Geological Society of Zimbabwe

GZS

Summer Symposium

8am to 5pm, Friday 27th November 2009
Department of Geology
University of Zimbabwe

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Zimbabwe Geological Society Summer Symposium 2009		
27th November 2009, Department of Geology, University of Zimbabwe		
Registration (incl teas and lunch) $10 for members (non-members should join)		
28th November - Field Trip to Magondi Belt with Sharad Master		
Start	**Topic**	**Speaker**
07:45	**Registration**	
08:15	Welcome	Forbes Mugumbate, Chairman Geological Society
08:30	**Opening**	**Victor Gapare, President Chamber of Mines**
08:55	Summary of Geological Society Activities	Hillary Gumbo, ZGS Committee
09:20	Proposed Ammendments to the Mines and Minerals Act	Paul Chimbodza, Geo Associates
09:45	Some Aspects of Hydrothermal Mineralisation	Tony Martin, SRK
10:10	Tea	
10:25	**A review of the stratigraphy and geological setting of the Palaeoproterozoic Magondi Supergroup, Zimbabwe- type locality**	**Sharad Master, WITS - Keynote Address**
11:20	A Brief Overview of Exploration for Karroo Sediment Hosted Uranium in Central/Southern Africa	Julian Green, Geoquest
11:45	Chishanya Carbonatites	Tim Holmes, ACR
12:10	Last Frontiers in Soil Geochemistry	Philip le Roux, Amari
12:35	Hydrogeological Studies At A Limestone Quarry	Andrew Pahwaringira
13:00	Lunch	
14:00	Data Capturing Problems, Solutions and Tools	Chiedza Mugwagwa, Maxwell Geoservices
14:25	Spatial Knowledge Management in the Mining Industry	Kingray Gowera, Holistic Information Systems
14:50	Global Navigation Satellite Systems - The Spatial Data Capturing Tool	Ned Mlambo, Geoscan
15:15	Tea	
15:30	Minerals that have a potential to host metals in their crystal structure at Dorowa rock phosphate mine, Zimbabwe	Maideyi Meck, UZ
15:55	3D Earth Exploration	Hillary Gumbo, 3D Earth Exploration
16:20	Summary	Tony Martin, SRK

Activities Of The Geological Society Of Zimbabwe

D. Chatora – Vice Chairman

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Having operated as a sub-branch of the Geological Society of South Africa from 1962 the Geological Society of Zimbabwe was established in 1981. A non-profit making professional organization, the Society is a body corporate under the common law of Zimbabwe. It enjoys perpetual succession and is capable of acquiring property and rights, incurring obligations, suing and being sued in its own name.

Membership of the society comprises Honorary Members, Members, Associate Members, Institutional Members and Student Members.

Management of the affairs of the Society are vested in an elected Executive Committee which has full power to carry out all or any of the objectives of the Society and shall transact all business on its behalf subject to the Constitution and By-Laws.

Elections to choose members of the Executive committee are held once a year at the Annual General Meeting.

The objectives of the Geological Society are:

- To promote the science and practice of geology
- To carry out activities conducive to the advancement of earth sciences.

Activities to achieve the objectives include:

- Holding Society talks; where visiting & local distinguished lecturers / professionals give presentations.
- Holding technical short courses & workshops,
- Organizing field trips,
- Publishing of a quarterly newsletter,
- Holding the Summer Symposium,
- Promoting research in earth sciences via:-
    - GSZ Research and Development Fund
    - Phaup Award – to best paper published internationally.

Promoting research in earth sciences via:-

G. Bond Award - to best BSc. Honours project,

M. Vinyu Award - to best School of Mines project.

Promoting the teaching of earth sciences via:-

Geology lecture fund with assistance from Industry,

BSc. Hons. Geology Scholarships.

Hosting International Conferences & Field trips.

The Society hosted 3 talks in Harare and one in Bulawayo in 2009 and published 3 Newsletters.

One trip to Murowa Diamonds was successfully organized while the ground work for the hosting of a workshop/conference to celebrate the 100th Anniversary of the Geological Survey of Zimbabwe in 2010 was done.

Tribute is paid to professionals who have kept the Society functioning despite the harsh operating environment.

Proposed Amendments to the Mines and Minerals Act

Paul Chimbodza

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The Chamber of Mines and the Ministry of Mines and Mining Development have over the last 5 years or so been working on proposed amendments to the current Mines and Minerals Act Chapter:21 05 and a draft Bill has been crafted and is awaiting finalization before being brought before the Parliament of Zimbabwe for ratification and enactment into law.

The main objective to the proposed Amendments is to have a Mines and Minerals Act that aims to produce policies that stimulate current and future investments and support existing investors and producers.

The scope of this presentation is to share some of the highlights and pertinent issues that the Amendment Bill seeks to address.

The proposed amendments will touch on issues related to the following amongst others,

- The Indigenisation and Empowerment of the Mining Sector
- Royalties payable by mining companies
- The Mining Affairs Board's role and constitution
- New Mining Title system
- Mining Leases Versus Mining Claims
- Extra lateral rights
- Special grants
- Landowner's fees
- Environmental protection

The Chamber of Mines has noted that the current Act is generally accepted as an excellent piece of legislation and the current amendment efforts are to buttress this fact and tie up some lose ends for the benefit of the mining industry and make it globally competitive.

A Review Of The Stratigraphy And Geological Setting Of The Palaeoproterozoic Magondi Supergroup, Zimbabwe- Type Locality For The “Lomagundi” Carbon Isotope Excursion

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The Paleoproterozoic Magondi Supergroup lies unconformably on the Archaean granitoid-greenstone terrain of the Zimbabwe Craton and experienced deformation and metamorphism at 2.06-1.96 Ga, to form the Magondi mobile belt. The Magondi Supergroup comprises three lithostratigraphic units: volcano-sedimentary rift deposits (Deweras Group) that are overlain by a passive margin to foreland basin sedimentary succession, including shallow-marine sediments (Lomagundi Group) in the east, and deeper-water distal deposits in the west (Piriwiri Group). The Lomagundi Group unconformably overlies the Deweras Group, but its contact with the Piriwiri Group is either structural or not exposed in the field. Based on the upward-coarsening trend and presence of volcanic rocks at the top of the Piriwiri and Lomagundi groups, the Piriwiri Group is generally considered to be a distal, deeper-water time-equivalent of the Lomagundi Group. The Magondi Supergroup experienced very low-grade metamorphism in the southeastern zone, but the grade increases to upper greenschist and amphibolite grade facies to the north along strike and, more dramatically, across strike to the west, reaching upper amphibolite to granulite facies in the Piriwiri Group.

Carbonates form prominent horizons in the lower Lomagundi Group, occur in the Deweras Group as thick packages in the northern part of the basin, but form only thin lenses elsewhere, and are quite rare in the Piriwiri Group. Sulphate pseudomorphs and beds of anhydrite are relatively common in the Deweras Group, and also occur in the Lomagundi group. In a reconnaissance isotopic study of global Precambrian carbonates, by Schidlowski and others in 1975, the carbonate rocks of the Lomagundi Group were found to be the most isotopically anomalous regional carbonate province in the world, being very enriched in 13C, with an average δ13C value of +8.2‰ VPDB. Subsequent work in the Magondi Basin has shown that high δ13C carbonates are also present in the continental rocks of the underlying Deweras Group. The “Lomagundi Event” has now been recognized globally in carbonate rocks deposited in the time span 2.2-2.06 Ga.

The initiation of the Deweras rift is not well constrained geochronologically. Available dating indicates an age of 2.16 to 2.12 Ga, but it may have started as early as 2.26 Ga, if the Chimbadzi Hill mafic-ultramafic intrusion is related to early Deweras rifting. Assuming that the deepening trend in the upper Lomagundi Group and upward-coarsening trend in the Piriwiri Group reflect subsidence in the foreland basin and sediment derivation from an approaching volcanic arc, the age of the onset of Magondi deformation at c. 2.0 Ga provide an upper age limit for sedimentation. The ca. 2 00 Ma duration of sedimentation in the Magondi Basin is better explained by deposition in a passive continental margin which changed to a foreland basin, rather than in a back-arc basin as had been earlier proposed.

Some Aspects of Hydrothermal Mineralisation

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Some 550 years ago Agricola recognised water as an essential ingredient along with salt and acid in the formation of mineral deposits. This was supported by geologists in the 19th C who further suggested that transport and deposition resulted from reversible chemical reactions. Today these views are accepted along with a better understanding of the tectonic processes and settings of ore deposits, although the source, transport and depositional mechanisms remain ambiguous in some instances.

Most economically extracted metals can be associated with hydrothermal activity, from those near the top of the periodic table – lithium – to those at the bottom – uranium. The only exceptions appear to be nickel and chromium. Vein deposits are amongst the most important, but hydrothermal activity can also be ascribed to many others including pegmatoids, porphyries, and stratabound base metals. Host rocks include all known types from igneous to sedimentary with distinct preferences for some metals.

The advent of plate tectonics has vastly increased our understanding of ore forming processes, and although not all hydrothermal deposits are considered to be directly associated plate movements, many are. The placement of Archaean vein systems into a plate tectonic setting is controversial.

A Brief Overview of Exploration for Karroo Sediment Hosted Uranium in Central/Southern Africa – With Specific Experiences/Examples from Zambia

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Potentially economically interesting uranium occurrences have been known to exist in the Upper Karroo startigraphy in Southern/Central Africa for many years. Considerable Uranium exploration and evaluation work was carried out in the Karroo of Zambia and Zimbabwe in the 1970's and early/mid 1980's by (amongst others) Saarburg- Interplan, Agip, PNC, Cogima as well as the two Geological Survey Departments and various state owned mining/exploration companies. The past five years has seen a huge resurgence (and re-learning the art) of uranium exploration in the region driven by a predicted mid - long term term worldwide uranium deficit (for power generation) and high commodity price. Using predominantly Zambia to draw examples from, this presentation aims to touch upon in 15 - 20 minutes only, some of the different styles and types of uranium mineralisation within the Karroo, talk briefly about some of the exploration techniques that have been employed as well as highlighting some of the modern day sucess stories. Information / data used for this presentation is either already in the public domain or used with the kind permission of individual companies.

Summary Of Chisanya Carbonatite Presentation

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There are two suites of African carbonatites: Calcic along the East African Rift and magnesium on the cratons

A number of carbonate sources are postulated:

1. Derived from partial melts of mantle peridotite
2. Fractionation residues of mantle CO2 rich silicate magmas
3. Mantle derived silicate melt dividing into two immiscible fluids

Chisanya geology

Occurs 25km north of Birchenough Bridge, the complex consists of Baradanga, Chisanya, Bepe and Sanya carbonatites, aged 127My

Intruded the southern Mutare batholith, metasomatised the granite country rock to quartz free K-feldspar, sodic and minor alkali amphibole and chloritised FeMg minerals
Carbonate makes up >95% of rock comprising calcite, dolomite, ankerite and siderite with magnetite, chlorite, pyrite and phlogopite as accessory minerals

Economics of the Chisanya complex

Historically been explored for Cu, a number of companies have assessed the phosphate potential.
ACR have mapped and tested some of the complex; phosphate results are very encouraging, REE's are being targeted.
Mapping, surveying and sampling is ongoing.
Drilling will be undertaken in Q1, 2010.

Last Frontiers in Soil Geochemistry

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Mobile Metal Ions (MMI) is a term used to describe metal ions that have moved in the weathered soil profile and that are only weakly or loosely adsorbed by surface soil particles. MMI is a geochemical survey technique used to accurately locate deep ore deposits at depth. False and displaced anomalies normally associated with conventional geochemical sampling methods are minimized. By measuring only mobile metal ions in surface soils sharp responses or anomalies over buried ore deposits could be identified. Significant reductions in exploration costs may be realized as future exploration techniques such as geophysics and drilling can be focused into smaller, prioritized exploration zones, saving both time and money.

During the sampling process about 350 grams of sample need to be taken at a depth of 10 – 15 cm below surface. Sophisticated chemical processes and instrumentation are used to measure mobile metal ions that have migrated into surface soils from mineralization below. MMI geochemistry strips mobile metal ions from the exterior of soil particles using a partial dissolution without digesting the soil itself, to measure metal ion concentrations in the parts per billion range.

The MMI sampling technique was tested and compared with conventional geochemical sampling data on Zimari Nickel (PVT) known mineralized nickel ore body at Nickel Hill, near Mvuma in Zimbabwe.

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The results of this comparative exercise are the basis for this presentation.

Data Capturing Problems, Solutions and Tools

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DataShed is a globally present industry standard for data management proven in exploration, mining and environmental.

Our services are delivered by geoscientists with a deep understanding of resource sector needs.

- Integrates seamlessly with mining, exploration, and GIS software.
- Improves accuracy of data for better decision making.
- Provides full audit trails to meet industry best practice.
- Adds value to a company's most important asset, its data.

Nomad provides exploration and mining staff with easy, accurate and speedy data capture at the point of entry. Validation rules improve the quality of data collected. Nomad can be used offline and then later automatically synchronised to your desktop or master database to upload the data. Nomad users can use the pre-installed data capture templates or customise their own. These templates are rapidly deployable in an integrated data management system.

LogChief is a geological data capture application created to run on a laptop or tablet. The application is designed to simplify the collection and management of geological data associated with surface sampling and drilling. It ensures that by using defaults and company libraries, the data integrity and validation is enforced at the point of entry. The application gives users the flexibility to customise the application for their specific needs. LogChief can be used offline, with the collected data automatically synchronise to any database, or exported out as Access table or a spreadsheet.

Spatial Knowledge Management in the Mining Industry

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Neither problem nor solution can exist independent of context. Historical context is always necessary but never sufficient. Sufficiency can only be achieved by also having a spatial context. Mining activities, as processes and a functions are context sensitive. While the mining industry has invested significantly in sub-surface characterisation of ore bodies, little attention has been paid to 2nd generation knowledge management tools, such as GIS, which would go a long way in surface characterisation. It is increasingly becoming clear that knowledge is one of the few resources or assets that is almost infinite. Despite the significant resources that the mining industry have put in collecting this asset, its management leaves a lot to be desired. While the spirit or purpose of any system is found in its content, the design and development efforts towards well-structured repositories for spatial knowledge in this industry have been by and large piece-meal. GIS offers the mining industry an opportunity to manage its spatially intelligent knowledge assets, which are central to informing various mining activities such as mineral exploration, production and environment management.

GNSS – The Spatial Data Capturing Tool

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1.0 Introduction

GNSS, an acronym for Global Navigation Satellite Systems, play a broader role in spatial data capture. It is robust, efficient and versatile in all those applications where positioning is critical. At the moment, it is now an indispensable tool for all mapping exercises, be it localized areas or national mapping projects.

Traditionally, surveying was associated with optical instruments for example compasses, Wild T1s, T2s and dumpy levels being aided by accessories such as staves, chains and tapes. In the office, a pocket calculator, scale rule, drawing board and inking pens were, among other accessories, very important instruments needed in the final map production chain. Not only was the initial data capturing process tedious and prone to insidious errors, but also the final data processing and manual drawing of maps required nerves of steel, especially when project areas were large. The advent of the Total Stations and computers loosened up the tight ends, and surveying became simplified both in the field and office. Now with GPS technology, surveying has became even simpler since all processes are automated, but obviously coming at a price.

2.0 Background and Overview

The GNSS technology even though it came as a novelty and primarily developed for military venom, the system's ripple effects were also felt in civilian life. The principal aim was to hit targets with surgical precision during military operations. However, the system was also harnessed to serve civilian life. GNSS receivers for civilian use were developed to receive and process signals propagated by the orbiting satellite vehicles (SVs). The receivers, using multi-bit signal processing capabilities aided by powerful and rigorous firmware and software, can compute positions on the earth's surface. The ability to compute positions (co-ordinates) on the earth's surface is the genesis of understanding the geo-spatial information power base.

This versatile technology, when fully embraced makes development smart. Its precision, efficiency and robustness facilitate timeous delivery of set targets and goals.

The system comprises of GPS, Glonass, Galileo and Beidou. Global Positioning System (GPS) is an American sponsored satellite technology and is run by the Pentagon, Department of Defence (DoD). The programme was rolled out in 1978. As of May 2009, the constellation consisted of 31 operational satellite vehicles orbiting around the earth at an average distance of twenty thousand kilometers above the earth's surface. At any point on earth, a minimum of four satellites is above the horizon. The system has four ground-based monitor stations, one master control station and three upload stations.

The satellites broadcast data packets via the L1 and L2 radio signals. All satellites are continuously monitored by the ground stations which transmit the information to the master control station. The master station calculates all the relevant parameters, for example, atomic clock corrections and orbit realignments, among other corrections. These corrections are transmitted to the upload stations which forthwith upload the data to respective satellites at least once a day.

Glonass is a Russian sponsored satellite based technology and was unleashed in 1982. The system is undergoing a modernization phase. There are twenty operational satellite vehicles, with the last three newest satellites being blasted into respective orbits in December 2008. Galileo is a European

Union satellite system which is still undergoing a developmental stage. Only two experimental satellites are in orbit. When fully operational, the satellite navigation system's constellation will consist of thirty satellite vehicles (SVs). By 2013, the system will reach full throttle.

Beidou is a Chinese satellite navigation technology. It is still in the embryonic phase. Initially, the system will provide regional capability. When fully rolled out, the constellation will consist of thirty SVs in orbit and five geo-stationary satellites. The fructification of the programme is expected to rapidly expand as from 2015 to 2020.

The combination of all the above when fully operational can benefit immensely all the nations. Even at this stage, the capability of GNSS can be rated at ninety percent.

3.0 How it works?

- Satellite trilateration – the basis of the system
- Satellite ranging – measuring distances from a satellite
- Accurate timing - why consistent clocks and 4th SV are needed
- Satellite positioning – knowing where a satellite is in space
- Correcting errors – correcting for ionospheric and tropospheric delays

The ellipsoid on which GPS operates is called WGS84 and consequently all measurements are made on a common platform and co-ordinate system.

For accurate surveying, differential GPS is the cornerstone. The method requires one receiver (base station) to be set up at a known survey control station, for example on a trigonometrical beacon, and the other receiver (rover station) to be carried around and occupying points during measurement. The base station and the roving receiver(s) must measure simultaneously. The approach can either be in post-processing or real time kinematic (RTK) modes. This allows corrections to be applied on the data captured at the rover, hence correct vectors relative to the base station.

4.0 Applications

The system is versatile, and a wider range of applications are covered. Applications covered in this discussion are biased towards the mining industry. Lidar mapping is a very vital and thrift mapping technology which is guided by GNSS technology. Large scale mapping projects require this technology. Maps produced can be used in various fields ranging from geology to infrastructural development. Mineral prospecting is carried out on a platform of accurately mapped areas. For the geologist, points of interest can have their co-ordinates extracted from the resultant maps in office and uploaded into the (GNSS)/GPS receivers. These waypoints can be navigated to in the field. A closer and more analytic look on the ground is carried out (ground truthing).

Borehole positions can be staked out with little or no difficulty at all. When differential GPS (DGPS) surveying technique is used, sub-centimetre accuracy is achievable. Proper feasibility studies based on accurate positions are undertaken and correct decisions are taken on board. For meaningful investment in the mining sector, mining rights by way of mine leases need not to be overemphasized at this juncture. Mine leases provide collateral security and can only be registered when accompanied by survey diagrams. Cadastral survey is expeditiously executed if DGPS is employed. Apart from meeting the Surveyor-General's specifications, DGPS surveying ensures short turnover periods. For example, it can take four months to survey 15 000 hectares of mine lease area by total station, but a record three weeks is achievable when DGPS techniques are employed.

Mine control survey requires use of DGPS for a reliable co-ordinates. Setting out of portals and mine infrastructure becomes easy and errors are minimized, provided good setting out procedures are adhered to. In opencast mining adventures, machine control makes the whole procedure smart.

GPS receivers mounted on excavators and draglines are synergized with the geologist design maps. This allows economical cuts of grades and appropriate depths so that the required sections are only worked on. Unwanted waste material will be excavated with full knowledge, unlike if the miners are using conventional surveying procedures. Surface stock piles are easily measured in record time by DGPS operating in RTK mode for determination of volumes. Mine planning becomes very informed with no lost time as with the tedious conventional methods.

Mine safety is also kept under check. Subsidence of the ground can be monitored. By using continuous operating reference stations (CORS), small movements can be detected and hence monitoring of subsidence. Mine reclamation requires a good GIS application, which is easily supported if GPS based measurements are used.

5.0 Conclusion

Spatial information in the mining sector forms the basis of an informed mineral resource development. GNSS mapping technology, provided all factors are equal, results in accurate maps being produced in the shortest time possible. For Zimbabwe's reconstruction, mining plays a significant role because apart from agriculture, mining contribute a substantial amount to the GDP. The Africa Reference Framework (AFREF), which seeks to unify the whole of Africa to operate on the same co-ordinate system for co-ordinated development also touches the mining industry. Continuously operating GPS base stations have been proposed throughout the African continent at distance intervals of 500km. Users may have to buy roving stations only, and costs will be reduced significantly.

Being a nice technology as it is, there is need to outlay substantial amounts to procure the equipment. However, the accrued benefits will eventually outweigh the procurement costs, and accelerated development is experienced.

Hydrogeological Studies At A Limestone Quarry

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Recharge, discharge and water quality studies were conducted in order to understand the hydro-geological regime affecting a limestone deposit.

The geology was established by core drilling. Production and observation wells were done by destructive drilling.

Constant and/or stepped drawdown tests were conducted. Recovery data was also collected from the production well and all observation wells near and far. A weir tank was used to check the flow meter readings and also provide a convenient location to determine the pH, TDS and temperature of the discharge.

The production well and the inner nest of observation wells were dug some 2km from the quarry and in the H/W of the deposit. The inner observation wells were sunk in the quarry perimeter.

Piezometers were installed in the main lithological units to monitor the water levels during production or during lack of it.

For shorter constant observation, data-loggers were planted in the wells as far as possible. The use of data loggers complimented the effort of taking readings at specified intervals.

Permeability was determined by the falling head and the packer tests. The falling head was conducted at the observation wells using data-loggers or dip-meters.

The integrity of the observation wells was established by geophysical methods (caliper, β and restitivity) in the initial stages of the study.

To supplement the study, historical data from wells dug in the environs was collected . Local authorities and all stake holders were told about the exercise.

Ideally, data should be collected from the observation wells for a whole year before any hydrological model are drawn. However, pertinent questions surrounding undesirable water levels had to be answered fast.

After processing the data it was evident that the pumping capacity of the quarry could be altered to deal with worst water recharge rates.

The deposit could not be pursued too far into the H/W because of ensuing high pressures.

The future of the mining lay in following the deposit west along strike.

The pumped water could be could directed into a channel with minimum recycle chances.

Minerals that have a potential to host metals in their crystal structure at Dorowa rock phosphate mine, Zimbabwe: Implication for environmental Management

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There are a substantial number of minerals in the Dorowa alkaline ring complex Chemical analysis (atomic absorption spectrometry and XRF) established that the phosphates at Dorowa are associated with metals and sub metallic elements that include copper, zirconium, strontium, rubidium, lead, zinc, cobalt, iron, and manganese..

The major minerals found in the ring complex are feldspars, pyroxenes, apatite, magnetite and calcite. Recent work (Meck et al in press) has established the potential metal host among the many minerals present and concluded that the minerals that have a potential to host toxic elements in their crystal structure are apatite and calcite which belong to the carbonate and phosphate families respectively. Apatite is the only mineral which can host pollutant trace elements (Sr, Fe, Cu, Pb, Zn, Cd, As, V, Cr,) in a more stable manner. Calcite can also host metals in its structures but the substitution is limited. Metal substitution capacity by the other observed minerals is not possible from a crystal-chemical perspective.

The fact that only a few minerals can host the pollutants means if they are identified and isolated then its easy to manage them. The fact that the accessibility of elements trapped in the calcite and apatite structures to the environment is very high due to the fact that both apatite and calcite dissolve in weak acids thus dissolvable in natural environmental conditions also calls for serious monitoring in environmental management

3D Earth Exploration

Hillary Gumbo

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3D Earth Exploration is a recently registered geophysical contracting and consulting company. Our focus is on 3D data integration, modelling and visualisation. We recently acquired a magnetotelluric (MT) unit that maps rock resistivity down to a depth of 1km from which geological and structural interpretation can be done. Unlike most other systems available on the market our unit called the Stratagem is very portable, easy to use and one can view the resistivity section during survey. We also plot up and view data every evening during survey. At present we can also plot the data in 3D (together with say drillhole data) at our office immediately after receipt of field data. In the near future we aim to provide our technician with the software to do that on site. We also have license for VPmg 3D magnetic modelling software and are currently running some trials on Selby Test Range, the Zimbabwe Geological Survey Geophysics Test site on the outskits of Harare. We will upgrade our license to include gravity and gravity gradient modelling sometime soon. We are in the process of acquiring more equipment and software to broaden our data acquisition and modelling range. We expect to have a set of magnetometers before the end of 2009.