting/area selection, exploration pipeline (sampling techniques, geophysical techniques, mineral chemistry) and evaluation will be given.

LIFE ON MARS? A REVIEW OF THE EVIDENCE

DAVID LOVE

Mars, the red planet. Our nearest neighbour. Is there life? Since the earliest days of humanity, people have speculated on this planet. From the first science fiction works onwards, stories have been woven. But in the last decade, increasing amounts of real evidence have started to come in, using remote sensing, using direct sampling on the surface and analysing meteorites from Mars that have reached Earth.

Much work has focussed on the presence and behaviour of water on Mars. The north pole of Mars today consists of layered deposits, formed due to alternating deposition of dust and ice during the northern summer and winter respectively. However, it is clear from areological investigations (areology is the geology of Mars) that there has been running water on Mars in the past. Evidence includes rock varnish, river channels and the discovery of sedimentary sequences that show fluvial transport.

Evidence from evaporates on Mars suggests the presence of a highly saline environment that is hostile to most life forms, but provides an ideal habitat for osmophilic or halophilic bacteria. Because of the low temperatures and atmospheric pressure ambient, any near-surface liquid water on Mars must be a highly concentrated brine solution. This means that the most likely form of life on Mars (if any) would be the halobacteria.

The most spectacular evidence has come from meteorites of Martian origin. Examination of Martian meteorites by Gibson's team at NASA have shown features which compare favourably with the accepted criteria for terrestrial microfossils and evidence for early life on the Earth. The morphological similarities between terrestrial microfossils, biofilms, and the features found in Martian meteorites are intriguing but have not been conclusively proven.

The evidence continues to come in that there probably was life on Mars, at least during its wetter past. It is not yet conclusive – but is increasingly compelling.
