Council for Geoscience

ANNUAL TECHNICAL REPORT of the Council for Geoscience 2008/9

Council for Geoscience

ANNUAL TECHNICAL REPORT

for the year ended 31st March 2008/9

COUNCIL FOR GEOSCIENCE
SOUTH AFRICA

Front cover:

View of the KwaZulu-Natal–Free State border looking east from the Sentinel, at 28°44'15.7" S 28E53'39.1" E, taken at an altitude of 2 802 m. Weathered basalt boulders in the foreground contrast with the flat-topped mountains of Beaufort Group sediments forming the Great Escarpment in the background.

Photo: Roger Price

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ISBN 978-1-920226-22-0

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Council for Geoscience

COUNCIL FOR GEOSCIENCE
ANNUAL TECHNICAL REPORT

for the year ended 31st March 2009

Compiled by R.R.M. Price, B.Sc.Hons Pri.Sci.Nat.

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of the council for geoscience

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FOREWORD

The Council for Geoscience (CGS) has had a successful year in respect to completing research which had been planned for the 2008/9 statutory programme. During the year ended March 2009 the CGS continued to play an active role in training young geoscientists by means of scholarships and in-house training programmes such as the School of Geological Mapping. Over 90 per cent of the CGS's bursary holders are from previously disadvantaged groups, and the organisation continues to play an important role in training geoscientists from other African countries through placement programmes and a programme in partnership with the University of the Witwatersrand and Pennsylvania State University. The CGS has also implemented a mentorship programme to fast-track career development and acquisition of expertise and knowledge for new and young geoscientists joining the organisation.

The CGS, as the leading organiser and in collaboration with other institutions, successfully hosted the General Assembly of the International Association of Seismology and Physics of the Earth's Interior in Cape Town. This was the first time that the IASPEI General Assembly had been held in Africa, and 347 delegates attended this event. As part of the assembly, a Summer School was held to train 27 African geoscientists as seismologists.

The CGS, in collaboration with the Department of Minerals and Energy, the Geological Society of South Africa and the South African Committee of the International Union of Geological Sciences, succeeded in winning the bid in Oslo for hosting the International Geological Congress (IGC) in Cape Town in 2016. The IGC is the largest general geological congress, and is held every four years. This is an important vote of confidence by the international geological community in South Africa and the African continent. As part of IGC 2016, a capacity-building initiative for African geoscientists is being formulated.

The CGS continues to play a prominent role in the development of geosciences in Africa, through the activities of the Organisation of African Geological Surveys. During the year a comprehensive report outlining the role of geological surveys in respect to the minerals development of the continent was produced, and a detailed strategy on the future of the organisation is being developed by member countries.

The Honourable Minister of Minerals and Energy launched a new state-of-the-art nearshore research vessel, *Geo Manzi*. This boat is a dedicated survey platform equipped with modern geophysical equipment that allows very high resolution sea-bed surveys. Information from these surveys will be important in locating offshore mineral deposits, identifying and researching nearshore reefs for fishery management, monitoring harbour entrances, and planning near-shore infrastructure elements such as pipelines, telecommunication cables and anchorages. The launch of this boat marked the commencement of modern geoscientific mapping of South Africa's offshore territory.

The CGS continues to provide technical support and skills to other state agencies, such as Eskom, with its nuclear power programme. The CGS dedicates many of its most experienced geoscientists to this project and has contributed towards providing a solid base for license applications for anticipated nuclear-power stations. The CGS will continue to provide its services to Eskom in what is now a strategically important national infrastructure development programme, and young geoscientists are placed with more experienced senior geologists in projects in order to transfer knowledge and build capacity. The CGS provides technical support to the Department of Minerals and Energy in addressing the environmental issues resulting from mining-related contamination which, be it water, soil or air-related, poses a serious challenge to the country because of its long mining legacy.

Collaboration has continued with a number of countries on various geoscience research projects, including JOGMEC (Japan Oil, Gas and Metals National Corporation) on a REE-related research project, and a coal assessment project with Botswana. These projects are being used to develop South Africa's scientists in high-technology mineral assessment and utilisation. The CGS continues to play a vital role in advancing South Africa's knowledge of global warming, and the CGS is compiling a carbon storage atlas for South Africa in collaboration with the South African National Energy Research Institute (SANERI).

Dr Thibedi Ramontja
Chief Executive Officer

INTERNATIONAL

2002-0069 **iSIMANGALISO WETLAND PARK RAISED SHORELINES**

Project leader: G.A. Botha, Ph.D.
Collaborating scientists: N. Porat, Ph.D., Geological Survey of Israel, R. Taylor, eZemvelo-KZN Wildlife, Ph.D.
Primary objective: *to provide a geochronological framework for the sequence of raised beach ridge sand deposits preserved at points around the shoreline of the St Lucia lagoon, and to assess the effects of sea-level lowering over the past 4 000 years, thus improving the accuracy of the Holocene sea-level fluctuation curve for southeastern Africa.*
Duration: 2005/6 to 2008/9.
Budget: 2008/9: R35 510.

Raised palaeo-shorelines aligned across the confluence of the KwaMbonjana stream with False Bay, iSimangaliso Wetland Park, mark the retreat of the lake shoreline over the past 4 000 years.

Motivation

This long-term research project has generated multi-disciplinary collaboration with researchers from around the world who have interests in environmental change in the Maputaland coastal plain region. The initial phases of the project elucidated the Cenozoic lithostratigraphy and geological evolution of the region. Subsequent phases of the project focussed on the palaeo-environmental change in the region and the impact on dune and wetland systems. These provide a long-term ecological basis for management of diverse habitats and ecosystems of the iSimangaliso Wetland Park World Heritage Site. The current focus is on the publication of research findings in international scientific journals.

Progress

The measurement of accurate elevation relative to mean sea level was achieved using differential GPS measurements of one raised beach ridge crest at each of five sites around the St Lucia lagoon. These precise elevation measurements permitted the correction of the topographic profiles surveyed across the beach ridge sets during an earlier phase of the project. The luminescence laboratory of the Geological Survey of Israel re-evaluated the OSL dates derived from the beach ridges at the sites sampled. The findings corroborate the coastal development models derived from other projects undertaken by the CGS on the Kosi lakes and Lake Sibaya. The results have been summarised in a manuscript that will be submitted to an international scientific journal for publication.

Conclusions

The research project has shown that the sequences of raised sand ridges that occur in embayments at points around the St Lucia lagoon represent raised shorelines related to past sea levels. The sandy ridges are not precise sea-level indicators and the actual mean sea level is better recorded by fixed biological indicators of intertidal zone mean sea levels that were dated from sites along the coast. The OSL dating shows that the St Lucia lagoon probably had a more direct link to the sea within the past 3 000 years. The direct marine link is now restricted by a narrow 15 km channel that does not permit the tidal prism to have a great influence on the ecology of the lakes. During the late Holocene it is likely that the direct marine link that was possibly located north of Cape Vidal was restricted by accretion of the high coastal barrier dunes. The research project provides critical evidence for the long-term evolution of the ecosystems within the coastal lakes and estuaries in the iSimangaliso Wetland Park World Heritage Site.

Future activities

The research project has fulfilled the goals defined. There is potential for the production of a popular geoscience publication on the geological and geomorphological evolution of the region.

2002-0133 **INTERNATIONAL METALLOGENIC MAP OF AFRICA: DATABASE MAINTENANCE**

Project leader: S. Frost-Killian, M.Sc.
Project team: W.R. Oosterhuis, B.Sc.Hons.
Primary objective: *to i) improve existing knowledge of mineral deposits of the SADC and NEPAD regions by updating the database, ii) improve the reliability of the data by verification and iii) to contribute towards capacity building and improved knowledge of deposit models in Africa.*
Duration: Ongoing.
Budget: 2008/9: R11 040.

The GMRAP team observing copper mineralisation near Cashin Mine, Colorado, USA.

Motivation

The Africa Minerals Database was designed as part of the compilation of the International Metallogenic Map of Africa (1:5 000 000). In view of the future thrust directions of the CGS, and the use of the data for a variety of current and future statutory and commercial projects, it is important that the data be up to date and relevant. This is particularly important for innovative manipulation and interrogation of the data to produce a variety of products, including prospectivity maps, as well as to advance knowledge of the origin and evolution of mineral deposits (deposit modelling).

Progress

The 1:5 000 000-scale International Metallogenic Map of Africa was published in June 2002 by the CGS under the auspices of the Commission for the Geological Map of the World (CGMW), with support from UNESCO. The ß-version of the digital International Metallogenic Map of Africa was released in 2003. Continuous updates have been made to the digital product, with a ß1-version released in early 2009. Sales of the digital data have continued through the 2008/9 project year. The map and associated digital data have been used for the production of both country-specific and more regional-derived maps, reports and publications. Clients include mining and exploration companies, consultants, other science councils, the Department of Minerals and Energy, university libraries and departments, and companies working as suppliers to the mining industry in Africa. Many of the current clients are from South Africa, Australia, Canada and the USA.

Continued effort has been made to establish contacts at the geological surveys in the various African countries in an effort to establish an Africa-wide network of professionals who are in a position to assist potential mineral investors.

Maintenance and updating of the database have continued, with a focus on southern Africa. Assistance was given to various CGS projects for clients throughout Africa. The CGS participation in the collaborative United States Geological Survey (USGS) Global Mineral Resource Assessment Project (GMRAP) for copper is ongoing. Preliminary results of the copper assessment of the southern African region have been presented to industry at relevant conferences over the past year.

Three papers were presented at the Geological Society of South Africa-Society of Economic Geologists Conference (GSA-SEG 2008): ‘Africa uncovered’ in July 2008 using data from the Africa minerals database.

Conclusions

The release of the digital data set has generated interest within the mining community at large. It is hoped that the publication of the map and digital data set will serve to promote interest and investment in the mineral industries of Africa.

Future activities

The maintenance of the Africa Minerals Database is seen as an ongoing task. It is hoped that the database will be further improved upon, updated and expanded within the next project year.

2002-0781 **PALAEONTOLOGY AND PALAEO-ECOLOGY OF THE ELLIOT AND CLARENS FORMATIONS**

Project leader: J. Neveling, Ph.D.
Project team: A.M. Yates, Ph.D. (University of the Witwatersrand), P.J. Hancox, Ph.D. (CCIC), M.F. Bonnan, Ph.D. (Western Illinois University).
Primary objective: *to investigate the palaeontology, palaeo-environment and stratigraphic relationships of the Elliot and Clarens Formations.*
Duration: 2003/4 to 2007/8.
Budget: R5 858.

Motivation

The Elliot Formation outcrops in the central part of South Africa, especially in the Eastern Cape, Free State and KwaZulu-Natal, and contains some of the world's earliest dinosaur and mammal fossils. Two informal vertebrate biozones have been recognised in the Elliot Formation, spanning the late Triassic and the early Jurassic. The uppermost of these biozones, the Massospondylus Range Zone, is dominated by the remains of the medium-sized prosauropod dinosaur Massospondylus, but in general its taxonomic diversity is low and is generally described as 'depauperate'. A review of established fossil collections by one of the project researchers, A. Yates, revealed the presence of a previously unknown dinosaur fauna in the upper Elliot Formation. A collaborative investigation was therefore launched to investigate the fossil fauna and local palaeo-environmental conditions of the Elliot Formation.

Progress

No field excavations were conducted during the 2008/9 year, but research continued in the laboratory. Preparation and analysis of the remaining fossil material continued and the initial results were documented as a short manuscript, but the authors produced a more comprehensive manuscript and submitted it to the electronic journal PLoS ONE. Unfortunately the manuscript was not accepted for publication as the reviewers desired more taxonomic data. The authors will resubmit the manuscript to a journal that is still to be decided upon.

Conclusions

A diverse sauropodomorph dinosaur fauna has been discovered in an interval that normally displays low diversity and is dominated by the primitive prosauropod dinosaur Massospondylus. The research group postulates that the vertebrate fauna from the study area reflects the presence of an unusual riparian gallery forest micro-environment associated with streams that are larger and of a more permanent nature than the typical fluvial setting for the upper Elliot Formation.

Future activities

The research team will continue to document their results and submit them for publication in scientific journals, but most of the work for this project has been concluded.

2007-0933 **MOZAMBIQUE PUBLICATIONS: GEOCHRONOLOGY AND P-T CONDITIONS OF THE MONAPO COMPLEX**

Project leader: G.H. Grantham, Ph.D.
Primary objective: *to publish aspects of interest arising from the Mozambique mapping project from 2005 to 2007.*
Duration: 2007/8 to 2008/9.
Budget: R17 500.

Motivation

During the Mozambique Mapping Project significant new data of interest to the broader international community was generated on the geology of Mozambique. It was decided to write several scientific papers to be published in peer-reviewed journals to bring these to the attention and to make them more accessible to the international geological community.

Progress and conclusions

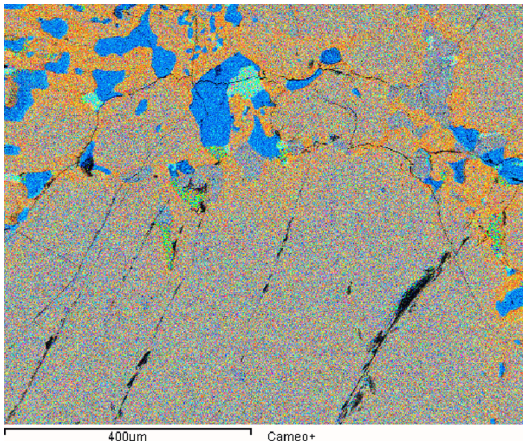
During 2008/9 the project focussed on the geological evolution of the Monapo Complex in northeastern Mozambique, approximately 100 km east of Nampula. A manuscript was prepared and is awaiting contributions from co-authors at the Universities of Stellenbosch and Cape Town.

The Monapo Complex consists of a 40 km crudely circular erosional remnant of a large crustal block thrust-faulted onto the Nampula Terrane during the formation of the Gondwana supercontinent approximately 570 Ma ago.

P-T estimates from thermobarometry, which uses the chemical compositions of various mineral phases, permit the interpretation that these rocks moved from a depth of approximately 33 km with a pressure of about 10 kb and temperature 1 000 °C, to shallower levels that have a pressure of 6–7 kb and temperature of 700 °C, initially forming an isothermal decompression path and followed by an isobaric cooling path.

One of the unusual and interesting assemblages contributing to the understanding of the path is a decompression reaction involving the Ca-Tschermaks molecule in clinopyroxene (pale blue-orange colour) exsolving to form anorthite plagioclase (dark blue). The exsolution from the clinopyroxene involves the separation of Al_2O_3 from concentrations of about 11% (pale blue-orange colour) in the clinopyroxene to about 5% (orange zone) in clinopyroxene, with the enrichment of Al_2O_3 in anorthite being about 38 per cent.

SHRIMP U-Pb dating on zircons taken from two samples from the Monapo Complex shows that the rocks were formed during magmatism and metamorphism approximately 630 Ma years ago and were metamorphosed again at about 570 Ma, which is when the change in pressure on the rocks from 10 kb to 7 kb is thought to have occurred.



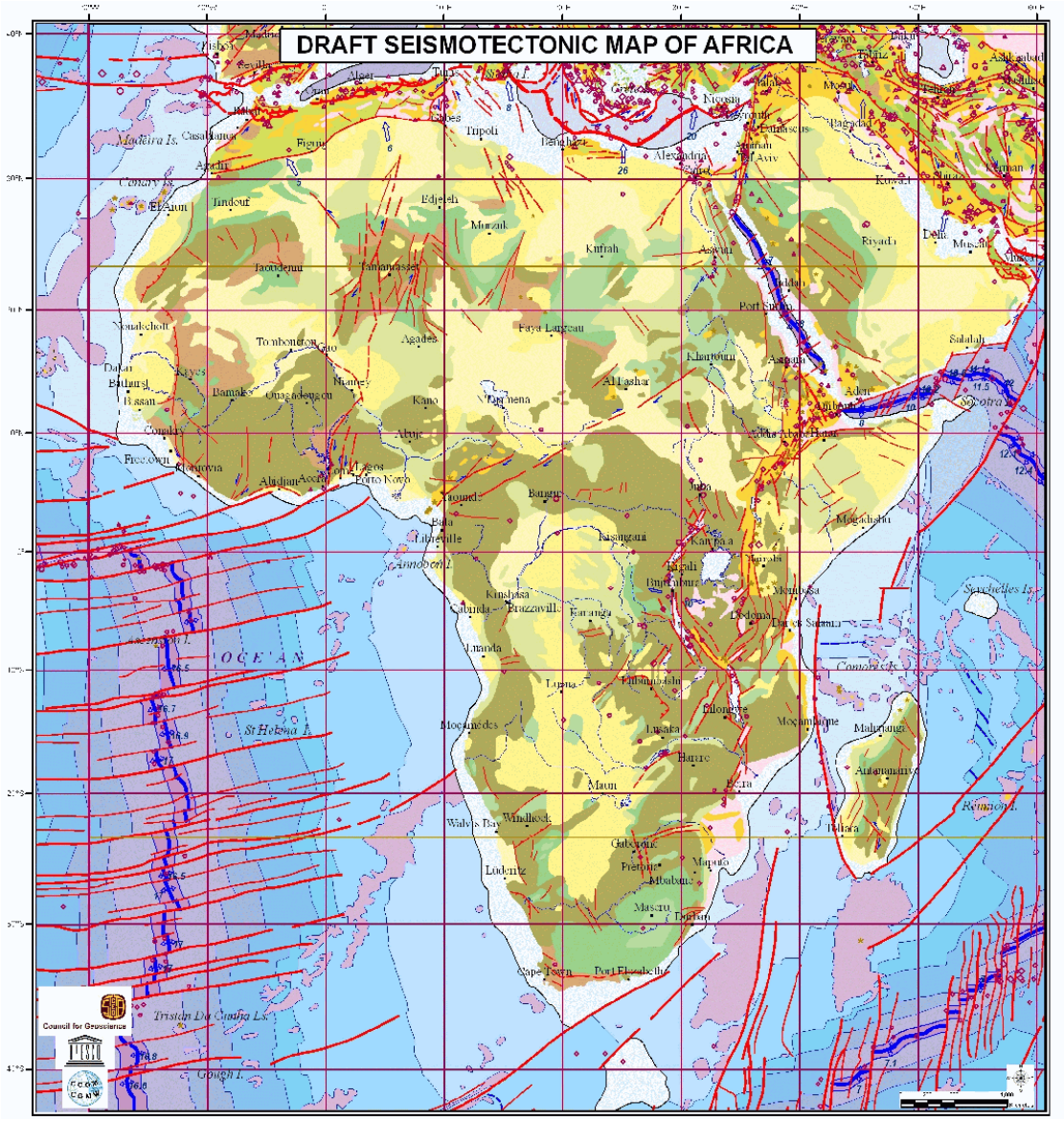
Electron microscope image of a decompression reaction involving the Ca-Tschermaks molecule in clinopyroxene (pale blue-orange colour) exsolving to form anorthite plagioclase (dark blue).

Future activities

Additional publications on other aspects of the geology of northern Mozambique are planned.

2007-0944 **SEISMOTECTONIC MAP OF AFRICA**

Project leader:	B.A. Ingram, M.Sc.
Project team:	P.K. Zawada, Ph.D., M.R.G. Grobbelaar, B.Sc.Hons, V. Midzi, Ph.D., D. Delvaux, Ph.D. (Belgium), P. Rossi, Ph.D. (France), J.P. Cadet, Ph.D. (France), F. Toteu, Ph.D. (Cameroon).
Primary objective:	*to produce a seismotectonic map and database for Africa which will support a sustainable earthquake disaster mitigation strategy.*
Duration:	2007/8 to 20010/11.
Budget:	R44 087.



Motivation

The Seismotectonic Map of Africa is a project of the Commission for the Geological Map of the World (CGMW) to improve knowledge of the geology and geodynamics of Africa. The map will complement the 1:5 000 000-scale Geological Map of Africa, and the 1:5 000 000-scale Tectonic Map of Africa which will be published during 2009, and results from the 21st Colloquium on African Geology (CAG21) which was held in Maputo in 2007. The Seismotectonic Map will assist in the mitigation of natural disasters in Africa. Whereas geological hazards are very important in northern Africa, limited impact is experienced in the sub-Saharan area, except in the East African Rift system and the Cameroon volcanic line, where earthquakes are associated with active fault zones or with volcanic activity. Seismic activity is also registered in the Cape Fold Belt and in deep mines of South Africa.

Progress

The draft Seismotectonic Map of Africa, with its legend, showing tectonic provinces, seismological and fault data, was completed during the year and an internal progress report was produced. The project leader attended the 2008 General Assembly of the CGMW at the 33rd International Geological Conference in Oslo and reported on the project's progress. The data which will be used for the Tectonic Map of Africa were received from the CGMW. Collaboration with the International Council for Scientific Unions, Regional Office of Africa (ICSU-ROA) is being considered to produce one combined map.

Conclusions

With the completion of the draft copy, the first phase of the Seismotectonic Map of Africa project is complete.

Future activities

The background to the map will be a simplified tectonic geology in low-intensity colours superimposed on a sun-shaded Digital Elevation Model, and in addition to recent active and neotectonic faults it is proposed that active volcanoes be indicated. The establishment of a combined project with ICSU-ROA should be sought to produce a combined seismotectonic map of Africa.

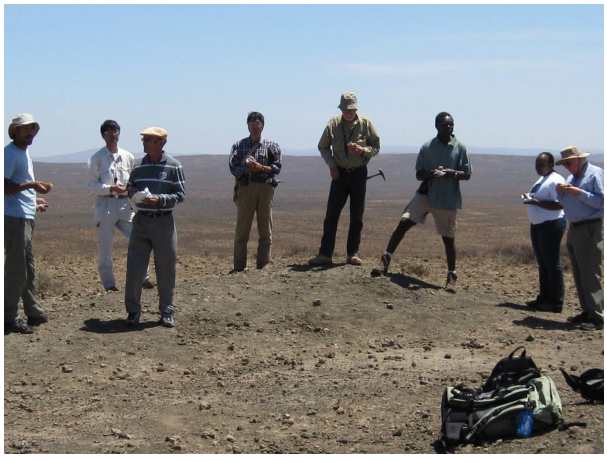
2008-1000 **EVALUATION OF RARE EARTH RESOURCE POTENTIAL OF SOUTH AFRICA**

Project leader:	E. Long'a Tongu, Ph.D., Y. Watanabe, Ph.D. (National Institute of Advanced Industrial Science and Technology – AIST)
Project team:	S. Mayekiso, B.Sc.Hons (CGS), T. Moriyama, Ph.D. (AIST), M. Kurihara (Japan Oil, Gas and Metals National Corporation – JOGMEC).
Primary objective:	*to research and explore for rare earth mineral resources.*
Duration:	2008/9 to 2012/13.

Motivation

The project aims to identify the rare earth element resource potential of South Africa. This will enable the country to become a producer of rare earth oxides, thereby aiding the growth of the country's economy. The project will assist the South African mining and exploration industry to focus on a potentially profitable new arena, though hitherto, poorly understood range of mineral commodities. By highlighting the economic potentialities of rare earth mineral commodities, rural and previously disadvantaged communities stand to benefit directly or indirectly through participation in mining and exploration of a relatively new range of resources.

The project will develop local skills for the exploration and mining of rare earth element resources. It must be remembered that South Africa, at present, is not a player in the production of rare earth oxides. It is therefore imperative that the CGS continues its participation in the project.



Team in the field to identify rare earth element resources.

Progress

Project 2008-1000 is a five year, collaborative project with the Geological Survey of Japan, represented by AIST and JOGMEC. So far, three separate field trips have been undertaken and 11 deposits have been sampled. Analysis of some of the samples indicates that three deposits show potential for the presence of significant rare earth resources and warrant further investigation.

Conclusions

The project will lead to the discovery of rare earth resources, which will generate jobs and alleviate poverty by making South Africa a producer of rare earth oxides.

Future activities

Future work will include sampling large carbonatite bodies which have not previously been assessed, as well as follow-up work on identified mineralised deposits.

2009-1004 **MAGMA DYNAMICS IN SILL AND DYKE SYSTEMS. CONSTRAINTS FROM MAGNETIC FABRICS AND PALAEOMAGNETISM IN THE KAROO LARGE IGNEOUS PROVINCE**

Project leader: L.P. Maré, M.Sc.
Project team: E.C. Ferré, Ph.D. (Southern Illinois University), C. Ranaweera, B.Sc.Hons, M. Marsh, B.Sc.Hons.
Primary objective: *to evaluate the magma dynamics of a large igneous province.*
Duration: 2008/9 to 2009/10.
Budget: R52 525.

Motivation

This is an NSF-funded international collaboration project. This project will allow participants to gain valuable experience and also to build important relationships with leading scientists in the United States of America.

The determination of magma flow direction is one of the first questions in the study of many igneous systems. This is particularly true for large igneous provinces, such as the Deccan, Ferrar and Karoo flood basalts, in which immense volumes of mafic magma have been transferred from the mantle towards the Earth's surface over relatively short periods of time.

A dolerite dyke in the vicinity of Kommandodrifdam that was sampled for magnetic studies.

The goal of the proposed research is to provide new field- and laboratory-based observations to constrain magma dynamics in sill and dyke systems. A set of six controlled field experiments using magnetic fabrics and palaeomagnetism on selected exposures of rocks within the Karoo Province will test hypotheses related to magma transfer in such complex systems. For each of these experiments flow fabrics will be determined independently by direct field observations and image analysis on oriented thin sections. The proposed research will complement, but not duplicate, research efforts made by other groups using geochemical, petrological or geophysical approaches.

Progress

During November 2008 samples have been collected at regular intervals (0.5 m) along Insizwa core INS98-08, along sections of the core where inverse magnetic fabric had been observed by other researchers. Additional samples were collected from a sill at the top of core CG1/85 that was drilled west of Syfergat.

Field work included sampling isolated dykes (for student Ranaweera) and sills of varying thickness (for student Marsh). A few samples were collected from the contact aureole around intrusions at Golden Valley, Long Dyke and Kommandodrif Dam with the aim of performing preliminary backed-contact tests. Sampling sites were located around Golden Valley, the Long Dyke between Cradock and Middelburg, Kommandodrif Dam, Graaff-Reinet and the Insizwa Complex.

Conclusions

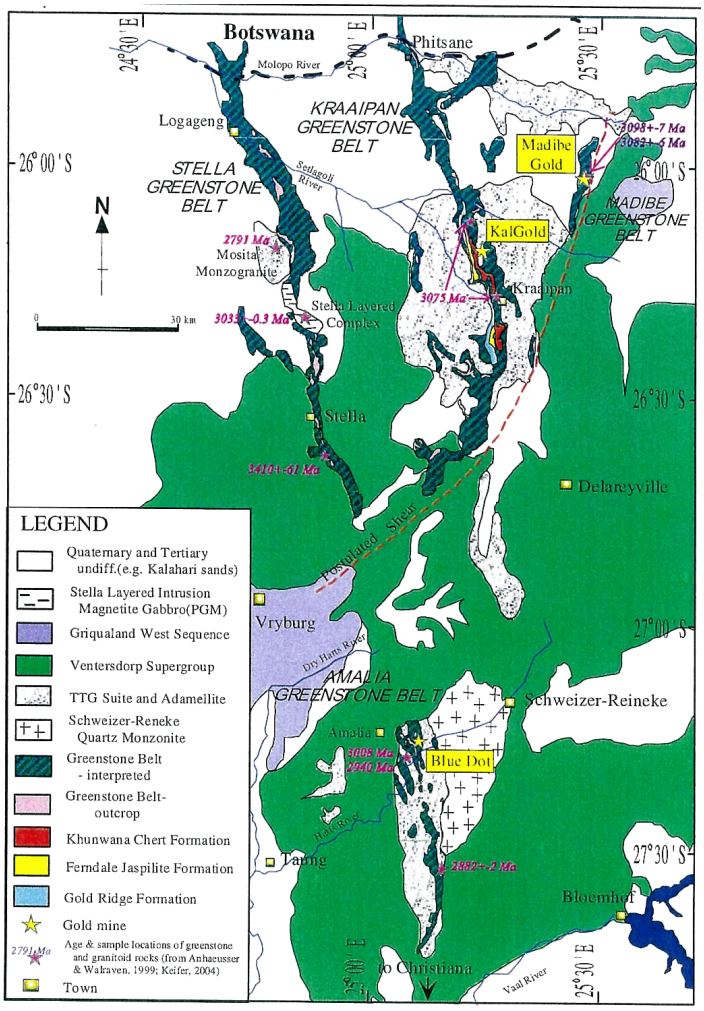
Sample collection during the 2008/9 field season was successful and each of the team members has enough samples to conduct selected experiments during 2009/10.

Future activities

During 2009/10 each team member will proceed to conduct pre-determined experiments on selected samples. The progress and preliminary results will be reported on during the American Geophysical Union Fall Meeting in San Francisco in December 2009.

2008-1057 **CONTROL OF MINERALISATION AT THE BLUEDOT MINING COMPANY, AMALIA GREENSTONE BELT: PETROGRAPHIC, MINERAL-CHEMICAL AND FLUID ASPECTS**

Project leader: N.Q. Hammond, Ph.D.
Project team: T. Mizuta, D.Sc., D. Ishiyama, Ph.D., K. Adomako-Ansah, M.Sc. (all of Akita University, Japan).
Primary objective: *to (i) investigate the genesis of gold mineralisation in banded iron-formation at the Abelskop and Goudplaat deposits of the Bluedot mining company in the Amalia greenstone belt, and (ii) make a comparison with similar studies previously conducted at the Kalahari Goldridge mine in the Kraaipan greenstone belt to provide a comprehensive understanding of the mineralisation history of the Amalia-Kraaipan greenstone belts.*
Duration: 2008/9 to 2010/11.
Budget: 2008/9: R7 780.



Motivation

The Kraaipan-Amalia greenstone belt in South Africa is one of many greenstone belts on the Kaapvaal Craton which hosts a number of gold and platinum deposits. There has been a general lack of knowledge concerning the mineralisation history in these greenstone terrains, which apparently is attributed to the general paucity of outcrops in a region entirely covered by calcretes and Kalahari sand. The advent of mining operations has revealed the region to be a potential metallogenic province, but realisation of the mineral potential of the Kraaipan-Amalia greenstone belt requires the development of effective mineralisation models and a thorough understanding of the belt.

A number of studies have recently documented the genesis of gold mineralisation in BIF, alteration patterns, fluid evolution and factors that control mineralisation in the Kraaipan greenstone belt.

The current research at the Abelskop and Goudplaat deposits of Bluedot mining company in the Amalia greenstone belt will attempt to define the genesis of gold mineralisation from a geochemical-mineralogical perspective. In conjunction with earlier studies on the Kalahari Goldridge deposits in the Kraaipan greenstone belt, this study will also aim at providing a comprehensive understanding of the mineralisation history of the Amalia-Kraaipan greenstone belt.

Progress

A field trip was undertaken to the Bluedot mining area for geological sampling and a study of the rocks associated with the mineralisation in December 2008. Sample preparations for petrographic studies and various analyses are currently being undertaken at Akita University.

Future activities

Field work at the deposit site will be followed up, however, analytical work will be the prime focus during the coming year.

2009-1060 **ANTARCTIC REVIEW**

Project leader: G.H. Grantham, Ph.D.
Primary objective: *to review the earth science component of the South African National Antarctic Programme (SANAP).*
Duration: 2007/8 to 2008/9.

Motivation

Arising from the insights gained from the Mozambique Mapping Project from 2000–2007, and the juxtaposition of Mozambique against Dronning Maud Land in Antarctica within the Gondwana supercontinent, it was decided that the CGS should consider developing interests in the geology of Antarctica. Consequently the earth science component of the South African National Antarctic Programme (SANAP) was reviewed.

Progress

During the year an application for funding to conduct follow-up research in Antarctica was submitted to the National Research Foundation (NRF). Regrettably, due to a lack of funding, the NRF declined to support the proposed research.

The review focussed largely on South Africa's involvement in the study of the geology of Antarctica from about 1960 to the present, and concluded that a potential statutory role exists for the CGS in SANAP and that considerable scope exists for research in various fields, provided that the current administrative, logistical and financial constraints can be overcome. In particular, research interests include comparative studies of the geology between northern Mozambique and Dronning Maud Land, focussing on the Mesoproterozoic (1 000–1 200 Ma) basement rocks, their younger Pan-African (ca. 450–600 Ma) history, as well as the rocks of the broader Karoo Basin. The latter aspect could extend and supplement the Tri-Nations Karoo Correlation project, involving collaboration between South Africa, Namibia and Botswana, which has received generous support from the Department of Science and Technology (DST).

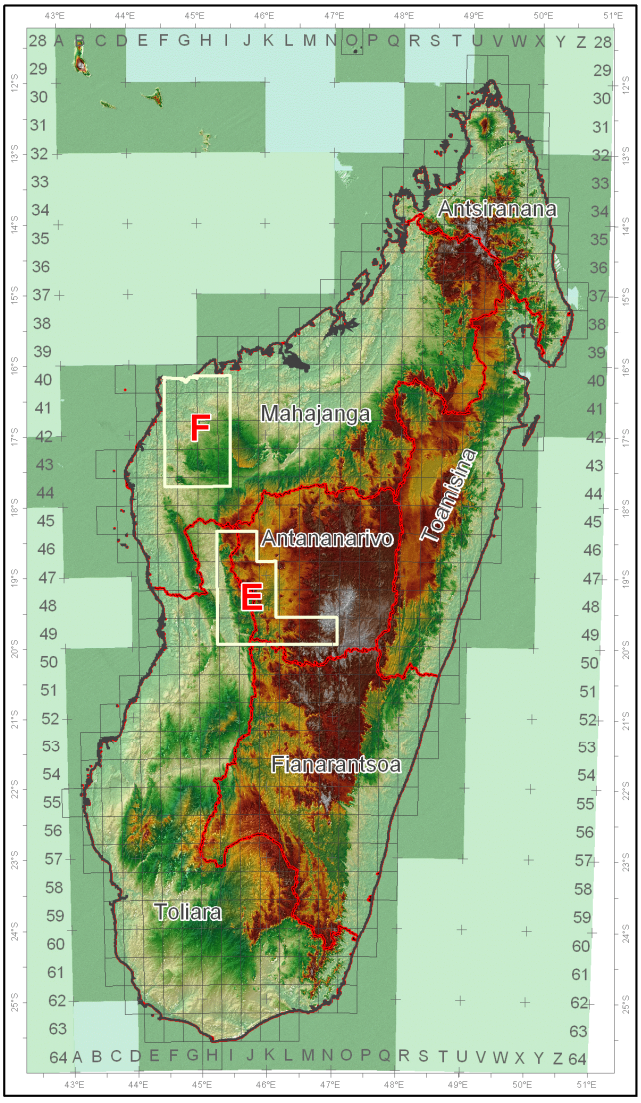
In March 2009 the NRF decided not to accept new funding applications for SANAP in 2009 and declared that the call for proposals for the 2010/11 year would only be considered from the current grant holders in the light of the possible restructuring of the SANAP programme.

2005-5590 **GEOLOGICAL MAPPING AND STREAM-SEDIMENT SAMPLING IN MADAGASCAR**

Project leader: P. Macey, Ph.D.
Primary objective: *to produce geological, geochemical, structural, geohydrological, environmental and mineral prospectivity maps and complete geoscientific research in two regions (Zones E and F) of Madagascar*.
Duration: 2005/6 to 2008/9.
Budget: Total: R11 800 000.

Motivation

The main aim of the mapping programme has been to replace the outdated geological map sheets with modern digital geological, geochemical and geophysical base maps and query-able geological, geochemical and geochronological databases for Madagascar, principally to promote mineral resource exploration, but also as support to sustainable social development projects, including those concerning the environment, urban development, agriculture and hydrogeology.



Progress

The CGS's geological mapping and stream-sediment sampling projects in central and northwestern Madagascar (Zones E and F) formed part of a geological mapping programme funded by the World Bank and DST and produced a revised geological map of the Precambrian rocks of the eastern two-thirds of the island. The project was administered in Madagascar by the Project de Gouvernance des Ressources Minérales (PGRM) under the auspices of the Ministère de L'Energie et des Mines (MEM). In addition to the CGS, the project participants were a British Geological Survey (BGS)-United States Geological Survey (USGS) consortium, a German consortium (BGR-GAF) and the Bureau de Recherches Géologiques et Minières (BGRM) of France.

The CGS team produced 34 geological, mineral prospectivity, environmental and hydrogeological maps and 62 stream-sediment geochemistry maps at scales of 1:100 000, 1:200 000 and 1:500 000, as well as two geological texts that integrate the mapping and field observations with allied research projects. The work was carried out during a three-year period from 2005 to 2009. The products were submitted to the PGRM-MEM and corrections, provided by reviewers appointed by the World Bank, are currently being dealt with.

Conclusions

The Madagascar mapping project is nearing completion and all the products having been submitted to the client. Only reviewers' corrections remain outstanding.

Future activities

Final corrections are to be completed.

SADC

2004-0830 **THE SOUTHERN AFRICAN MAGNETOTELLURIC EXPERIMENT (SAMTEX): COMPLETION OF THE FIELD WORK COMPONENT OF THE PROJECT**

Project leader: R.H. Stettler, Nat.H.Dip.
Project team: L. Loots, B.Sc.Hons, D. Kruger.
Primary objective: *to carry out a magnetotelluric survey of Namibia, Botswana and South Africa.*
Duration: 2004/5 to 2008/9.
Budget: R277 140.

Installing magnetotelluric equipment.

Motivation

This project is the final phase of an international programme by scientists from South Africa, Botswana, Namibia, Ireland, the United States of America and Germany, to study the deep crust beneath the cratons of southern Africa.

Progress

Phase IV of the project was carried out between February and June 2008. The work was mostly concentrated in South Africa and Namibia, with a few sites in Botswana. The aim of this final phase was to extend profiles in order to augment data that had been previously collected. Measurements were taken In Namibia at 72 sites, in Botswana at 39 sites and in the Limpopo Province at 11 sites.

The involvement of the CGS in Phase IV of the SAMTEX project included field work and the supply of vehicles and logistics. The CGS was not involved in any processing or interpretation of the data collected in this last phase.

Conclusions

The field work of the basic SAMTEX experiment is complete after six years and four field seasons. The SAMTEX experiment will now continue with the processing of the data to refine the results and to improve the interpretation of the data.

The experiment proved that the Kaapvaal Craton is indeed the oldest surviving continent, and is well developed up to a depth of at least 250 km. The SAMTEX field experiment was possible owing to the collaboration of a large number of international and local academic, government and industry partners.

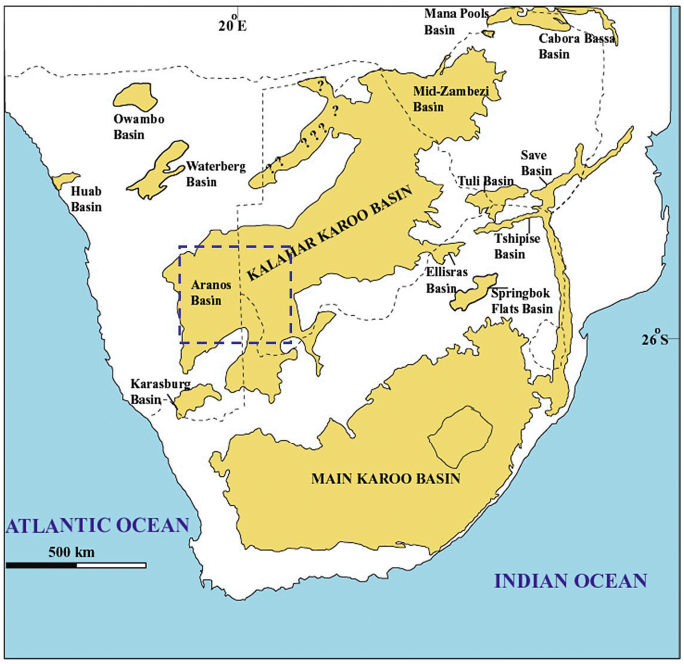
2006-5624 **TRI-NATIONS KAROO BASIN CORRELATION PROJECT**

Project leader: J. Neveling, Ph.D.
Project team: J. Maseko, B.Sc.Hons, V. Nxumalo, B.Sc.Hons, S. Ndengu, B.Sc.Hons (all of CGS), B.N. Modie, Ph.D., T. Segwabe, B.Sc. (Botswana Department of Geological Survey).
Primary objective: *to investigate and correlate the sedimentary rocks in the Karoo basins of South Africa, Botswana and Namibia.*
Duration: 2006/7 to 2008/9.
Budget: R213 000.

Motivation

This project is a continuation of an earlier statutory project (0903) and supports the DST's efforts to stimulate research collaboration in the SADC region.

South Africa, Namibia and Botswana face similar socio-economic challenges, and all three countries are underlain in part by the Karoo sequence which is strategically important as it contains the region's coal deposits and is the primary source of electricity for South Africa and its neighbours. Surprisingly few detailed studies have investigated the development of the various basins containing Karoo rocks in the wider region. The purpose of the collaborative tri-nations study is to investigate the distribution of mineral resources (especially coal), to strengthen the scientific ties between participating countries and to develop regional scientific capacity.



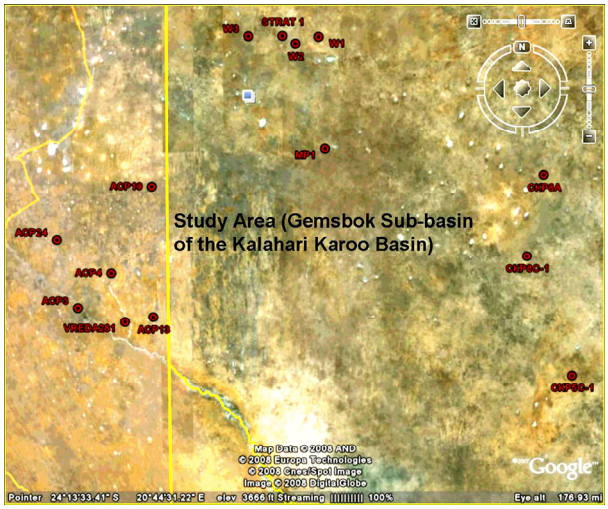
This collaborative project requires participation by the geological surveys of the three countries involved, aiming to build regional skills capacity amongst young scientists. The research focusses on the strata and tectonic evolution of the Kalahari-Karoo Basin, a structure which extends from southeastern Namibia, through central Botswana into Zimbabwe and the northwestern regions of South Africa.

Progress

T. Segwabe of the Botswana Department of Geological Survey (BDGS) researched the mineral potential of the northern belt and southeast–central sub-basins of the Kalahari-Karoo Basin, focussing on coal and coalbed methane. This research complies with the statutory objectives of the BDGS and is also the topic of Segwabe's M.Sc. research project at Rhodes University. During the year Segwabe completed this investigation and submitted his M.Sc. thesis. It was accepted by the reviewer and Segwabe will graduate in April 2009.

V. Nxumalo was appointed to research the tectonic history of the southern potion of the Kalahari-Karoo Basin, under supervision of the project leader, as a replacement for J. Maseko who resigned. Nxumalo's research focusses on the geology, internal correlation and tectonics of the Gemsbok Sub-Basin, on the western extremity of the Kalahari-Karoo Basin, and the Aranos Basin of Namibia. This project forms the basis for an M.Sc. degree at the University of the Witwatersrand. Progress has been good and Nxumalo completed the bulk of her literature research on the stratigraphy of the Karoo Basins of southern Africa, depositional systems, provenance and tectonic development of the Kalahari-Karoo Basin. She visited the BDGS's premises at Lobatse and Kang, and the Geological Survey of Namibia (GSN), to collect literature and borehole data. A synthesis of borehole logs, lithostratigraphic data, lithofacies, geochemistry and petrography of the sandstones and depositional environments is in progress. Sandstone samples from southwestern Botswana have been submitted for XRD analysis, and the production of thin and polished sections for mineral identification is underway. Preliminary stratigraphic borehole logs have been drawn up, and stratigraphic subdivisions are being analysed.

The GSN has been unable to assign a geologist to this project since 2007 owing to personnel constraints.



Map of the study area

Two papers and a poster were presented at the international conference of the American Association for Petroleum Geologists that was held in Cape Town between 26 and 29 October 2008.

Conclusions

The first of two research projects have now been completed, and the second is progressing well.

Future activities

During the coming year the project will focus on the completion of the research. Most of the data have been collected and may be augmented by a field-mapping trip to the Aranos Basin in Namibia to compare outcrop geology with borehole data and to collect additional sedimentological data, especially palaeocurrent data.

CENTRAL MAPPING UNIT

2007-0605 **GEOLOGICAL MAP AND EXPLANATION OF THE 1:50 000-SCALE SHEET 2528CD RIETVLEI DAM**

Project leader: B.A. Ingram, M.Sc.
Primary objective: *to compile a geological map and explanation for the 1:50 000-scale sheet 2528CD Rietvlei Dam.*
Duration: 2007/8 to 2008/9.

Motivation

Previous 1:50 000-scale mapping had been published in 1973 as part of the 1:50 000-scale geological series. Subsequent urban development and sterilisation of deposits created a need for higher resolution maps to assist in development and resource management. The CGS produces detailed geological maps and explanations of rapidly developing parts of South Africa and this is a last window of opportunity to record surface geology in areas of rapid urbanisation, as well as to add value to the 1973 edition of the 1:50 000-scale geological map series. The new map will be available to the general public, town planners and developers, and will inspire derivative products, such as maps on construction materials, dolomite studies and engineering geology.

The development of sinkholes and dolines on land underlain by dolomite is exacerbated by the artificial lowering of the water table and it is thought that the incidence of sinkhole development is related to the rate at which the water table is lowered. The formation of sinkholes is a risk because the dolomite forms a generally flat terrain and the dolomitic area is well developed. Several new sinkholes have been shown on the map, and the mapping project has delineated areas where sinkholes are likely to develop.

Economically important commodities, including dolomite, limestone, quartzite (silica and aggregate), clay and groundwater, are found in this area.

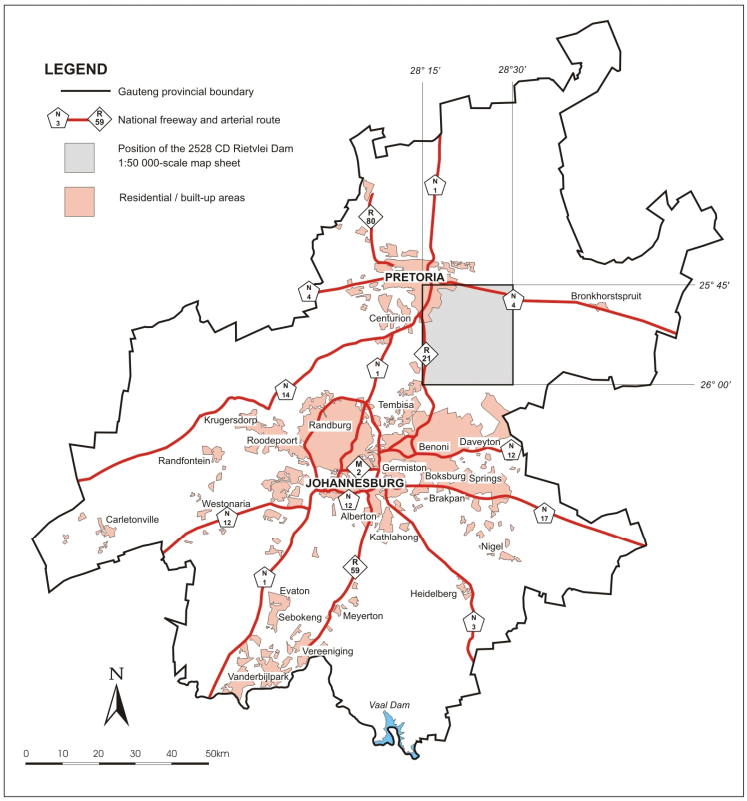
Progress

The 1:50 000-scale map 2528CD Rietvlei Dam and its explanation were edited scientifically and are ready for publication.

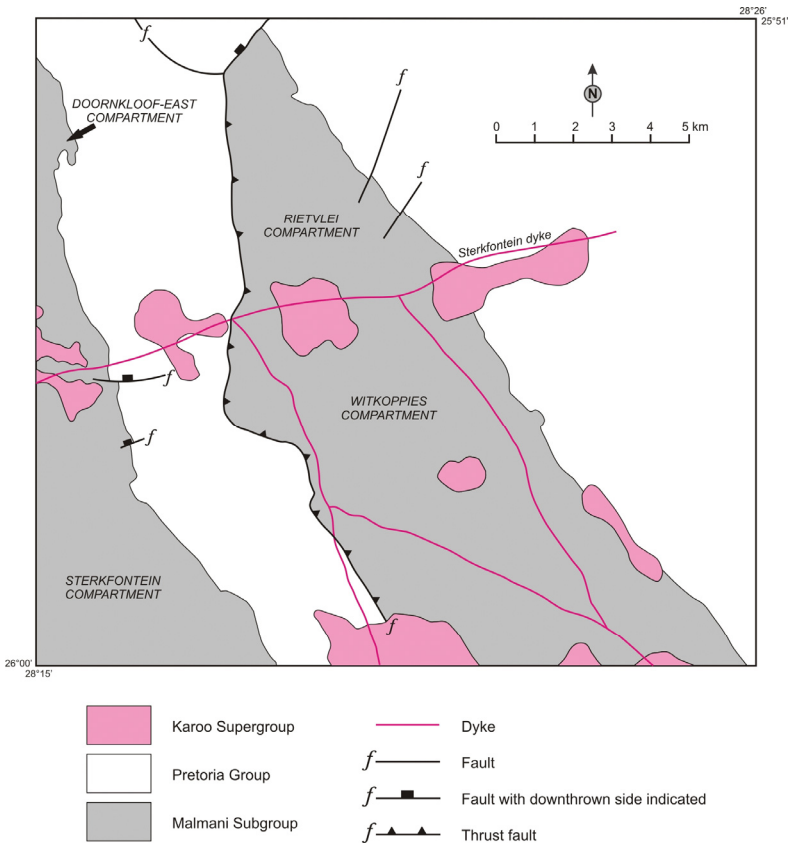
Conclusions

The 2528CD Rietvlei Dam map and explanation have been completed. Mapping was carried out prior to the completion of several new housing and business developments that resulted mainly from population growth.

The area is underlain primarily by the Transvaal Supergroup sedimentary rocks, intruded by diabase sills and dykes during the late Transvaal, and outliers of the Karoo Supergroup deposits. The Chuniespoort Group consists of varying dolomite- and chert-bearing units (the Monte Christo, Lyttelton and Eccles Formations). Chert breccia of the Diepkloof Formation is locally developed on the Chuniespoort Group. Claystone and shale, conglomerate and quartzite of the Rooihoogte Formation unconformably overlie the Chuniespoort Group, while the Timeball Hill Formation – siltstone, claystone, shale and quartzite – overlies the Rooihoogte Formation conformably. The overlying and poorly exposed quartzite of the Boshoek Formation is succeeded by pyroclastic rocks and lava of the Hekpoort Formation. A thin, poorly exposed quartzite layer of the Dwaalheuwel Formation overlies the Hekpoort Formation. The overlying



Locality map of the 2528CD Rietvlei Dam 1:50 000-scale map sheet in relation to the Gauteng Province of South Africa.



Distribution and extent of the dolomite hydrogeological compartments on the 2528CD Rietvlei Dam sheet.

Strubenkop Formation consists primarily of claystone and siltstone and is overlain by quartzite of the Daspoort Formation, which is, in turn, overlain by claystone and siltstone of the Silverton Formation and quartzite of the Magaliesberg Formation.

Karoo Supergroup outliers that include Dwyka Group diamictite and Vryheid Formation shale and sandstone are poorly exposed in the area. Recent deposits of alluvium, colluvium, ferricrete and con-glomerate occur sporadically in the area.

Structural analysis indicates that there was movement along bedding planes and a well-developed foliation record shows extensional deformation. Sinistral shear joints, which are associated with en-echelon tension gashes, have a southwest–northeast strike. Small- scale folding in the Chuniespoort Group and Timeball Hill Formation is mostly symmetrical and gentle to open. Asymmetrical folds trend towards the west. Strike-slip faults have a southwest–northeast strike and are younger than diabase sills. The most striking feature of the area is the duplication of the Pretoria and Chuniespoort Groups. Displacement and duplication of the sedimentary rocks by southwesterly verging thrust faults are the greatest to the east and southeast of Pretoria, where the regional strike curves sharply around the Johannesburg-Pretoria dome. The Chuniespoort Group was thrust onto the Timeball Hill Formation along north-striking thrust faults. The orientations of fold axes and joints, as well as the orientation of the strain ellipse, infer a maximum compression in an east–northeast—west–southwest direction, whereas the maximum extension was in a west–northwest—east–southeast direction.

Volcanic episodes may have originated during periods of tectonic instability, such as intrusion of the abundant sills into the sedimentary rocks prior to the major intrusion of the Bushveld Complex.

The ripple marks, stromatolites and laminations exposed in the sedimentary rocks of the Chuniespoort and Pretoria Groups reflect general features of lacustrine facies, whereas polymict conglomerate, such as the diamictite of the Timeball Hill Formation, reflects glacial deposition. The Hekpoort Formation consists of mud flows and deposits of pyroclastic material that indicate terrestrial volcanism. There is evidence of tidal activity in a low-energy depositional regime and shallow-water environment throughout the Pretoria Group.

Notable economic deposits in the area include aggregate, brick-making materials, coal, dimension stone, iron ore and high-grade silica. Four groundwater compartments, formed in dolomite by intrusive rocks, lie within the study area. Increased water usage from boreholes has resulted in a considerable lowering of the water table in the Rietvlei compartment, which will ultimately lead to accelerated karst formation in the dolomite, illustrated by the appearance of 27 new sinkholes which have been identified in the Rietvlei and Witkoppies compartments.

The Pretoria Group sedimentary rocks had predominantly granitic, sedimentary and possibly ultramafic sources. The geochemical signature of the Pretoria Group rock types is indicative of a divergent tectonic setting, and therefore comparable with a rift tectonic setting. Regional geochemical mapping identified the most important geochemical anomalies; As, Co, Cr, Cu, Fe, Ni, Sc and V being associated with the Timeball Hill, Strubenkop and Silverton Formations, as well as with associated diabase intrusions.

Future activities

GIS and cartographic production of the map, and preparation of the explanation will be carried out in 2009/10, after which these products will be published.

2002-0607/0608 **GEOLOGICAL MAP AND JOINT EXPLANATION OF THE 1:50 000-SCALE SHEETS 2627BD LENASIA AND 2628AV ALBERTON**

Project leader: F. Gabbrielli, Ph.D.
Project team: M.R. Johnson, Ph.D.
Primary objective: *to revise the existing 1:50 000-scale geological maps 2627BD Lenasia and 2628AC Alberton and produce an explanation.*
Duration: 2005/6 to 2006/7.

Motivation

The revision of these maps and production of a joint explanation is part of a greater programme that includes the revision of geological maps and explanations of the 1:50 000-scale maps 2627DB Vereeniging, 2628BA Delmas, 2627BC Westonaria and 2528CC Centurion. This project was undertaken to provide updated information on the geology of the Gauteng Province for all interest parties, including geologists, urban planners, soil scientists and companies intending to prospect in the area. The region has undergone rapid urban and industrial development during the last decades and the provision of updated geological and geotechnical information has become a matter of urgency.

Progress

The Lenasia-Alberton project started in January 2007 but was stopped soon after; it resumed during the course of 2008. It is now in its final phase. The two geological maps and accompanying legends have been finalised and the joint explanation is nearly completed.

Conclusions

Folding in the upper shale unit of the Timeball Hill Formation, Pretoria Group, on the farm Alewynspoort 145 IR south of the Klipriviersberg.

The study area lies to the south of Johannesburg. Whitish, coarse-grained quartzite of the Mondeor Formation, Central Rand Group, occurs in the northern part of the area. Volcanic rocks of the Klipriviersberg Group are exposed along the Klipriviersberg and Suikerbosrant ridges. The Klipriviersberg Group conformably overlies the Central Rand Group and consists of a series of tholeiitic basalt flows that have undergone lower greenschist grade metamorphism. Late Archaean to Proterozoic rocks of the Transvaal Supergroup underlie the greater part of the area, which consists, from the base upwards, of the Black Reef Formation (mainly quartzite), the Chuniespoort Group (dolomite and chert), and the Pretoria Group (shale, sandstone and conglomerate with a prominent andesite unit towards the top). Phanerozoic sedimentary rocks of the Karoo Supergroup are few and scattered, and consist of diamictite and conglomerate of glacial and fluvioglacial origin (Dwyka Group), overlain by marine clastic sediments, mostly shale and sandstone, of the Ecca Group. Intrusive rocks consist of diabase sills, which can be correlated with the Bushveld Complex, syenite dykes of Pilanesberg Complex age, and dolerite dykes and sills of the Karoo Dolerite Suite.

Folding and faulting are extensive in the Transvaal Supergroup rocks and appear to be related to the updoming of the Vredefort Dome, the compressional stresses being generally directed towards the northeast. Large-scale folding and thrusting have affected the Pretoria Group, particularly in the area covered by 1:50 000-scale sheet 2627BD Lenasia, where the succession from the Rooihoogte Formation to the Hekpoort Formation has been repeated at least three times.

Aggregate, crusher sand, brick clay and refractory clay are the only economic deposits in the area.

Future activities

The explanation will be completed and submitted, together with the map, for publication.

2004-0864 **THE TECTONOSTRATIGRAPHY AND SEDIMENTOLOGY OF THE UPPER CHUNIESPOORT GROUP AND LOWER PRETORIA GROUP WITH SPECIAL REFERENCE TO THE FORMATION OF KARST IN GAUTENG**

Project leader: P.J.A. Bosch, M.Sc.
Project team: P. Eriksson, Ph.D. (University of Pretoria).
Primary objective: *to study the tectonostratigraphy and sedimentology of the upper Chuniespoort Group and lower Pretoria Group with special reference to the formation of karst topography in Gauteng.*
Duration: 2005/6 to 2009/10.
Budget: R46 275.

Motivation

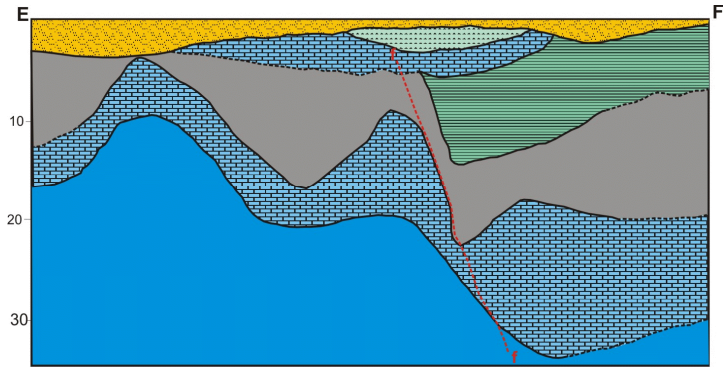
Development on dolomitic land can be hazardous as there is a potential for the development of sinkholes and dolines. An approach which encompasses all geoscience aspects is necessary to understand dolomitic land, and lithostratigraphic units, karst weathering, soil development and geological structures must all be investigated. For this reason, all land underlain by dolomite must to be clearly delineated.

This research project will benefit the scientific community by:

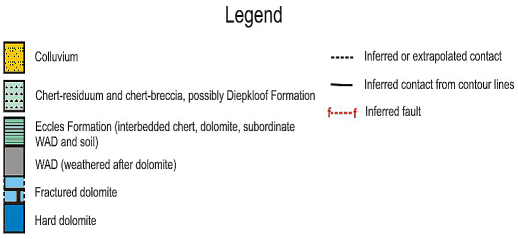
1. increasing the scientific knowledge of this period in Earth's history. This is important internationally, as these strata are not well-developed elsewhere. The period's importance is enhanced by the presence of halite imprints and salt blisters, which contributes to information on oceanic and atmospheric conditions during this period.
2. improving the quality of geological maps of the Transvaal Supergroup basin.
3. assisting in the generation of exploration targets, enhancing economic growth, employment and rural development.
4. contributing to understanding geological structures and lithologies, and aiding in the development of models for the prediction of geological hazards, especially sinkholes.

Progress

Work done so far includes drawing profiles through portions of the Rooihoogte Formation, south of Johannesburg. Periods of dolomite exhumation, resulting in karst formation in Gauteng, were documented and a map of dolomitic land in Gauteng (areas where dolomite is less than 100 m from surface) was also developed in conjunction with other CGS staff. Site-specific investigations were carried out along a portion of the Gautrain route; at Cornwall Hill, at Heuweloord, in the Manovani area near Olifantsfontein, at Pierre van Ryneveld Ext. 3 near Pretoria, on Klipriviersval 371 north of Meyerton and on Portion 24 of Droogegrond 380 JR in Centurion.



Cross-section through Portion 24 of the farm Droogegrond 380 JR, compiled from borehole logs and showing previously unnoticed geological structures.



A highlight of this study was the introduction of the holistic approach to the scientific community in a paper delivered at the "Problem Soils in South Africa" conference held at Midrand on 4 November 2008.

Conclusions

The site-specific investigations followed a new approach. The upper limits of formations were identified, and isopach maps and cross-sections were drawn. This information can be used to make better-informed decisions in zoning urban areas. A study involving about 400 surface boreholes in the Olifantsfontein area is underway, and three-dimensional modelling will be carried out with the help of RockWorks14 software. The results will be used with the existing information to compile the final research project report.

From the literature studies and field work it is deduced that dolomite landscapes are complex, owing to variable lithologies, geological structures and various cycles of erosion. Portions of the Chuniespoort Group were possibly exhumed and karst developed prior to the deposition of the Pretoria, Waterberg, Dwyka and Ecca Groups. Exhumation and karst development probably also took place in response to the uplift of southern Africa which caused the African, post-African 1 and post-African 2 erosional land surfaces. These conclusions are supported by the

presence of sinkholes filled with Rooihoogte Formation sediments, Karoo Supergroup sediments, Tertiary cave deposits and modern Terra Rossa soils.

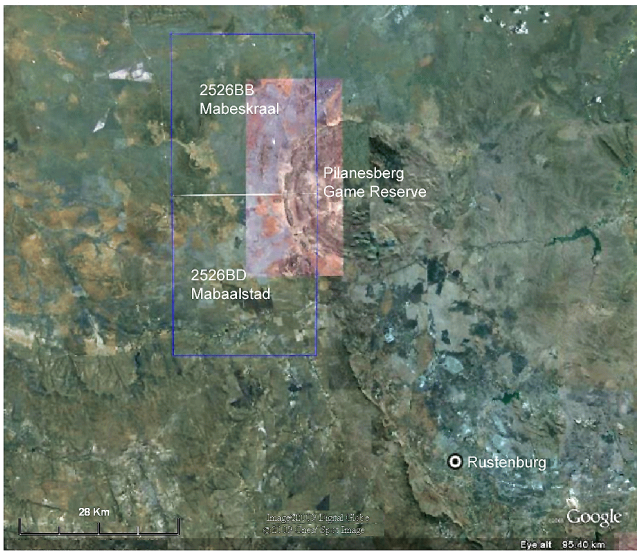
2005-0901 **1:50 000-SCALE REGIONAL MAPPING OF THE MABESKRAAL AND MABAALSTAD AREAS**

Project leader: R. Shelembe, M.Sc.
Project team: B.A. Ingram, M.Sc., S. Molefe, L. Molonyama, B.Sc.
Primary objective: *to produce an up-to-date 1:50 000-scale geological base map of the 2526BB Mabeskraal and the 2526BD Mabaalstad areas in the North West Province.*
Duration: 2006/7 to 2008/9.
Budget: R800.

Motivation

The Mabeskraal–Mabaalstad project fulfils the statutory mandate of the CGS and will contribute to geoscientific knowledge which will encourage rural development, innovation, skills development and alleviation of poverty. The CGS is engaged in exploration and target generation for commodities such as those found in the map area.

The assessment of mineral potential, development and application of an exploration model for the commodities hosted by the Bushveld Complex in the Mabeskraal and Mabaalstad map areas, as well as various data resources, such as satellite imagery, regional geochemistry, PGE analyses and geophysics, will also impact on the outcome from this project.



Location of the Mabeskraal/Mabaalstad map area (blue box).

Progress

The following work has been completed:

Field work and geological sample collection for both areas have been completed, and petrographic studies have been undertaken. Two borehole cores from the Mabeskraal area have been logged, and geochemical data have been analysed. Draft 1:50 000-scale maps 2526BB Mabeskraal and 2526BD Mabaalstad have been produced and a geological explanation has been compiled.

Crack-like microbial algal mats in the Magaliesberg Quartzite in the Mabeskraal area.

Conclusions

Petrographic studies of the Pretoria Group rocks in the Mabeskraal and Mabaalstad areas have shown that metamorphic conditions that prevailed during the emplacement of the Bushveld intrusion ranged from low to high temperature and at a low pressure. This is in contrast to assumptions by some scientists that the Transvaal Supergroup was subjected to low-grade metamorphism. Some of the hornfelses are exclusive to either the Mabeskraal or Mabaalstad areas showing the heat distribution at the time of metamorphism.

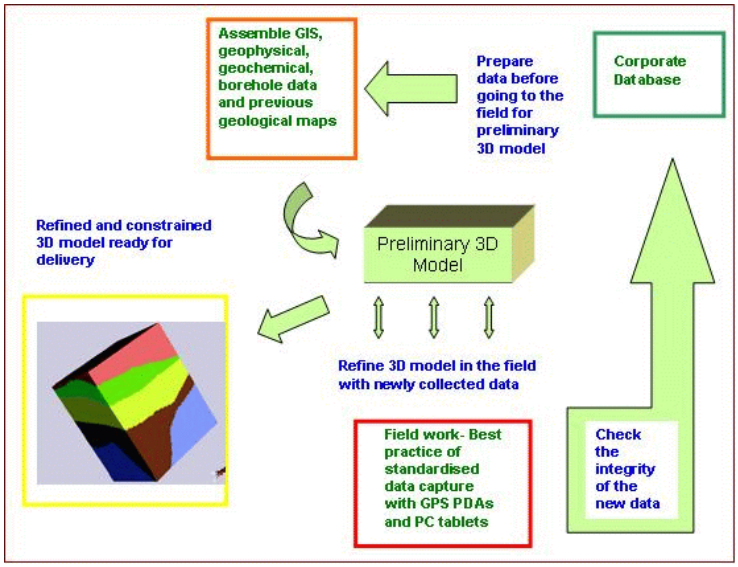
The Bushveld-related sills played some role in metamorphism and have also been uralitised themselves by the main Bushveld intrusion. Some of the sills are contemporaneous with the Bushveld Complex. In this project, studies for target generation were assisted by regional geochemistry, geophysics, PGE analyses and geological mapping.

Future activities

Activities envisaged include technical editing and publishing of a manuscript.

2008-0994 **THE INTEGRATION OF 3-DIMENSIONAL MODELLING INTO REGIONAL GEOLOGICAL MAPPING**

Project leader: R. Shelembe, M.Sc.
Primary objective: *to i) integrate 3-dimensional modelling in regional geological mapping, and ii) evaluate 3-dimensional modelling software.*
Duration: 2007/2008 to 2009/2010.
Budget: R26 180.



Examples of data used for 3D model building.

Motivation

The CGS aims at increasing technological application in the earth sciences, and one objective is the production of 3-dimensional geological models for various parts of South Africa. Innovation and skills development are some of the CGS's other objectives. Young scientists must also be trained in al the various disciplines. This project will contribute to enhancing knowledge and 3D-model understanding by scientists of the CGS.

This project involves use of the 1:50 000-scale 2526BB Mabeskraal map sheet as a test area for 3-dimensional modelling, so that the geology and structure of the area will be better understood.

An inherent objective is stimulation and broadening of scientific knowledge using virtual reality, innovation and skills development, as well as formulating a best practice for standardised data collection. Three-dimensional modelling will be a tool used to 'view' and understand how geological entities vary spatially so as to investigate the completed geological subsurface framework.

Progress

In the period of April 2008 to March 2009 the GOCAD Suite 2.5.2 modelling software was evaluated and a report produced. GOCAD, like other similar software packages, requires preparation and loading of data from the study area in specific file formats. This software, which requires intense training, was found to create models allowing the user to change the model as desired. Many of the functions of GOCAD are suitable for mines. The evaluation reported on all functionalities of GOCAD, as well as their advantages and disadvantages.

The BGS was visited with the aim of initiating co-operation on 3D modelling. The 2nd International Geological Survey Investigation 3D (GSI3D) conference was attended, where case studies on the use of GSI3D were presented. A strategy report on optimal implementation of best practices for standardising data collection and project products, as well as skills development, was produced.

Conclusions

Three-dimensional modelling will assist in viewing and investigating the complete subsurface geology, which is normally concealed. The 3-dimensional modelling tool can also be used for decision making for geological problems.

Future activities

In the strategy, survival and continuity plans, integration of 3D-modelling into geological mapping is envisaged. The CGS will have to form associations with universities and other geological surveys outside South Africa in order for CGS staff to acquire intensive 3D-modelling skills. The strategy will not only involve the building of attribute 3D (that can be transformed into 4D models adding the element of time) geological models as standard products, various types of corporate data created in various studies in CGS business unit will be used.

2008-0998 **THE PALAEOPROTEROZOIC TRANSVAALIDE THRUST-AND-FOLD BELT IN THE PRETORIA AND CHUNIESPOORT GROUPS**

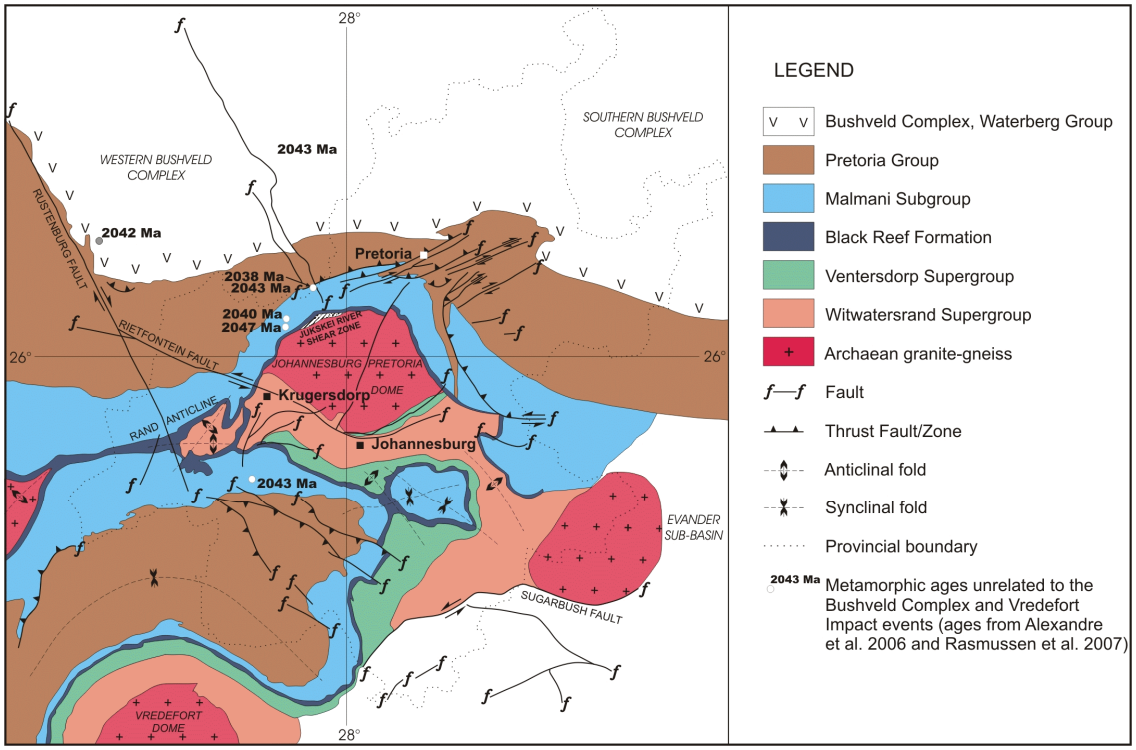
Project leader: B.A. Ingram, M.Sc.
Project team: M.A.G. Andreoli, Ph.D., R.L. Gibson, Ph.D. (supervisors).
Primary objective: *to study the tectonic history of the Pretoria and Chuniespoort Groups from the intrusion of the Bushveld Complex to the Vredefort meteorite impact, and the structural implications for dolomitic hazard areas.*
Duration: 2008/9 to 20011/12.
Budget: R118 730.

Motivation

This project aims to study the deformation and metamorphism not previously recognised in the upper Transvaal Supergroup rocks situated between the Bushveld Igneous Complex and the Vredefort Impact Structure, while unravelling the tectonic setting and framework of the central parts of the Kaapvaal Craton during the Palaeoproterozoic. If a structural model could be developed from the study of the Transvaalide belt for the dolomitic areas in northern Gauteng, it will assist in reducing the risk in housing development on these areas. A study of the structural history will improve the understanding of the control and location of economically important minerals hosted in geological structures attributed to the Transvaalide Orogeny.

Progress

A visit was made to a water pipe trench, about 8,5 km south-southeast of the Hartbeespoort Dam, from north of the N4 to Witwatersberg, Saartjiesnek in the Pretoria Group rocks. The geology comprises basaltic andesite, siltstone, claystone and quartzite of the lower to middle Pretoria Group and diabase intrusions. The rocks dip 15–25° to the west-northwest. The Witwatersberg consists of predominantly arenaceous rocks of the Strubenkop and Daspoort Formations and is oriented east-northeast—west-southwest following the strike of the more resistant beds. A large sinistral strike-slip fault, striking southeast, is best expressed at Saartjiesnek, where it displaces the more resistant Strubenkop and Daspoort Formations. Six samples were collected from this area for thin-section studies. The trench for the pipeline exposed the massive basaltic andesite and pyroclastics of the Hekpoort Formation. At a depth of 3 m the rocks are more weathered than expected.



Simplified geological map showing the most important structural features in the study area as well as metamorphic ages related to the Transvaalide orogenic event.

Several apparent folds with subhorizontal axial planes were seen in the walls of the trench through the Hekpoort andesite. Two main joint sets cross-cut the apparent folds: vertical-subvertical and horizontal-subhorizontal. The folded layers appear to have a consistent thickness. It is uncertain whether the folds are structural features formed by deformation or caused by normal weathering processes associated with corestones.

The rarely seen contact of the upper Boshoek Formation quartzite with the overlying Hekpoort Formation andesite is exposed in the pipeline trench. This contact is usually well weathered and can only be seen in road cuttings and trenches. The contact varies from straight to wavy and probably reflects an uneven surface formed during weathering or glacial activity prior to the extrusion of the lava. Although this unconformity is poorly studied in the Transvaal Basin, researchers have suggested that the glacial activity which deposited the Makganyane and Boshoek diamictites occurred at ca. 2 320–2 210 Ma. This period overlaps with the 2 225 ± 3 Ma age of the overlying Hekpoort Formation and 2 316 ± 7 Ma age of the underlying Timeball Hill Formation.

Dislocation features are only present in interbedded siltstone and claystone layers of the Strubenkop Formation in the Witwatersberg area. A possible fault is manifested by interruption of the overlying beds (dipping 37° to the west) by broken and sheared rocks and a change in the dip angle of the underlying beds (dipping 31° to the west). The fault, which dips 39° to the east-northeast, has a dip direction opposite to and an apparent opposite direction of displacement to the normal throw of the large sinistral strike-slip fault in Saartjiesnek. This low-angle thrust fault may be related to the deformation attributed to the intrusion of the Bushveld Complex.

A small normal fault in the upper Strubenkop Formation dips southwest at 52°. The interbedded siltstone and claystone layers dip 20° to the north-northwest. The relative movement of a displaced marker bed suggests a normal fault with an apparent displacement in the trench wall of about 50 cm. This small fault dips in the same direction and has a similar direction of displacement as the normal throw of the large sinistral strike-slip fault in Saartjiesnek. It could be postulated that the small fault represents a smaller splay (branch) fault or is part of a fault zone related to the Saartjiesnek fault. The sinistral movement and normal throw of the smaller, as well as larger, fault suggest extensional tectonics that probably is not related to the intrusion of the Bushveld Complex.

Concretions that were formed during deposition or by early diagenesis or metamorphism are seen in interbedded siltstone and claystone layers of the upper Strubenkop Formation. The concretions appear to be concentrated in pelitic layers, and are up to 8 mm long, 5 mm wide and 2 mm thick.

The disk-shaped and elongate crystals altering to iron-rich minerals are probably cordierite that formed as a result of contact metamorphism caused by the intrusion of a large diabase body about 100 m to the northwest of the outcrop. These disc-shaped, partly iron-enriched features are confined only to pelitic beds, which may suggest a preferred sedimentary or early diagenetic origin. The possibility of their being caliche nodules or ferruginous concretions cannot be excluded. Cordierite in low-grade metamorphic rocks is normally blue with a clear crystal structure. Weathering of cordierite should leave a polymorph with an outline of the crystalline structure, so these disc-shaped structures are more likely to be be ferruginous concretions. The two hypotheses will have to be tested with thin sections and XRD analyses.

Open, low-amplitude folds with fold axes parallel to the strike of bedding are seen in the upper Strubenkop Formation. The folding may be related to the Bushveld Complex event or caused by the intrusion of the large diabase about 100 m to the northwest of the outcrop.

Conclusions

The core study area is located between the world's two largest economically important deposits hosted by the Bushveld Complex and the Witwatersrand Supergroup. An improved understanding of the structural geology of the Transvaal Supergroup will benefit and aid in unravelling the structural control of mineralisation in these internationally important deposits, especially as new mines are being planned or developed at ever-increasing depths.

An improved understanding of the Transvaal Basin, its structure, tectonic setting and geological history will help to generate future exploration targets (economic growth and employment, rural development). A comprehension of the geological structures and their correct spatial and temporal distribution will aid in the development of models that can be used in the prediction of geological hazards (e.g. sinkholes, unstable ground and active faults). The characterisation of geological structures and underlying lithology will enable engineering geologists and developers to recognise high-risk areas in the Transvaal Supergroup, which has seen accelerated development over the past 10 years.

Future activities

The first period of the work will focus on the accumulation of data from available sources and the field. The initial focus of the work will be concentrated in a core area from Rustenburg in the west to Delmas in the east. Specific additional target areas around the Transvaal Basin will be identified where more detailed work can be done, especially on the Pretoria Group, to aid in identifying the extent of the fold belt. The field work will be focussed on measurements of geological structures, descriptions of rocks and sampling of structural features in the target areas. Limited revision mapping might be required, and Landsat images will be analysed for structures. The results will be added to a GIS-based database. Orientated geological samples will be taken for petrographical and structural analyses, and perhaps thermobarometry and fluid-inclusion studies. White mica from thrust faults and cleavage planes will be dated to determine ages of deformation.

The second period of the work will be focussed on processing data and writing the text. This period will also be devoted to research where the structural history will be discussed and interpretations with regard to the tectonic environment will be made. It will also include laboratory work and discussions with stakeholders. During this period a dolomitic hazard model related to the structural features will be developed.

2008-1002 **THE ECONOMIC GEOLOGY AND STRATIGRAPHY OF THE AREA COVERED BY 1:50 000-SCALE SHEETS 2526AA NIETVERDIEND AND 2526AB SESOBE**

Project leader: B. Yibas, Ph.D.
Project team: K. Prasad, Ph.D., A. Tessema, Ph.D., S. Molefe.
Project objective: *to i) assess the mineral potential and stratigraphy of the area covered by the 2526AA Nietverdiend and 2526AB Sesobo 1:50 000-scale map areas and produce accurate geological maps as part of the mapping programme of the Rustenburg 1:250 000-scale geological sheet, and ii) identify economic deposits in the Bushveld Complex and the carbonatites of the Ystervarkkop Complex to encourage rural development and support poverty eradication.*
Duration: 2008/9 to 2009/10.
Budget: R44 043.

Motivation

Mineral assessments of selected areas form an integral part of the mineral resource development process. The area under consideration has potential as a source of mineral deposits that could benefit the inhabitants, and the project will build capacity in mineral economics in the CGS.

One of the chromite seams in the bronzite-dunite suite of the Bushveld Complex in the project area.

Progress

The project commenced during 2008/9. A review of all available information in old reports, as well as various remote-sensing data, regional geochemistry and geophysical data sets was undertaken.

The mapping phase of the project commenced early in April 2008 in the Nietverdiend area and progressed well, resulting in 90 per cent completion of the field work, with over 544 observation points, and sufficient rock samples, structural data and photographs being collected.

A LANDSAT TM7 map of the area using CCI (Band 742) aeromagnetic maps and radiometric maps were compiled. Over 142 thin sections were made, 90 samples submitted for XRF and ICP-MS analysis, and results of 70 XRF analyses were received. XRD results of nine special samples from the Goudini carbonatite complex have been obtained.

Conclusions

The project is progressing successfully and the year's target has been exceeded. It is anticipated that by the end of 2009/10 the project will be completed as planned.

Future activities

It is envisaged that by the end of 2009/10 a provisional map and explanation will be completed, as well as a comprehensive project report and maps showing the geology, structure, geochemistry, geophysics and economic geology of the area.

2009-1012 **1:50 000-SCALE REGIONAL MAPPING OF SHEET 2526BC MADIKWE**

Project leader: R. Shelembe, M.Sc.
Project team: S. Molefe, L. Molonyama.
Primary objective: *to i) produce a 1:50 000-scale geological map and explanation of the Madikwe area, and ii) compare the mineralogy of the area with that of the Mabaalstad and Mabeskraal map areas in order to assess the extent and intensity of the metamorphic aureole caused by the intrusion of the Bushveld intrusion.*
Duration: 2007/8 to 2009/10.
Budget: R88 960.

Location of the Madikwe area southwest of the Pilanesberg Complex.

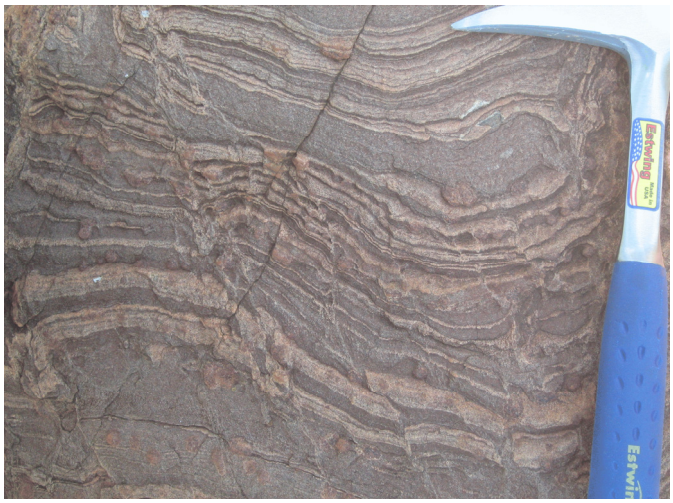
Motivation

The Madikwe map area in the North West Province is situated southwest of the Pilanesberg Complex. Mapping the Madikwe area will complement the mapping of the 2526BB Mabeskraal and 2526BD Mabaalstad areas.

The Magaliesberg, Silverton, Daspoort and Strubenkop Formations of the Pretoria Group make up the greater part of the map area. The strata young to the northeast, which is contrary to the younging direction of the Mabeskraal area owing to the curving of strata around the Bushveld Complex. These formations are comprised of quartzite, hornfels and slate lithologies which are products of metamorphism. An analysis of the effect of the Bushveld Complex on the mineralogy of the area will be of interest, as Madikwe is farther from the Bushveld Complex than the Mabeskraal and Mabaalstad areas.

With urbanisation and agricultural development, land use in the area is rapidly changing, and geological outcrops are being obscured, thus limiting access by geoscientists. It is therefore critical that geological information be acquired to interpret subsurface geological information before these areas are modified by anthropogenic activities. Research into these rocks will assist in determining the relationship between the pyroxenite sills that exist in the area and the Bushveld strata.

East–west-trending lineaments are present in the Madikwe map area. This project will attempt to investigate the origin and relationships of these lineaments, the possibility of a connection to the Thabazimbi-Murchison Lineament, and investigate any related outcrops.


Layered garnet hornfels of the Silverton Formation in the Madikwe area indicating higher temperature metamorphic conditions.

Progress

Field work and geological sample collection have been completed, and a preliminary 1:50 000-scale map has been compiled. Samples were submitted for analysis by XRF and a progress report was completed. Preliminary petrographic work is nearing completion.

Conclusions

Investigations in the Madikwe area will be useful in assessing the extent of the metamorphic aureole and the heat distribution of the Bushveld Complex. The structural lineaments in the area will give insight into its local tectonic influence.

Future activities

Compilation of a detailed geological explanation and refining of the preliminary geological base map are the key future activities.

SOUTH AFRICAN COMMITTEE FOR STRATIGRAPHY (SACS)

2002-0449 SACS PUBLICATIONS

Project leader: M.R. Johnson, Ph.D.
Project team: A. van Heerden, B.A.
Primary objective: *to provide definitive, standardised descriptions of all formally approved lithostratigraphic units recognised in South Africa.*
Duration: Ongoing.

Motivation

The published lithostratigraphic descriptions will constitute an essential source of information on the stratigraphy of southern Africa, thus enabling geologists to correctly identify and map all currently recognised stratigraphic units during field work, and provide basic data for use in reports and publications.

Progress

The status of the publications currently in production is as follows:

SACS Catalogue Volume 10 (containing descriptions of the Cullinan Kimberlite Suite, Dennilton Formation, Ecca Group, Hartenbos Formation, Kuils River Batholith units, Nelshoogte Trondhjemite, Saldanha Batholith units, Terra Nostra Formation and Vaalfontein Suite): in press.
SACS Lithostratigraphic Series No. 50 (Lithostratigraphy of the Msikaba Formation): in press.
SACS Catalogue Volume 14. Four contributions have been received for this volume (Emakwezini Formation, Maputuland Group, Mngazana Formation and Darling Batholith units): most of these are awaiting further inputs from the authors before they can be finalised.
SACS Lithostratigraphic Series No. 51 (Lithostratigraphy of the T'hammaberg Formation, Bushmanland Group): text and figures were finalised after additional inputs were received from the authors.

Future activities

Further lithostratigrapc units will be formally described.

2002-0473 SACS DATABASE

Project leader: M.R. Johnson, Ph.D.
Project team: S. Tucker, Dip.S.B.M.
Primary objective: *to store basic information on stratigraphic units recommended for use on maps, and in reports and publications of the CGS.*
Duration: Ongoing.
Budget: Included in the GEODE budget.

Motivation

It is necessary that standard names and map labels are used on geological maps, as well as in reports and publications by CGS geologists and, as far as possible, by the rest of the geological community as well.

Progress

During the year three lithostratigraphic units were added to the database and one was deleted. The publication status of the various units was updated and a number of minor errors corrected. The summary table posted on the internet was replaced with the most recent version. A total of 1 514 recommended names are now contained in the database.

Future activities

This project is ongoing.

1999-0519 **SACS SECRETARIAL FUNCTIONS, INCLUDING MEETINGS AND FIELD TRIPS**

Project leader: M.R. Johnson, Ph.D.
Project team: P.K. Zawada, Ph.D., N. Keyser, M.Sc., G.A. Botha, Ph.D., J.S.V. Reddering, Ph.D., P.H. Macey, Ph.D., C.H. de Beer, M.Sc., H.P. Siegfried, Ph.D., L. Chevallier, Ph.D., D.I. Cole, Ph.D., D.L. Roberts, Ph.D., J.H.A. Viljoen, Ph.D., A.L.D. Agenbacht, M.Sc., G. Brandl, Ph.D., N. Baglow, M.Sc., P.J.A. Bosch, M.Sc., G.S. de Kock, Ph.D., J. Neveling, Ph.D.
Primary objective: *to make recommendations concerning stratigraphic classification and nomenclature in South Africa and the formal approval of new units by organising and attending meetings and field trips, as well as refereeing and editing manuscripts submitted publication.*
Duration: Ongoing.

Motivation

The Geological Survey of South Africa and its successor, the CGS, have provided logistical and financial support for the activities of SACS, as all stratigraphic names used by the geoscience community (including CGS maps, reports and publications) should conform to the South African Code of Stratigraphic Terminology and Nomenclature.

As an organisational member of the ISSC (International Subcommission for Stratigraphic Classification), SACS also makes an input and receives feedback concerning stratigraphic terminology at an international level.

Progress

The Task Group for the Cape Granite Suite held a meeting and field trip in September 2008. ISSC Newsletters and Circulars received were studied, and responded to where appropriate.

The legends of all the 1:250 000- and 1:50 000-scale maps currently being produced by the CGS, as well as some of the accompanying explanations, were edited and checked for stratigraphic correctness. In some cases errors and inconsistencies on the maps themselves were noted and brought to the attention of the cartographers.

Future activities

This project is ongoing.

2004-0879 **1:2 000 000-SCALE LITHOSTRATIGRAPHIC MAP OF SOUTH AFRICA**

Project leader: M.R. Johnson, Ph.D.
Project team: C. Thomas, Nat.Dip.Cart.
Primary objective: *to produce a 1:2 000 000-scale map showing the distribution of rocks falling within 70 major lithostratigraphic groupings.*
Duration: 2003/4 to 2008/9.

Motivation

A simplified 1:2 000 000-scale lithostratigraphic map will be an essential part of the CGS's publications on the geology of South Africa and will be a basic tool in geological education, complementing the published 1:1 000 000-scale geological map. Being half the size and much less expensive to purchase, this map should prove particularly attractive not only to students, but to all those who cannot afford or who do not have the space for the much larger 1:1 000 000-scale wall map.

Progress

Final printing of the map should take place in the near future.

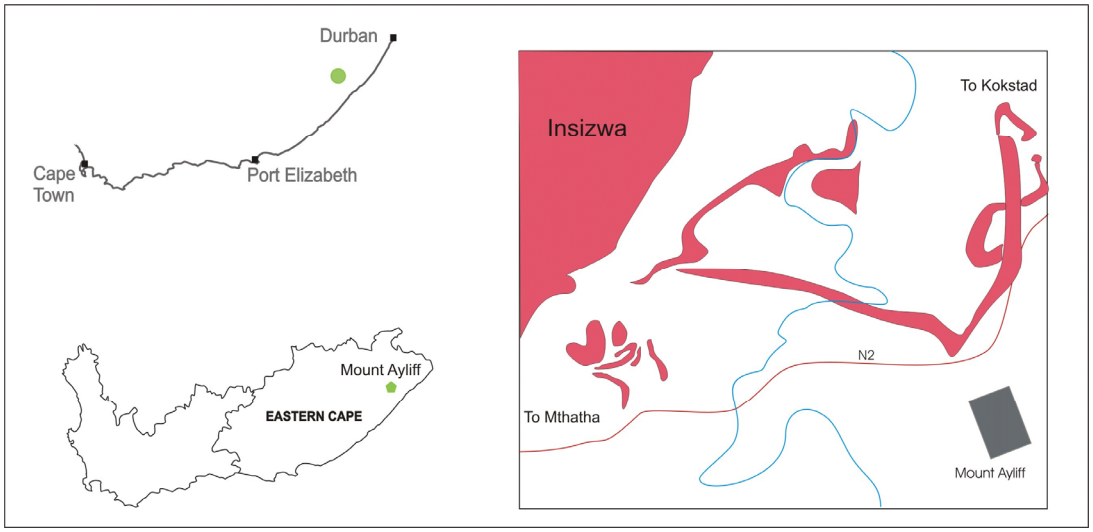
Future activities

This project is now complete.

EASTERN CAPE

2008-1041 **REGOLITH WEATHERING PROFILES IN THE INSIZWA AREA: IMPLICATIONS FOR THE IDENTIFICATION OF MINERAL DEPOSITS**

Project leader: V.R. Mitha, M.Sc.
Primary objective: *to identify physical, geochemical and mineralogical changes that occur in the regolith and how these changes affect the surface expression of mineralisation.*
Duration: 2008/9.
Budget: R30 900.



Motivation

The Jurassic Insizwa Complex is a well-known group of differentiated mineralised intrusions lying between Tabankulu and Kokstad. At Mount Ayliff geochemical and mineralogical indicators show the existence of mineralisation and although the intrusion has been extensively drilled and studied, regolith studies have not been attempted.
The regolith is unconsolidated or secondarily re-cemented cover overlying more coherent bedrock which has formed through the actions of weathering, erosion, sediment transport and deposition. These materials generally obscure the bedrock, but retain some mineralogical and geochemical characteristics that can be used to identify hidden mineral deposits.

Regolith mass flow deposits in the Insizwa area.

The project is aimed at identifying the physical, geochemical and mineralogical changes that influence the surface expression of potential mineralisation. At present, these factors are poorly understood in the southern African context. This research aims to provide context-specific techniques and models that can be used during exploration for economically mineralised intrusions elsewhere in the region which could provide a significant economic boost for this economically underdeveloped region of the Eastern Cape Province. The geoscientific information derived from regolith description and characterisation will also be useful to developers and local, provincial and national government land-use planning agencies.

Progress

The initial field work phase was completed and highlighted a range of regolith types in the area. Gully erosion of regolith profiles is responsible for the high drainage density in the Insizwa area and leads to truncation or localised burial of regolith profiles.

Several regolith profiles were sampled with the aim of identifying vertical geochemical variation in the unconsolidated materials covering the sedimentary country rock and dolerite intrusive rocks. Samples were sent for geochemical analysis and the results are not yet available for review.

Conclusions

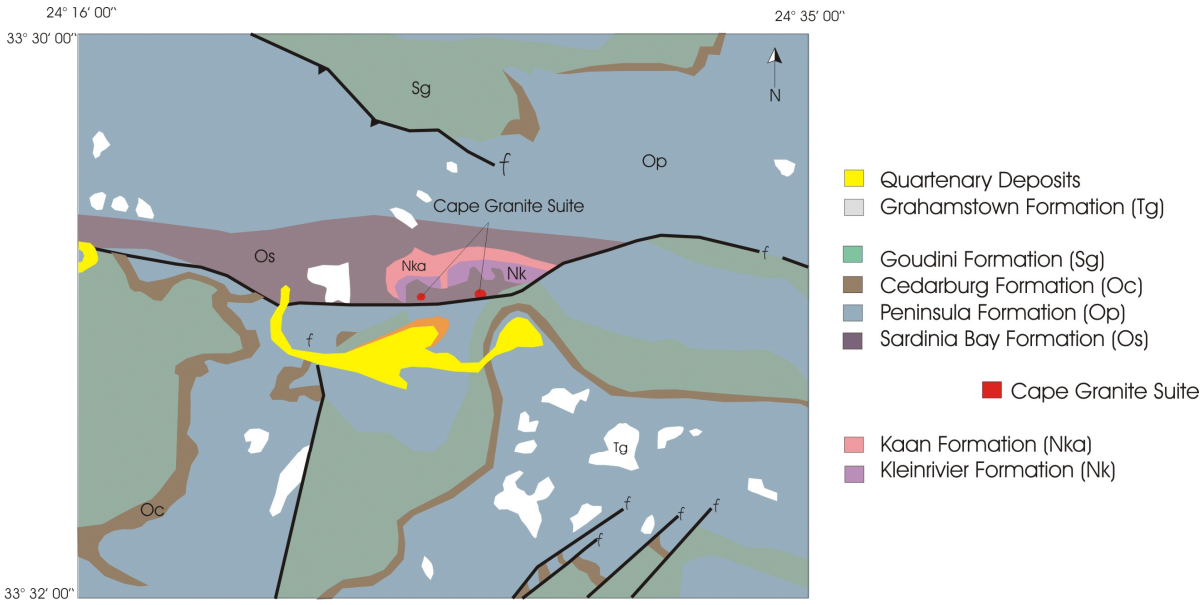
Initial investigations have identified a range of regolith characteristics in the foothill areas around the Insizwa Complex that will fundamentally influence the mineral exploration methodology used in this erosional regolith regime.

Future activities

There is considerable potential to expand regolith studies to include all major mineralised zones across a range of terrain morphological and climatic regimes. The mapping of regolith profiles, characterisation of unconsolidated sedimentary and pedogenic cover, and an enhanced understanding of mineral tracer-element geochemistry under different environmental conditions is critical for the success of regional mineral exploration programmes.

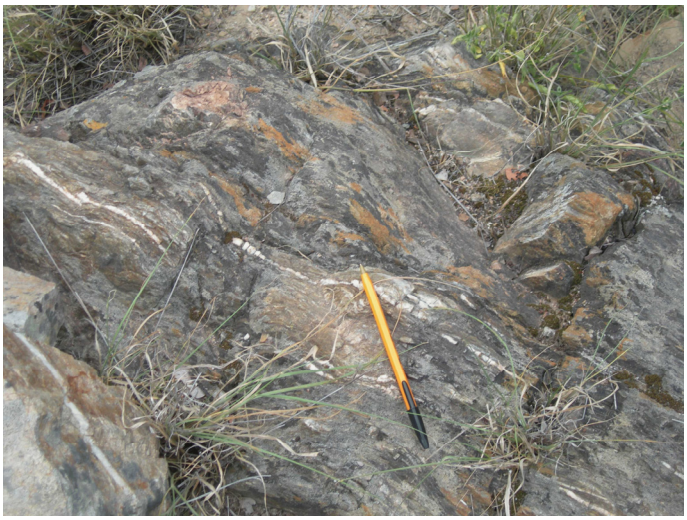
2009-1042 **AN INVESTIGATION INTO THE BASEMENT ROCKS UNDERLYING THE TABLE MOUNTAIN GROUP IN THE EASTERN CAPE**

Project leader: D.E. Black, B.Sc.Hons.
Primary objective: *to research the basement underlying the Table Mountain Group and the granites of the Eastern Cape.*
Duration: 2008/9.
Budget: 2008/9: R31 900.



Motivation

This petrological investigation aims to confirm the presence of granitic intrusions that have been mapped in the Baviaanskloof area (sheet 3324 BA). The presence of granitic rocks within this area may have structural implications for the existence of the minor exposure of basement material in the Sardinia Bay and Schoenmakerskop areas near Port Elizabeth. The findings will influence the understanding of structural fabrics and suboutcrop patterns within the Gamtoos Fault zone.



Outcrop of rock previously mapped as granite in the Baviaanskloof area showing strong structural fabric.

Progress

An aerial photograph interpretation of the area was conducted and satellite imagery has been assessed. Existing geological map data and the geological literature concerning this subject have been compiled and will be used to classify the basement rock exposures.

The field-work phase has been completed. Although two previously mapped occurrences are depicted on maps of the area, only one of these outcrops could be located. The extent of this site was mapped and the alleged granitic rock sampled for geochemical analysis. The 'granitic' rock exposed is highly weathered and has a strong schistose fabric. The contact with the surrounding country rock is highly metamorphosed. Samples have been submitted for geochemical analysis and thin sections have been prepared for petrographic investigations.

Future activities

The results of analyses of samples by XRF will be studied, and thin sections which have been prepared will be examined.

2007-0980 **GEOLOGICAL MAP AND EXPLANATION OF 1:50 000-SCALE SHEET 3129BD & 3130AC MKAMBATHI AND PART OF SHEET 3129BB KANYAYO**

Project leader:	J.S.V. Reddering, Ph.D.
Project team:	V. Mitha, M.Sc., D. Kilian, B.Sc.Hons, D. Black, B.Sc.Hons.
Primary objective:	*to undertake detailed geological mapping of the 1:50 000-scale map covering the Eastern Cape coastal zone between Mboyti and Mtentu.*
Duration:	2007/8 to 2008/9.
Budget:	2008/9: R26 121.

The Mlambomkulu Falls at the eastern end of Waterfall Bluff discharges directly into the sea. The cliffs are formed by undercutting of bedrock jointed parallel to the sea maintaining the vertical cliff profile. At the coast this is called a 'bluff'. The flat surface at the top of the cliff is the 'post-African I' surface, a post-Micene erosion surface. The river was unable to cut down to sea level through the hard quartzite of the Msikaba Formation and its valley lies about halfway up the cliff. This is one of three falls discharging straight into the sea in the northeastern Wild Coast, and one of only about 10 worldwide.

Motivation

The regional mapping programme adopted by the Eastern Cape Unit has focussed on the densely populated coastal zone where many rapidly developing urban and tourist nodes are located. These areas generally have a high incidence of poverty and poor infrastructure development. The mapping project will link with areas to the south that have already been mapped in detail and provide continuity between geological mapping and research activities in the Eastern Cape and KwaZulu-Natal Units.

The mapping project aims to improve the precision of the existing map and to apply the latest lithostratigraphic subdivisions to the area.

Progress

Most of the area was mapped during the previous financial year, but limited access in remote areas and the lack of accommodation in the area forced the mapping programme to be extended. The focus was on addressing geological contact relationships in problem areas and compiling the comprehensive map explanation.

Conclusions

The mapping and map explanation have been completed. The mapping has provided additional detail and revealed the occurrence of dolerite sills. A detailed lineament analysis has been conducted to aid groundwater exploration and development in this rural area.

Future activities

The map and explanation will be published. There is potential for the development of geoscience information at a popular level that can support school and tourist education.

2008-0950 **LATE QUATERNARY REACTIVATION OF THE KANGO FAULT – PALAEOSEISMIC TRENCH RESULTS**

Project leader:	M.L. Goedhart, M.Sc.
Project team:	M. Roos, Nat.H.Dip.Cart., C. Dondo, B.Sc.Hons, J. Engelbrecht, M.Sc., V. Midzi, Ph.D., C.J.S. Fourie, Ph.D. (CSIR), Z. Jacobs, Ph.D. (Wollongong University, Australia), P.W.K. Booth, R.W. Shone, Ph.D. (Nelson Mandela Metropolitan University).
Primary objective:	*to investigate the neotectonic reactivation of the Kango fault using Optically Stimulated Luminescence dating techniques.*
Duration:	2008/9.
Budget:	R12 400.

Motivation

The perception that South Africa is a stable intraplate region having infrequent or rare earthquakes is based on a relatively short 350 year historical and instrumental record of seismic events. The recurrence interval of large, surface-rupturing earthquakes in intraplate regions causing extensive damage may be in the order of 100 000 to 150 000 years. The existing seismic record used for regional hazard assessment may not record such large, significant events. To correct this imbalance the CGS embarked on a review of the country's seismic hazard to include, for the first time, palaeoseismic data, which is data from pre-historic earthquakes, but measuring the location, timing and magnitude of earthquakes before historic records of individual seismic events is a difficult and time-consuming task. The best precision can be achieved through stringent geological investigation along major zones of crustal weakness in order to target sites of past surface rupture related to palaeoseismic events.

Progress

Research findings from the first trench excavated across the Kango fault line have been the subject of intense scrutiny by local geoscientists and the international palaeoseismicity community. Results have been presented at the International Association of Seismology and Physics of the Earth's Interior (IASPEI 2009) assembly in Cape Town. The methodology and conclusions have also been presented to a select group of international experts, who have visited the fault zone and trench site.

The trench wall profiles have contributed to the logic-tree approach towards the revised probabilistic seismic hazard assessment being conducted for the region. Remote sensing is being used to assess the potential regional uplift (isostatic rebound) of the region. Collaboration with local and overseas universities has been developed to research structures beneath the trench floor, and particularly to date the sediments. Assessment of the fault and its association with historical and instrumental seismicity is also underway, with several recent events being tentatively linked to this fault system.

Conclusions

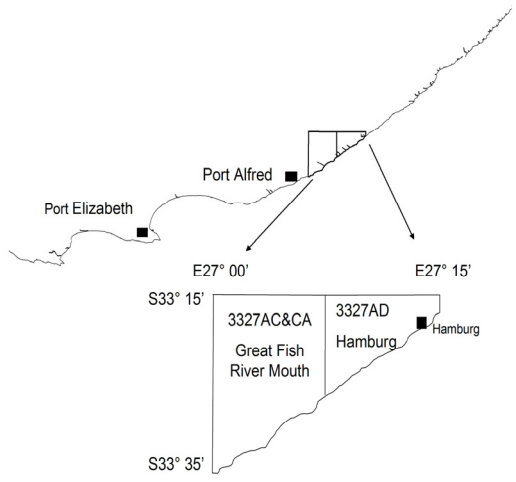
The investigation of this trench excavated across the extensive Kango fault line site has provided a unique view of Quaternary palaeoseismicity in the Eastern Cape region and the southern Cape Fold Belt. The research findings have played a critical role in the assessment of the seismic hazard in the region. This has direct impact on critical infrastructure development in the region, such as harbours, nuclear power plants, oil refineries, dams, bridges, hospitals, schools and tall buildings. Significant capacity building has been achieved within the CGS and international collaboration has yielded highly valuable research.

Future activities

Owing to the encouraging results obtained and the value of this site in providing a precise temporal record of seismicity on this extensive structural feature, this project has been extended by the addition of several new palaeoseismic investigations. Additional resources will fund drilling and additional geophysical investigations aimed at elucidating the oldest palaeoseismic records preserved at the site. These investigations are designed to confirm and define the long-term slip rate for a new probabilistic seismic hazard assessment of the Eastern Cape Fold Belt, a seemingly stable area. New investigations will include several new test pits around the existing trench, and a new trench at a river-bank site farther west. Drilling at the trench site is also planned for the current year to test the depth to bedrock and size of the bedrock scarp. In addition, geophysical tests are planned at both sites, as well as across the fault system at several other localities. Detailed sampling for age-dating purposes, using Carbon-14, OSL and U-isotopes, is also planned at the new excavations, from drill core, and from outcrops along the fault system. Cosmogenic dating is planned for the high-level terraces along the fault trace. Collaboration with both local and overseas universities is integral to this project, and results are being incorporated into hazard assessments of a number of new developments in the greater Port Elizabeth region.

2009-1056 **1:50 000-SCALE GEOLOGICAL MAP 3327AD HAMBURG**

Project leader: J.S.V. Reddering, Ph.D.
Project team: D. Claassen, B.Sc.Hons, D. Black, B.Sc.Hons.
Primary objective: *to produce and publish a geological map for the 1:50 000-scale sheet 3327AD Hamburg.*
Duration: 2008/9.
Budget: R161 000.



Motivation

The map area falls within the Fish River Spatial Development Initiative (SDI) designated by the government as a development zone. The area fills a gap in the revised 1:50 000 geological map coverage of the coastal region between Port Elizabeth and East London. To facilitate rural development it is necessary to revise the geological maps of the area and to identify earth resources, such as construction materials, which are required to support development. An improved understanding of the distribution of Cenozoic deposits is particularly necessary. Apart from identifying potential economic mineral deposits the mapping provided structural data that is essential for groundwater exploration.

The map explanation will be combined with that for the adjacent map 3327AC&CA Fish River Mouth which lies to the west.

Progress

Field work was completed at the end of February 2009. A large number of previously unmapped occurrences of the Alexandria Formation have been identified north of the Keiskamma River, near the villages of KwaViVi and Mazikhanye; south of the river near Hamburg and in the northwest near the village of Tuku. The mapping of Nanaga Formation aeolian deposits is a considerable improvement on previous documentation. Special attention was paid to coastal deposits, with storm deposits and coastal dune formation processes for both the 3327AD Hamburg and 3327AC&CA Great Fish River Mouth maps. Occurrences of thick ferricrete and colluvium were also mapped. The revised map has been compiled, and compilation of the combined 3327AD Hamburg and 3327AC&CA Fish River Mouth explanation is nearing completion.

Conclusions

The mapping has been completed and the consolidation of the new lithostratigraphic nomenclature and detailed descriptions of rock units present has been achieved in the combined map explanation which covers a development node on the Eastern Cape coast.

Future activities

The geological map will form a basis for future geotechnical mapping which will be carried out as urban areas develop.

GEOCHEMISTRY

2008-0968 **REGIONAL GEOCHEMICAL MAPPING**

Project leader: M. Cloete, Ph.D.
Project team: J.H. Elsenbroek, M.Sc., S.W. Strauss, M.Sc., R. Netshitungulwana, B.Sc.Hons, E. Mulovhedzi, B.Sc.Hons, D. van der Walt, B.Sc.Hons, M. Bensid, B.Sc.Hons, S. Hlatshwayo, B.Sc.Hons, M. Maya, B.Sc.Hons.
Primary objective: *to continue the ongoing Regional Geochemical Mapping Programme as a core function of the CGS.*
Duration: Ongoing.
Budget: R10 000 000.

Motivation

The Regional Geochemistry Unit produces regional geochemical maps to complement existing geological information. The aim of the geochemical survey is to create a geochemical database, which will provide information useful for identifying exploration targets for a wide range of commodities, testing exploration models and initiating geological research.

The verification of important anomalies before the data are released to the public is also a prerequisite.

Progress

Sampling was carried out at a sample density of one soil sample per km^2. All the areas were sampled by helicopter-supported transport, although sampling on foot with 4x4 vehicle support was carried out in terrains where the helicopter could not land. Soil samples, approximately 5 kg each, were dry-sieved to extract the -75 micron fraction. This fraction was analysed by the following techniques:

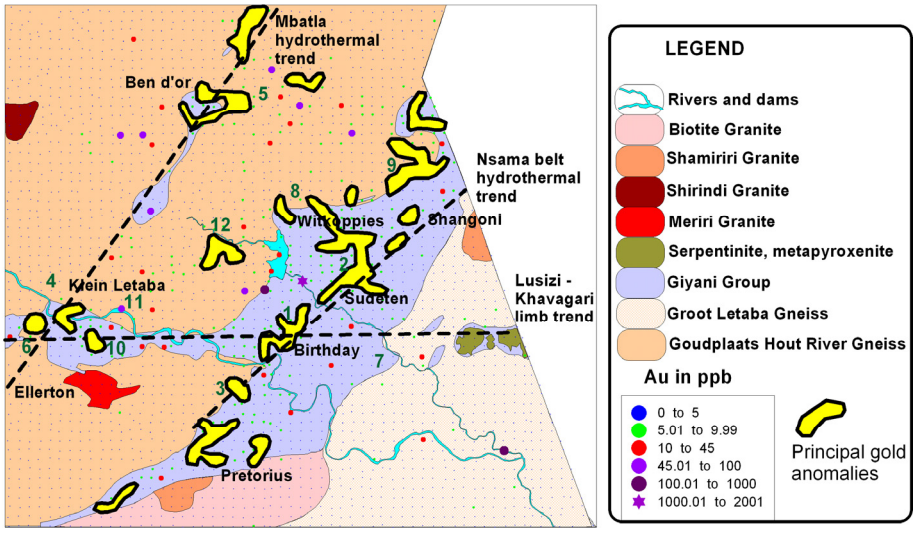
Simultaneous X-Ray Fluorescence Spectrometry (Sim-XRF) for: SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, Ag, As, Ba, Cd, Ce, Co, Cr, Cu, Ga, Hf, La, Mo, Nb, Nd, Ni, Pb, Rb, S, Sb, Sc, Sn, Sr, Ta, Te, Th, U, V, W, Y, Zn and Zr;
DC Arc Emission Spectrography at the Henan Laboratory, People's Republic of China for elements such as: Pt, Pd and gold.

Regional geochemistry of sheet 2430D Bourke's Luck, comprising the 1:50 000-scale sheets 2430DA Mogaba (3OK), 2430DB Bourke's Luck (3OL), 2430DC Origstad (3OO) and 2430DD Graskop (3OP)

The 1:100 000-scale Bourke's Luck data set comprises a comprehensive data set of 2 801 samples. Analyses are in progress.

Regional geochemical sampling of sheet 2430B Hoedspruit comprising the 1:50 000-scale sheets 2430BA Selati River (3OC), 2430BB Mica (3OD), 2430BC Strijdom Tonnel (3OG) and 2430BD Hoedspruit (3OH)

The 1:100 000-scale Hoedspruit data set comprises a comprehensive data set of 2 581 samples. Analyses are in progress.



The geochemical synthesis map for gold. Results based on the geochemical distribution map of gold (DCAES).

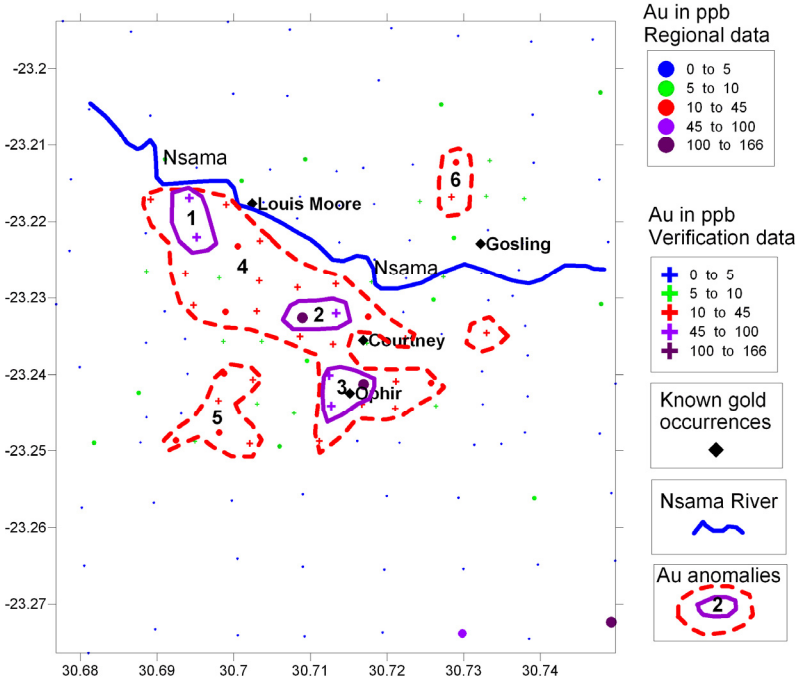
Regional geochemical mapping of sheet 2330D Gravelotte comprising the 1:50 000 map sheets 2330DA La Cotte (3IK), 2330DB KaMakhuva (3IL), 2330DC Gravelotte (3IO) and 2330DD Mulati (3IP), and parts of 2331CA Mahlangeni (3JI) and 2331CC Phalaborwa (3JM)

Analysis of the samples from the 1:100 000-scale Gravelotte sheet is in progress.

Regional geochemical mapping of sheet 2330B Giyani comprising the 1:50 000-scale sheets 2330BA Tlangelane (3IC), 2330BB Shangani (3ID), 2330BC Giyani (3IG) and 2330BD Nsama (3IH)

The regional geochemical mapping of the Giyani sheet was funded by the Medium-Term Expenditure Framework (MTEF).

The Giyani data set consists of 2 725 samples and 98 100 data points. The geochemical data set allowed the investigation of single-element distribution patterns, as well as geochemical synthesis from a geological and exploration point of view. The geological synthesis map showed unique geochemical fingerprints for the various geological domains. Some discrepancies between existing geological units and the geochemical distribution patterns were also identified and remapping is suggested in those areas.



Verification of the Louis Moore gold anomaly on the 1:100 000-scale Giyani sheet.

As gold is an important commodity in greenstone belts, twelve gold anomalies were identified on the Giyani sheet. One of the gold anomalies that was conspicuous was the Louis Moore anomaly (No. 12).

The three most prominent gold anomalies in the verification area largely coincide with the position of the known occurrences, especially the Louis Moore (1), Courtney (2) and Ophir (3) occurrences. The co-ordinates of the occurrences are probably not totally correct and therefore do not fit the anomalies well, thus further investigation is necessary. The strong gold distribution patterns (1 to 3) may therefore be largely a result of contamination from the old workings. However, the broader anomaly (4 and 5) to the west of the Courtney and Ophir and south of the Louis Moore occurrences are promising and warrant investigation. The anomalous verification results for gold in the Louis Moore area largely coincide with the four known gold occurrences in the area (Louis Moore, Gosling, Courtney and Ophir).

From the provisional 'gold only' synthesis for the Louis Moore area, it is expected that the gold mineralisation in the area may be of the low-temperature coarse-grained epithermal vein type. These kind of deposits are normally small but of very high grade.

Future activities

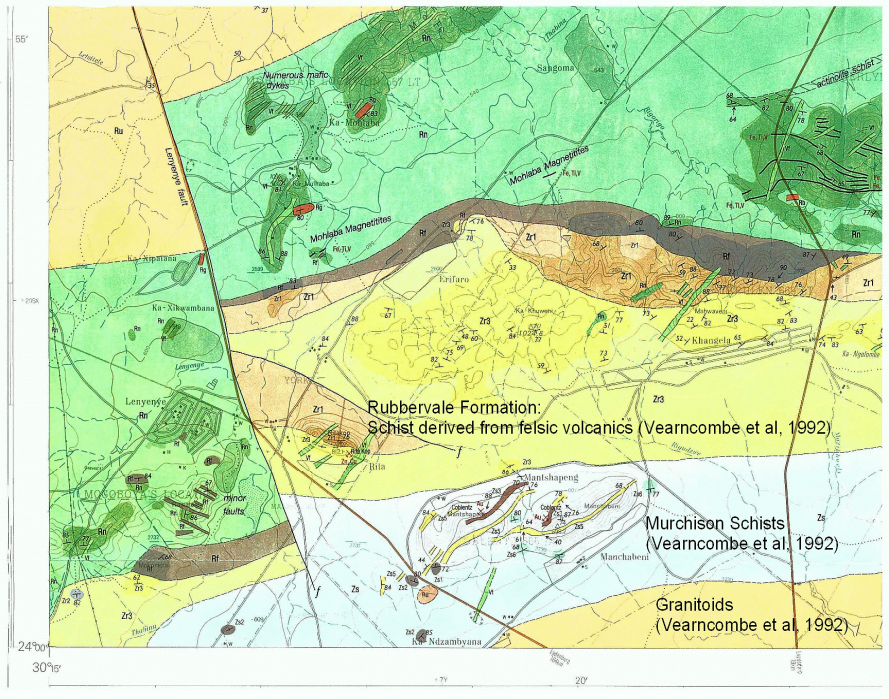
Further work in the Louis Moore area is recommended as a result of the provisional verification survey. The following is recommended for further work in the Louis Moore area:

1. Field visit to verify the contamination model;
2. Field visit to obtain the exact co-ordinates for the gold occurrences and old workings;
3. Next level of infill soil sampling in the uncontaminated areas (to the west of Courtney and Ophir, in particular).

Verification of the Mantshapeng chrome anomalies on sheet 2330CD Letsitelle (3IN)

Progress

Outcrops of ultramafic rocks, including serpentinite and talc schists (Zs1) and mafic rocks (Zs2), are situated on the southwestern side of the Mantsapeng Mountain. The nickel and chromium anomalies, which are associated with mafic and ultramafic rocks, are widely distributed around the two mountains, suggesting a more abundant presence of mafic and ultramafic rocks than indicated on the geological map. The elements cobalt and arsenic are anomalous on the northwestern side of the Mantsapeng Mountain and correspond with the stronger Au1 anomaly. Two known gold occurrences are also present in the stronger Au1 anomaly. Platinum and palladium are anomalous in the southern part of the Mantsapeng Mountain, corresponding with the mapped outcrops of the mafic and ultramafic rocks.

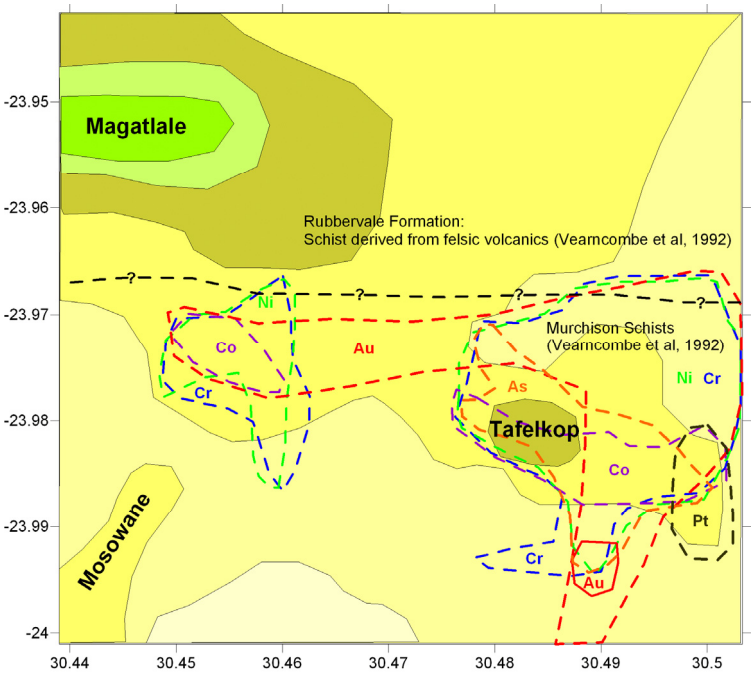


Geological map of the study area.

The Mantshapeng Cr-Ni-Pt-Pd-Au anomaly occurs in the Murchison Greenstone Belt and covers an area of approximately 15 km^2. The anomaly comprises a typical multi-element anomaly normally associated with a mafic-ultramafic complex. A few outcrops of mafic-ultramafic rocks (talc schist and mafic rocks) were previously mapped in the area, but the geochemistry suggests that a much more prominent complex is present. As the anomaly shows strong Cr-Ni-Pt-Pd-Au-Co-As values the geology is expected to be very complex. The presence of anomalous quantities of precious metals in the soils also warrants more exploration work.

In order to gain a better understanding of the origin and nature of the anomalies and to allow the construction of a model for the mafic-ultramafic complex the following is recommended:

1. A further high-density geochemical soils survey in order to define if the complex continues and to delineate the most anomalous and mineralised zones, with gold, Pt and Pd the leading vectors;
2. North–south soil geochemical traverses in order to establish if the complex is layered;
3. Trenching to obtain samples from possible mineralised zones;
4. High-density airborne geophysics (magnetic and radiometric) in order to delineate the controlling structures and the size of the complex;
5. Borehole drilling if required, based on the final geometallic model.



The geochemical map overlain on the elevation contour map of the study area.

Verification of the Mosowane and Tafelkop Cr anomalies on 1:50 000-scale sheet 2330CD Letsitelle (3IN)

Progress

Outcrops of mafic rocks (Zs2) are seen north of Mosowane and at Tafelkop. The nickel, chromium and cobalt anomalies coincide north of Mosowane on the mafic rocks. This anomaly suggests a much larger presence of mafic rocks than was mapped in the area. A much bigger anomaly of Ni, Cr, Co and As exists at Tafelkop, also suggesting a much larger presence of mafic to ultramafic rocks. Although both anomalies have gold support, the gold anomaly at Tafelkop is much stronger having As support as well. On the eastern side of Tafelkop a platinum anomaly overlaps the nickel, chromium and cobalt anomaly.

The Mosowane-Tafelkop Cr-Ni-Pt-Pd-Au anomaly occurs approximately 8 km east of the Mantshapeng anomaly, and covers an area of approximately 8 km^2. The anomaly also comprises a typical multi-element anomaly normally associated with a mafic-ultramafic complex. A few outcrops of mafic-ultramafic rocks (talc schist and mafic rocks) were previously mapped, but the geochemistry confirms the presence of a much more substantial complex in the area. As the anomaly shows high Cr-Ni-Pt-Pd-Au-Co-As levels the geology is expected to be very complex. The presence of anomalous quantities of precious metals in the soils, with gold values up to 150 ppb, renders this anomaly very interesting.

Recommendation

In order to gain a better understanding of the origin and nature of the anomalies, and to allow the construction of a model for the mafic-ultramafic complex, the following is recommended:

1. Another high-density geochemical soil survey in order to determine the extent of the complex and to delineate the most anomalous and mineralised zones, with gold, Pt and Pd the leading vectors;
2. North–south soil geochemical traverses in order to establish whether the complex is layered;
3. Trenching to obtain rocks from possible mineralised zones;
4. High-density airborne geophysics (magnetic and radiometric) in order to delineate the controlling structures and the size of the complex;
5. Borehole drilling if required, based on the final geometallic model.

Verification of the copper anomalies on the 1:50 000-scale sheets 2330CA Duiwelskloof (3II) and 2330CC Tzaneen (3IM)

Progress

An investigation into single-element distribution patterns, as well as a geochemical synthesis from a geological and exploration point of view, was carried out. Several geochemical anomalies were identified and a Cu anomaly was verified, as a result of which 219 soil samples were taken on a 500 m grid spacing. These samples were dry-sieved to extract the -75 micron fraction and analysed on a Simultaneous X-Ray Fluorescence Spectrometer (Sim-XRF). Geochemical distribution maps were compiled for the elements copper, zinc, lead and sulphur. Anomalous concentrations for Cu (up to 4 800 ppm), Zn (up to 1 200 ppm) and Pb (up to 560 ppm) were obtained. Five samples with anomalous Cu results (ranges from 1 929 to 4 855 ppm) and two samples with anomalous Pb results were analysed on the PIMA for their clay mineral contents, and all seven samples also had fairly high levels of zinc and sulphur. Both samples 3II54 and 3II45, with anomalous lead, contain halloysite and anhydrite. All the samples with anomalous copper levels also contained halloysite. Four samples contained kaolinite and three samples contained anhydrite. One sample contained magnesite. The presence of halloysite suggests hydrothermal alteration of alumino-silicate minerals. The anhydrite could be associated with sulphides in vein deposits and therefore suggests, with the presence of copper, lead and zinc, that a gossan could be present.

The initial data suggest a network of mineralised vein systems (veins, stockwork or breccia) at the present erosional level, and a mesothermal to epithermal system lying above a deeper primary mineral source. The origin and importance for such mineralisation is, however, still open to interpretation and should be pursued as soon as possible.

Recommendations

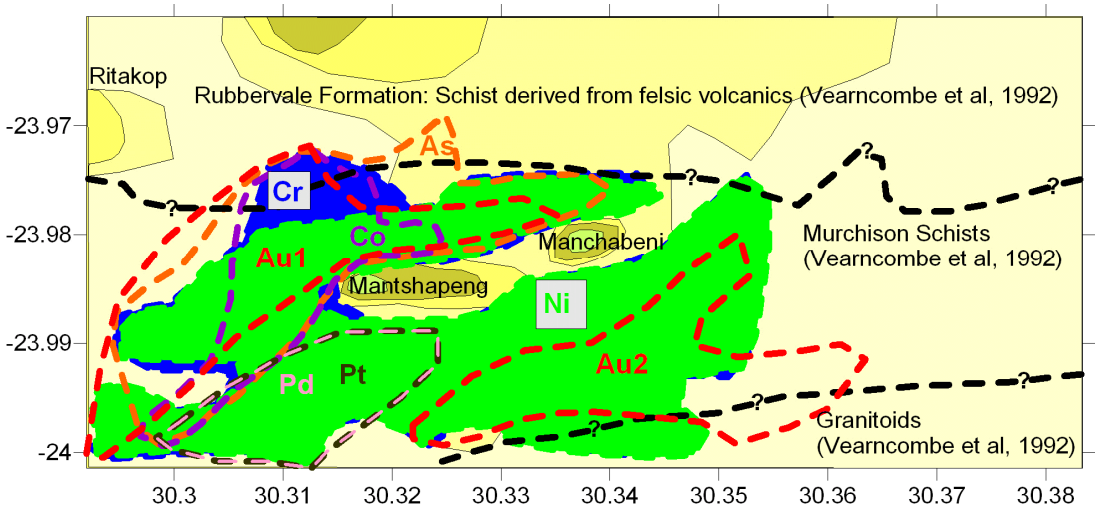
In order to gain a better understanding of the origin and nature of the anomalies and to allow the construction of a model for the hydrothermal processes behind it, the following is recommended:

1. Further high-density geochemical soil surveys in order to define the most anomalous and mineralised zones, with Cu the leading vector;
2. Detailed soil alteration mapping in the anomalous areas in order to determine the nature of the alteration zones around any fluid conduits. High-resolution infra-red Landsat images and ground 'PIMA' surveys may assist in this mapping;
3. Trenching to obtain rocks from possible mineralised zones;
4. High-density airborne geophysics (magnetic and radiometric) in order to delineate the controlling structures and to identify a possible heat source;

5. Ground electromagnetic (EM) surveys in target areas to identify areas with possible metallic deposits, and
6. Drilling boreholes, if required, based on the final geometallic model.

Regional geochemical mapping of sheet 2330C Tzaneen comprising the 1:50 000-scale sheets 2330CA Duiwelskloof (3II), 2330CB Ga-Modjadji (3IJ), 2330CC Tzaneen (3IM) and 2330CD Letsitelle (3IN)

The Tzaneen data set consists of 2 785 samples. Geochemical synthesis maps for the dominant geological units were created, showing their unique geochemical fingerprints. Provisional geochemical modelling also resulted in the identification of three 'new' geochemical exploration targets in the study area. Two of the anomalies are regarded as prime targets for gold exploration in the greenstone belt.



The synthesis on the geochemical map of the 1:100 000 scale Tzaneen map for the elements Pt, Pd and gold.

The geochemical modelling also delineated an important anthropomorphic anomaly which could have far-reaching health implications for life along the Letaba River. The cause of the anomaly is still unknown but could be either from pesticide or fertiliser.

The comprehensive data set therefore already proved to be a valuable national asset with further value still to be added through thorough interpretation of the geochemical data.

The following Pt, Pd and gold anomalies were identified:

The Novengilla Suite and the Biotite Granite display interesting Pt anomaly trends generally in NE–SW directions. The strongest Pt anomaly trend follows the Tzaneen Lineament and is probably associated with mafic-ultramafic dykes in the area. The Pt anomalous trends are also supported by Pd anomalies and to a lesser extent by gold anomalies.

Recommendations

Three 'new' anomalies were identified and are recommended for follow-up exploration. Two of the anomalies are situated in the greenstone belt. The geochemistry suggests that the host rocks are probably ultramafic rocks (Mg, Ni, Cr, V, Co) and banded iron formation (Fe, Mn, Sc). Mineralisation is expected to be gold and/or base metals with arsenopyrite (As) associated with it. A high-density geochemical grid is recommended over the two anomalies in order to delineate the best areas for further exploration.

Conclusion

The comprehensive data set has already proven to be a valuable national asset with further value to be added through thorough interpretation of the geochemical data. It is essential to continue the statutory Regional Geochemical Mapping Programme as it serves one of the core functions of the geological mapping strategy at the CGS. It also builds the infrastructure to support the small-scale mining and poverty alleviation strategies of South Africa.

GEOPHYSICS

DATA COLLECTION, PROCESSING AND CURATION

2002-0174 PHYSICAL PROPERTIES DATABASE

Project leader: L.P. Maré, M.Sc.
Project team: L.R. Tabane, D. Kruger, L. Loots, B.Sc.Hons, R.M. Sethobya, B.Tech., M.A. Sekiba, N.Dip., S. Tucker, Dip.S.B.M.
Primary objective: *to continue with the collection of samples and the expansion of the Physical Properties Database and conduct selective research on acquired data and petrophysical methods.*
Duration: Ongoing.
Budget: Current year: R12 930.

Motivation

The South African Geophysical Atlas, Volume IV, Physical Properties of South African Rocks, is a compilation of published and non-confidential physical properties of South African rocks. The aim of the Atlas is to provide geoscientists with a quick reference to physical-property information, as well as a comprehensive set of source references.

Progress

During 2008/9 petrophysical analyses, including bulk density, magnetic susceptibility, intensity of magnetisation, magnetic remanence, electrical resistivity, induced polarisation, as well as seismic velocity were performed on different stratigraphic units in South Africa.

Some of the stratigraphic units that have been covered during this period include additional dolerite dykes from the Archaean and Proterozoic, as well as samples from two borehole core from the southeastern lobe of the Bushveld Complex. Selected physical properties were measured on samples from these two Bushveld core and the results and their interpretation were used in a B.Tech. dissertation.

The Physical Properties Atlas of South African Rocks has been replaced on the website by downloadable property-specific reports.

Tables and figures have been created of physical property data ranges for selected rock types within the igneous, metamorphic and sedimentary groups.

A map service was created on the Geoportal and a project registered, entitled geophysical tests, where the available physical property test points are shown in relation to South African geology, as well as some infrastructure data for orientation.

Conclusions

The project is on track with its effort to cover as many stratigraphic units as possible.

Future activities

During 2009/10 samples from boreholes through the southeastern lobe of the Bushveld Complex, which are stored at the National Core Library, will be further analysed for their magnetic properties, with special reference to the stratigraphic polarity. The results will be used to compare the southeastern lobe of the BIC with the rest of the well-studied Bushveld occurrences. This research will form part of the B.Tech. dissertation for a junior staff member.

Tests on new dielectric and seismic (s-wave) equipment are to be conducted with the aim of expanding the Petrophysical Laboratory's services.

2002-0679 UPKEEP AND DEVELOPMENT OF DATABASES

Project leader: M. Havenga, B.Sc.Hons.
Project team: A. Graham, Nat.Cert., P. Cole, M.Sc., J. Cole, M.Sc., O.W. Dingoko, B.Sc.Hons, L.R. Legotlo, B.Tech., R.H. Stettler, Nat.H.Dip., N.N. Nefale, B.Sc.
Primary objective: *to maintain and expand the geophysical databases, including GIS coverages.*
Duration: Ongoing.

Motivation

The Geophysics Unit has large amounts of data which need to be properly maintained, backed up and catalogued in order to establish increased work efficiency and better productivity.

Progress

The main focus during 2008/9 was to complete the capture of all publications relating to geophysics through the years. The paper versions were scanned and added to the database. These publications can be searched by keyword, author or report number. There are reports in the database from 1929 to 2008.

Another objective was to capture the entire set of 1:50 000 scanned and georeferenced topographic sheets. This was completed during 2008/9. All the gravity base stations and the relevant information were also captured in the database.

New airborne data were captured as these were flown. The total number of publications added to the database since the beginning of the financial year is in excess of 1 000.

A database quality control system was implemented to check all the data in the database to ensure that all the data are correctly captured. This will become an ongoing process and will be part of the database project.

Conclusions

The database assists geophysicists to perform certain tasks faster and more efficiently, enabling users to locate data sets immediately from their computers. Searches for unpublished reports are no longer a tedious exercise. A complete record of the data in the Geophysics Unit database is readily available and data duplication is no longer a major concern.

Future activities

Future activities of the project will include re-checking old airborne data sets, fixing and re-processing the data, where necessary, and adding the corrected data to the database. New data will be added to the database as these are collected and the interface will be continuously updated to suit the needs of users.

2009-1003 HIGH-DENSITY MAGNETIC AND RADIOMETRIC AIRBORNE DATA ACQUISITION

Project leaders: P. Cole, M.Sc., D.G. Eberle, Ph.D.
Project team: Southern Exploration Surveys, E. Chirenje, M.Sc., O.W. Dingoko, B.Sc.Hons, M. Havenga, B.Sc.Hons, P.K. Nyabeze, M.Sc., A. Tessera, Ph.D., R.L. Legotlo, B.Tech., A. Graham, Nat.Cert.
Primary objective: *to conduct geophysical mapping and identify exploration target areas.*
Duration: Ongoing.
Budget: Total: R12 880 400; 2008/9: R8 363 211.

Motivation

This project is part of a greater effort to cover the entire Republic of South Africa with airborne geophysical high-resolution–high-density total magnetic intensity and natural gamma-radiation data, producing magnetic, digital terrain model, exposure rate (total count), potassium, thorium and uranium surface concentration data sets. These data sets will become the countrywide base for further geological mapping, mineral, groundwater and hydrocarbon exploration, environmental- and land-use projects. The data will support other CGS projects as well as other sectors in the earth sciences, and the project is funded by the Medium-Term Expenditure Framework (MTEF).

Progress

A two-stage process is followed: an initial stage consisting of airborne geophysical data acquisition, processing and compilation, and a subsequent ground-based stage involving processing the data to screen it for promising exploration targets and to follow up anomalies with a variety of ground-based techniques to assess their mineral potential.

Two main areas were flown in the North West and Mpumalanga Provinces. In total, fifty 1:50 000-scale sheets were covered by the new high-resolution airborne geophysical data. Selection of these sheets coincided with exploration for geological indicators for gold In the Kraaipan greenstone belt of the North West Province and Bushveld-type lithologies connecting the southeastern and eastern lobes of the Bushveld Complex in Mpumalanga.

The integrated interpretation methodology to immediately identify mineral exploration target areas from airborne geophysical and other complementary geological and geochemical data has been refined. An integrated data suite from the Northern Cape Province was automatically converted into an exploration target map, which led to the discovery of surface showings of a manganese mineral.

Geophysical ground follow-up was performed on selected areas. This, along with an extensive interpretation, produced potential mineral targets for minerals such as chrome, nickel, cobalt, diamond and platinum group elements.

Conclusions

The data by the airborne survey will be used in minerals exploration, groundwater targeting, as well as small-scale mining projects. The largely automated methodology of jointly interpreting airborne geophysical and geochemical data was implemented. This programme has proved itself to be a critical part of the statutory work of the CGS.

Future activities

The portions of the country that have not yet been flown at this resolution will be covered during coming years. To facilitate the use of the data for commercial organisations, consultancies, SMEs or communal small-scale mining organisations, the data will be evaluated after acquisition to provide potential mineral exploration target areas.

GEOPHYSICAL INTERPRETATION

2006-0897 **PALAEOMAGNETIC STUDY ON THE PRECAMBRIAN MAFIC DYKES OF MPUMALANGA**

Project leader:	L.P. Maré, M.Sc.
Project team:	L.R. Tabane, D. Kruger.
Primary objective:	*to study the palaeomagnetism, geochemistry and petrography of the NW- and NE-trending dykes of the Nelshoogte and Kaap Valley plutons.*
Duration:	2006/7 to 2009/10.
Budget:	Total: R51 323; 2008/9: R29 225.

Motivation

The aim of this study is to determine the palaeomagnetic pole positions for the various dyke trends in the Mpumalanga Province. These pole positions might provide essential information on mantle evolution during the Proterozoic period and the possible source of the dyke swarm magma.

Progress

Two major dyke trends cut the Kaap Valley and Nelshoogte plutons. The most prominent of these strikes 317°"19°(northwest) and the other is approximately perpendicular to it, striking 46°"20° (northeast).

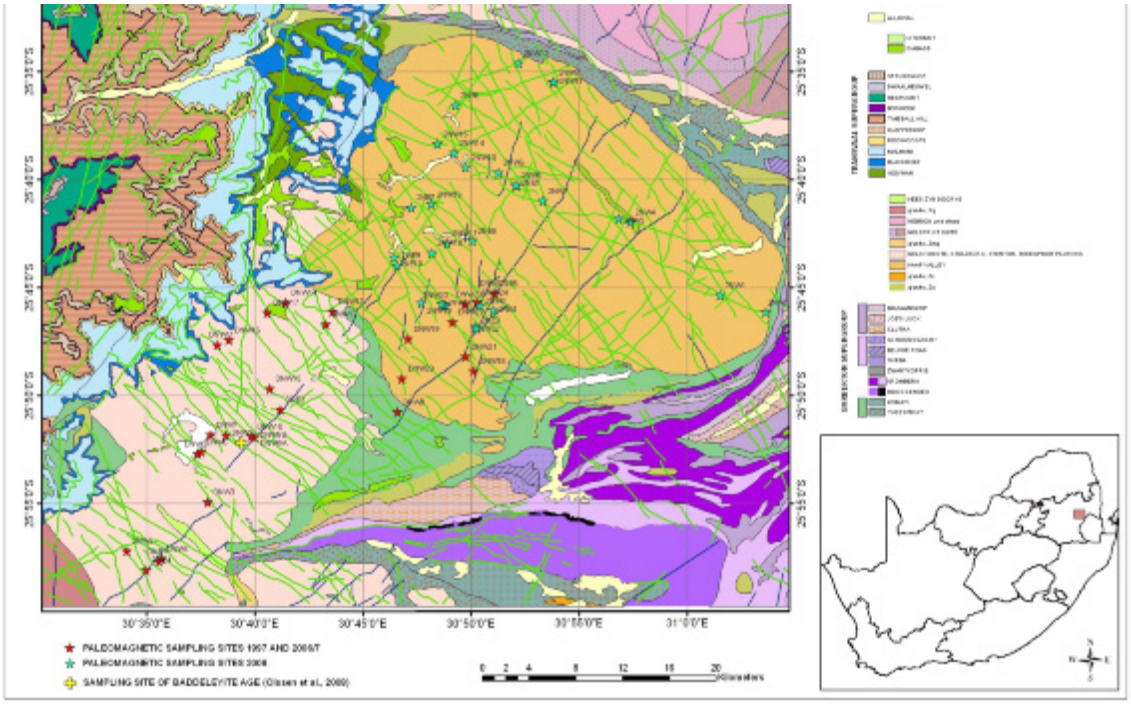
A $^{207}Pb/^{206}Pb$ age of 2 972"11 Ma for two concordant points of the NW-trending dykes was produced. More recently Olssen a U-Pb baddeleyite age of 2 965"0.74 Ma for the NW-trending dykes from the regression of four analyses was reported.

During the 2008/9 field season an additional 21 NW-trending and 10 NE-trending dolerite dykes were sampled from the Kaap Valley pluton. In total 49 NW-trending and 14 NE-trending dykes have been sampled, including five closely spaced NW-trending granodioritic dykes.

Major- and trace-element analyses were obtained, petrographic slides were prepared and limited magnetic analyses were performed on the samples collected during 2008.

Conclusions

The whole-rock compositional data show that the rocks are dominantly medium-potassium within-plate ocean-island tholeiitic basalts with compositions typical of active continental margins. The major- and trace-element analyses indicate a normal fractionation trend of basaltic magma.



There was no clear distinction in the geochemical signatures of the different groups within the NW-trending swarms. The groups within NE-trending swarms could be distinguished in terms of their MgO content.

Preliminary AMS results indicate a good correlation between the maximum (K1) component and magma flow direction with magnetite identified as the main magnetisation component.

Future activities

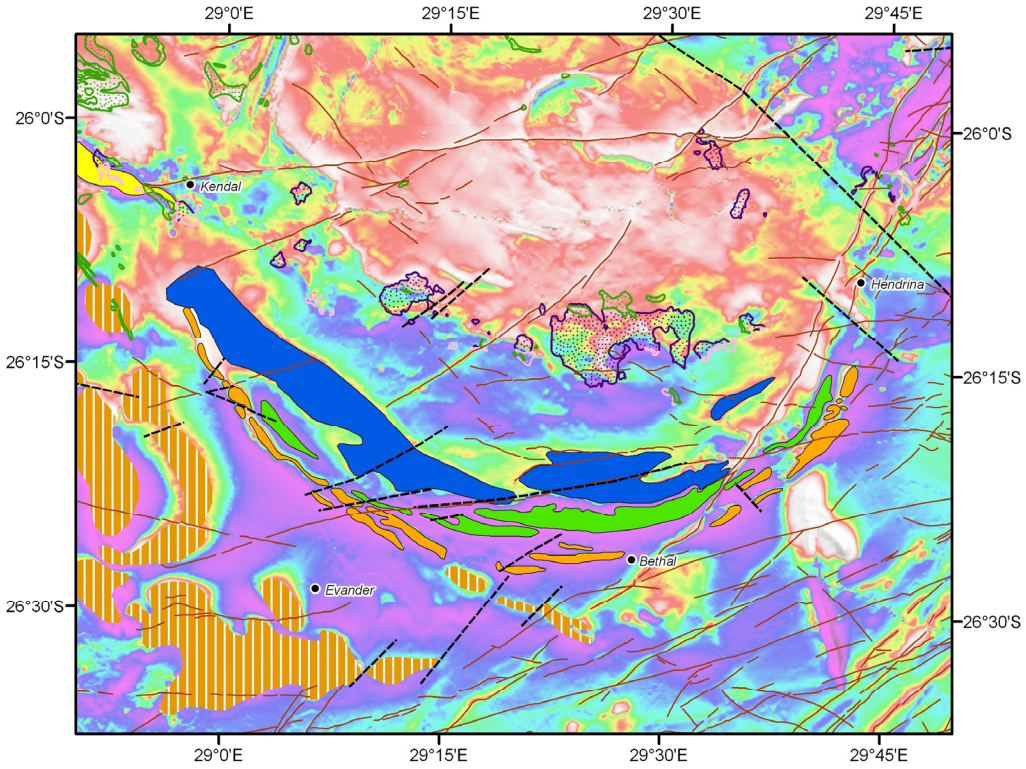
During 2009/10 the geochemical results from the various dolerite dyke swarms will be correlated with geochemical results from possible associated geological units, such as the Pongola and Ventersdorp Supergroups. After completion of the palaeomagnetic study the results will be correlated with palaeomagnetic results from these associated geological units. The final output of this study will be a scientific paper.

2007-0937 **INTERPRETATION OF HIGH-DENSITY AIRBORNE GEOPHYSICAL DATA OVER THE SOUTHEASTERN LIMB OF THE BUSHVELD COMPLEX**

Project leader: J. Cole, M.Sc.
Primary objective: *to interpret airborne magnetic and radiometric data in order to determine the geometry of the southeast limb of the Bushveld Complex*.
Duration: 2006/07 to 2010/11.
Budget: Total: R8 100; 2008/9: R6 000.

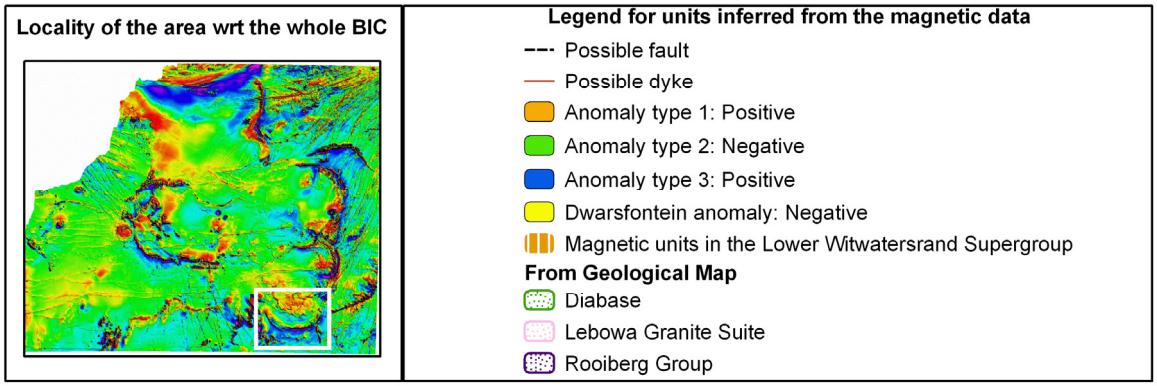
Motivation

The Bushveld Igneous Complex is of immense economic importance in South Africa. The western, eastern and northern lobes of the Complex have been extensively studied and mined, but most of the southeastern limb is covered by Karoo sediments and as a result only limited work has been published. Regional aeromagnetic and gravity data have been processed by staff of the Geophysics Unit, but high-resolution airborne geophysical data collected over the Bethal area still has to be studied.



Progress

During the year a surface interpretation of magnetic data collected over the southeastern lobe was conducted. The data show a series of anomalies corresponding to the outer rim of this lobe, consisting of narrow positive anomalies on the outermost boundary, followed by a set of high-intensity negative anomalies, and finally positive anomalies along the inside. Due to lack of outcrop and limited borehole information, it is difficult to assign these anomalies to specific zones of the Rustenburg Layered Suite, so it was decided to study the available magnetic data (1 km regional and 200 m high-resolution data where available) for other parts of the Complex where mapped outcrops can be compared with the magnetic data. In general, it was found that the Upper Zone corresponded to high intensity, predominantly positive anomalies. In the eastern lobe, outcrops of the Transvaal Supergroup within the Upper Zone are responsible for well-defined magnetic lows. Upper Zone rocks in the southern, east–west-trending part of the western lobe also cause strong positive anomalies, but is was found that the lower part of this zone was associated with large amplitude negative anomalies. These negatives are much larger than the normal negative part of a dipolar anomaly in the prevailing geomagnetic field in South Africa. The Main Zone is generally associated with weak, negative magnetic anomalies.



High-resolution airborne data and interpretation for the southeastern lobe of the Bushveld Complex.

In addition to the magnetic data, regional gravity data were also used to assist with the interpretation. The mafic rocks of the Rustenburg Layered Suite are responsible for gravity highs, with the highest amplitude coinciding with, or falling immediately adjacent to the Upper Zone rocks. The gravity values associated with the Main Zone are lower, but still high compared with the surrounding Transvaal sediments.

The knowledge gained from these interpretations was applied to the data over the southeastern lobe. Positive magnetic anomalies along the inside of the outer rim coincide with the highest gravity values and are interpreted to be caused by Upper Zone rocks. The negative anomalies along the outside of this may still be associated with the Upper Zone, as was found for the western lobe. Most of the boreholes studied during the 1970s and 1980s were drilled into this negative, and found analogues to the Upper and Lower Zone. Palaeomagnetic work on some of these core is currently underway and will hopefully shed more light on the reason for the strong negative. The outermost positive anomalies do not compare to anything found in the eastern and western lobes. It is unclear whether these anomalies are caused by Upper Zone material, possible diabase intrusions or even contact metamorphism.

Conclusions

This study of the available magnetic and gravity data over the eastern and western lobes of the Bushveld Igneous Complex assisted with the interpretation of the geophysical data over the southeastern lobe of the Complex. Anomalies that are similar to those associated with the Upper Zone in other parts of the Complex were identified in this lobe, but there were other anomalies that could not be explained in terms of observations from the western and eastern lobes.

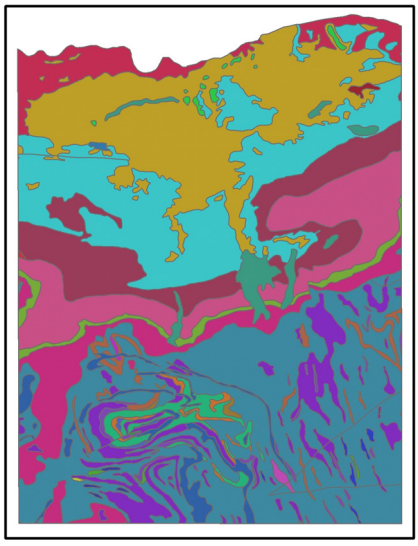
Future activities

Prior to starting with two- and three-dimensional models of the southeastern lobe, physical properties measured down boreholes in this and other parts of the Complex will be used to create magnetic and density stratigraphies. Two-dimensional models will first be created, starting in areas where more information is available, and extending to areas that are less well understood. Finally a three-dimensional model will be created.

2006-0938 **A STRUCTURAL ANALYSIS OF THE GEOPHYSICAL SIGNATURE RELATIONSHIP BETWEEN LINEAR FEATURES AND PLUG-LIKE BODIES ON SHEETS 2229AB MAPUNGUBWE AND 2229AD COILA**

Project leader: M. Havenga, B.Sc.Hons.
Primary objective: *to compare the geophysical signatures of linear features and plug-like bodies on sheets 2229AB Mapungubwe and 2229AD Coila.*
Duration: 2007/8 to 2008/9.
Budget: Total: R44 433; 2008/9: R15 000.
Motivation

A number of data sets are available that cover the 2229AB Mapungubwe and 2229AD Coila sheets. These include:



Geology of the study area.

200 m line spacing aeromagnetic and radiometric data
Resistivity traverses
Vibroseis lines
Regional gravity data
Regional magnetic data
Regional radiometric data
Mineral occurrences data
Landsat images
Aster images.

These data sets can aid in the study of relationships between the plug-like intrusions and linear features near the Venetia Diamond Mine, which will improve the understanding of the area, and the processes that controlled emplacement of Venetia and the plug-like intrusions.

Progress

The research has been completed and a Bulletin has been submitted to the Publications Section of the CGS. Two papers are in the process of being submitted to peer-reviewed journals. The project leader has submitted findings from this project as an M.Sc. thesis at the University of the Witwatersrand.

Conclusions

The interpretation is completed, and a number of very interesting structural features visible in the magnetic data have been investigated and their relationships studied. These inter-relationships other their relationship with the Venetia kimberlite could supply valuable information for future studies and development in the area.

Future activities

This project is now complete.

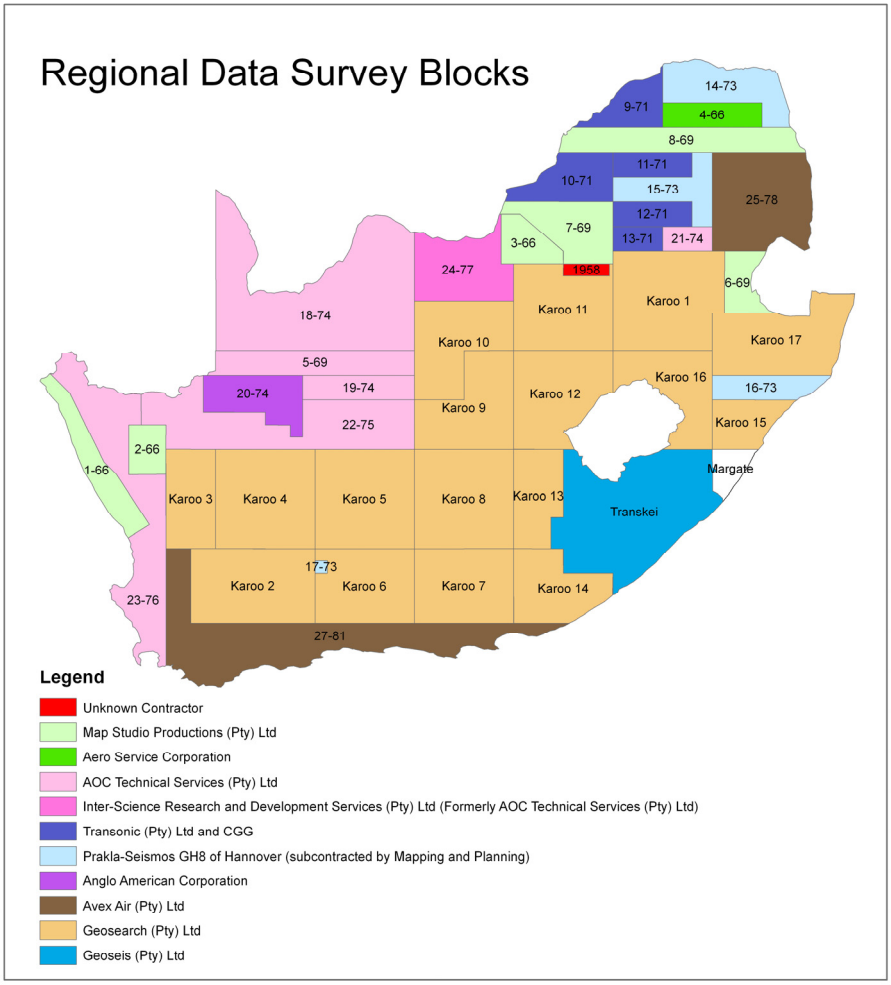
2009-1021 **REPROCESSING OF OLD AIRBORNE GEOPHYSICAL DATA**

Project leader: O.W. Dingoko, B.Sc.Hons.
Project team: M. Havenga, B.Sc.Hons, P. Cole, M.Sc.
Primary objective: *to review existing airborne geophysical data and reprocess the data where necessary.*
Duration: Ongoing.

Motivation

The South African airborne survey was flown between 1958 and 1997. A final processed version of the data was published in 1997 on a 1:1 000 000 scale. Two versions of the maps were produced, the first displaying the standard 'Total Magnetic Field Intensity'. The second version showed a 'Magnetic Fabric' and was an enhanced version of the data, showing shallow magnetic features.

In the light of more modern techniques becoming available to improve data quality, a programme was started in 2005/6 to reprocess the data. This process was continued in 2008/9 and formed the basis of the reprocessing project.



Airborne geophysical survey blocks.

Progress

During 2008/9 magnetic data from nine blocks were considered. These were blocks 1/66, 2/66, 3/66, 4/66, 5/69, 6/69, 7/69, 8/69 and 18. Data from three of these blocks, namely blocks 3/66, 4/66 and 7/69, were found to have leveling errors and were therefore reprocessed.

Conclusions

The project is on track with its effort to cover as many survey blocks as possible.

Future activities

During 2008/9 more survey blocks will be examined and reprocessing will be carried out where necessary.

2009-1014 **INVESTIGATION OF THE CRUST IN THE SOUTHERN KAROO USING THE SEISMIC REFLECTION TECHNIQUE**

Project leader: L. Loots, B.Sc.Hons.
Primary objective: *to study the structure and stratigraphy of crustal features.*
Duration: Ongoing.
Budget: 2008/9: R61 610.

Motivation

There are no previous publications on the seismic reflection line in question. The line is quite unique in the sense that it crosses over the Beattie magnetic anomaly and part of the Southern Cape Conductive belt. There are also a very limited number of publications available on the formation of the crust in this area. The project is centred on a line from Beaufort West in the north along the national route N12 to Klaarstroom in the south.

Progress

During 2008 the data were reprocessed using industry-based software at the GeoForschungsZentrum in Potsdam. A preliminary interpretation has been done on the data and it has been correlated with similar work done in the area.

An in-depth interpretation will be done in the near future and the findings will be correlated with boreholes and other geophysical data that were collected in the surrounding area.

Conclusions

The project is on track with the effort to do interpretation as soon as possible with an M.Sc. in mind.

Future activities

During 2009/10 detailed interpretation will continue and the results will be published as soon as possible.

NEW TECHNOLOGIES

2006-0896 **TIME DOMAIN AIRBORNE ELECTROMAGNETIC SYSTEM**

Project leader: D.G. Eberle, Ph.D.
Project team: V. Hallbauer-Zadorozhnaya, Ph.D., P. Cole, M.Sc., O.W. Dingoko, B.Sc.Hons.
Primary objective: *to install, adapt and test the TD-AEM system.*
Duration: Ongoing.
Budget: Total: R1 006 395; 2008/9: R557 513.

Motivation

The new time-domain airborne electromagnetic (TD-AEM) system will be applied to geological mapping, mineral exploration, alluvial diamond exploration, groundwater investigations, environmental and engineering projects. Airborne Electromagnetic (AEM) exploration methods constitute a vast field and technological advances are being made continuously by researchers. Acquisition of the system will expand the scope of airborne geophysical methods available to the CGS.

Progress

The Geophysics Unit is in the process of implementing the TD-AEM platform. Equipment has been manufactured by a company in Russia (ELTA-GEO) and sent to South Africa. However, the aircraft has not been available to perform installation and testing during the 2008/9 financial year. A wing-tip concept and a bird launch and capture structure (BLCS) were designed by Aero Services Ltd, who are in charge to manufacture modifications of the aircraft required to mount the system.

Conclusions

In the coming year, the CGS's Cessna Grand Caravan 208B will be available for the project. The project will progressively continue with mounting, adapting and testing the TD-AEM system.

Future activities

Installation and testing will need to continue. Once the Geophysics Unit runs the hardware it will be crucial to keep up to date with latest theoretical advances. Processing and interpretation of the TD-AEM data have to be considered and a methodology needs to be developed, tested and implemented. Continuous improvement of AEM data acquisition, processing and interpretation will be mandatory to stay ahead of the competition.

2008-0939 **DEVELOPING THE THEORY, INSTRUMENTATION AND INTERPRETATION OF THE IP METHOD APPLIED TO SURFACE MEASUREMENTS AND PHYSICAL MODELLING OF ROCK SAMPLES**

Project leader:	V.Y. Hallbauer-Zadorozhnaya, Ph.D.
Project team:	L.P. Maré, M.Sc.
Primary objective:	*to study the membrane IP effect in order to gain a better understanding of the physical phenomenon and interpretation of surface and laboratory measures data.*
Duration:	2007/8 to 2009/10.
Budget:	Total: R54 868; 2008/9: R6 000.

Motivation

Information about physical parameters of investigated rocks is very important. Any mathematical and physical modelling requires a primary model, i.e. model based on a priopi data about structures and reliable data of physical properties of rocks. Another application of a rock's properties is the estimation of the permeability of rocks and parameters of transportation of water and contaminants. Physical parameters can be obtained studying samples of excavated rocks. However, laboratory measurements show it is not possible to obtain 'true' resistivity and chargeability, membrane polarisation prevented current flow. Measurements disported by membrane polarisation (and other types of polarisations) show that the resistivity and polarisability depend on a few parameters, such as applied electrical current, frequency, porosity, salinity of electrolyte and size of pores. The motivation of this project is to study the physical phenomenon of the membrane IP effect, its mathematical consideration, analysis of parameters, the controlled IP effect, developing the algorithms and calculating programs for the interpretation of data obtained by the surface IP method and physical modelling of rocks.

Progress

During the project the theoretical basis of membrane polarisation continued to be developed. It was shown that the resistivity of sediments depends on the type of applied current: low frequency current blocked pores during a certain period of time and the resistivity of sediments depends on the amount of open pores at a fixed time. During the polarisation process all contacts between pores of different transfer numbers will be blocked and the electrical current will flow through the remaining channels. The amplitude of the potential difference (voltage) of such rocks not only depends on solutions filling pore spaces, porosity and tourtuosity of pore channels, but also on ion mobility, diffusion coefficient and difference of transfer numbers. It was shown the measured chargeability is proportional to porosity. However, the relationship between resistivity and porosity is very complicated. Mathematical modelling and laboratory measurements both confirmed the membrane IP effect diminishing with increasing salinity of fluid-filled pores of rocks. Mathematical modelling of the process of current flow in several samples of different lithology (shale, shale with dropped stones, tillite, mudstone, lava, hematite, Mn-ore) confirmed the proposed model. It was shown that the pore-size distribution can be different even when the porosity of the sample is the same. The dominated radii of investigated samples are varied from 10 μm up to 1 μm. The pore size distribution is important for estimation of transport parameters, especially of transportation of contaminants.

Conclusions

Mathematical programs for modelling of IP referred to as 'induced polarisation caused by constrictivity of pores' were improved. Parameters controlling blockage of pores and excess/loss ions at the contacted pores, such as porosity, salinity, frequency and size of pores were analysed. Mathematical modelling of the process of current flow in several samples confirmed the proposed model. The 'product' of this stage of work is the pore size distribution in the sample and dominated radii. It was shown that the size (pore radii) of pores can be different even when the porosity of the sample is the same.

Future activities

More samples will be interpreted, measurements of samples in the instrument provided frequency domain source; include effect of electro-osmosis polarisation into the mathematical description of polarisation effect, try to estimate its influence to the measured signals; give physical meaning of the parameter of chargeability based on model of constrictivtity of pores; compare data obtained using neutron tomography (NECSA), and mathematical modelling of pore space using CGS RIP instrument and calculating program for interpretation; more applications for groundwater survey (transportation and permeability), mining and engineering industry.

2008-0962 **REDEVELOPMENT OF MS-DOS-BASED PROGRAMS INTO MS-WINDOWS SOFTWARE**

Project leader: O.W. Dingoko, B.Sc.Hons.
Project team: P. Cole, M.Sc., L.J. Ledwaba, B.Sc.Hons.
Primary objective: *to redevelop old MS-DOS command-line programs into graphic user interface (GUI) software.*
Duration: Ongoing.
Budget: 2008/9: R2 100.

Motivation

Command-line programs are old and as such, are not easy to use. Some of these programs are not portable and this hinders co-operation between scientific staff members. A major reason for this is incompatibility with modern operating systems. Windows programs, which use graphical interfaces, are easy to use and are portable. Several old FORTRAN programs have been identified as worthy of upgrades. There is also a need to improve old programs to make the unit more efficient. Programs that need to be redeveloped include a gravity interpretation program and general processing software for efficient quality control on data. As part of this project, Linux shell scripting was done on behalf of the Seismology Unit.

Progress

During 2008/9 three shell scripts and two Windows programs were developed. One FORTRAN program was redeveloped into a Windows application.

Grav3D is a least-squares inversion program authored in FORTRAN. The input to the Grav3D program is an ER Mapper grid file and the output is a geometrical model which best fits the input data.

SYSMIN 2.0 is an upgrade of the original SYSMIN program. This software is used for processing airborne geophysical data. Some of the new features in the new release include automatic flight recognition, serial date computation and line data visualisation. Apart from formatting the data, some processing can be done. This includes dead time correction, barometric altitude computation and directory processing of quality control data files.

LineMerge was developed for merging flight plan line numbers into an SEG-GDF database.

SeimoExtact is a Visual Basic 6.0 program used to extract important information from a seismological catalogue.

Conclusions

The project is on track with its effort to redevelop as many DOS programs as possible.

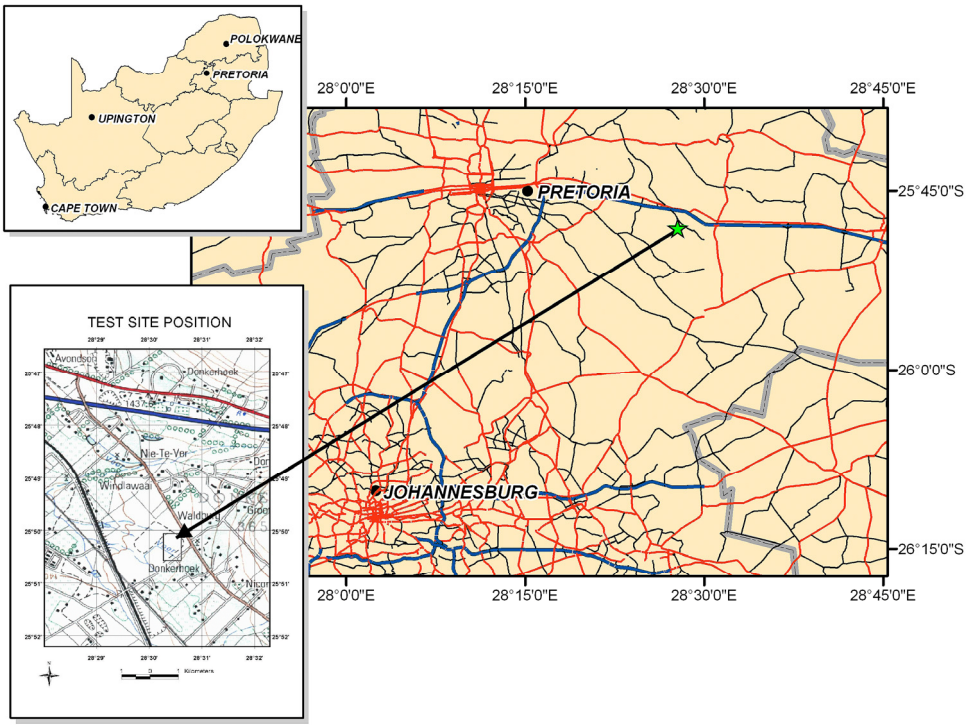
Future activities

During 2009/10 more Windows programs will be developed using the existing FORTRAN code.

EDUCATION THRUST

2006-0905 **DEVELOPMENT AND TRAINING AT GEOPHYSICAL TEST SITE**

Project leader: R.H. Stettler, Nat.H.Dip.
Project team: R.L. Legotlo, B.Tech., P.K. Nyabeze, M.Sc., E. Chirenje, M.Sc., L. Loots, B.Sc.Hons. R.M. Sethobya, B.Tech., M.A. Sekiba Nat.Dip. O.W. Dingoko, B.Sc.Hons.
Primary objective: *to test instruments and provide training.*
Duration: Ongoing.
Budget: Total: R167 940; 2008/9: R45 000.



Motivation

During the past two years the Geophysics Unit has attempted to establish an environmental test site at Donkerhoek, but the results have been unsatisfactory. It was therefore decided to focus on one or more places having known geological features (faults, dykes, sinkholes, etc.) and to establish a geophysical test site where instruments can be tested and personnel and students can be trained.

Progress

During the period under review the CGS purchased a high-precision navigation magnetometer, multi-channel resistivity, an electromagnetic system and a gravimeter. The equipment was successfully tested at the CGS's Donkerhoek property located 25 km east of Pretoria.

The magnetometer (Scintrex NAVMAG SM-5) has a built-in GPS unit and can measure up to an accuracy of 0.01 nT and can be used for mineral exploration and geological studies. The multi-channel resistivity unit (Iris SYSCAL Pro 48 Channel) can automatically investigate lateral and depth variations in apparent resistivity. The electromagnetic unit (Geonics EM-34) can be used to rapidly investigate ground conductivity variations to depths of 60 m and can be used for engineering, environmental and mineral exploration surveys. The gravimeter (Scintrex CG5) was tested at Bapsfontein located 20 km south of the site at Donkerhoek and can be used effectively to identify areas which show density contrasts, for example sinkholes in dolomitic areas.

Conclusions

This report showed that the instruments collected high-quality data successfully. Equipment will continue to be collected using similar guidelines in future years, to ensure the optimum operation of the equipment.

EQUIPMENT MAINTENANCE

2009-1027 **CALIBRATION OF GRAVITY METERS**

Project leader: R.H. Stettler, Nat.H.Dip.
Project team: R.L. Legotlo, B.Tech.
Primary objective: *to determine which of the gravity meters are still functional and to calibrate those that are.*
Budget: 2008/9: R10 892.

Motivation

The purpose of this project is to calibrate the gravity meters so that the readings obtained by different instruments are the same. This is important when two gravity meters are employed on the same job or if the work is tied to the national gravity grid.

The Scintrex CG5 Autograph.

Progress

The CGS presently has eleven La Coste and Romberg gravity meters. These instruments were bought in the 1970s and were primarily used for the regional gravity program. After completion of this program they have mostly fallen in disuse.

During July and August 2008 all the La Coste and Romberg gravity meters were tested extensively and only one was found to be working correctly (although the display was very dark and the operator would have problems reading it under normal field conditions). These gravity meters were not repaired due to the uneconomic costs involved.

It was realised that one of the Scintrex Autograph CG5 gravity meters was giving erroneous readings in that the drift was very high. At the advice of the agent this gravity meter was tested and several suggestions were made, all with limited or no results. It was decided to postpone the national calibration of the gravity meters until both instruments are in good working order, and to carry out a local calibration instead. This was done with the other CG5 gravity meter and the value was within 0.01 milligal of the tied-in value. This made it unnecessary to calculate a new calibration factor.

Conclusions

One Scintrex Autograph has been successfully maintained and calibrated, and the other one is still being tested, and the data are being sent to the technical team at Scintrex. It is recommended that a national calibration (between Pretoria and Paarl) be done once both are in good working order.

INFORMATION AND COLLECTIONS MANAGEMENT

MUSEUM

Curator: L. Marais-Botes, B.A.(Hons)
Scientist: E. de Kock, M.Sc.
Graphic designer: A. Raath, Nat.Dip.
Project team: M.K. Mohuba, S. Mahwayi

The Geoscience Museum is located in the premises of the Transvaal Museum in central Pretoria. The collection of the museum is made up of gemstones, meteorites, and mineral and rock specimens. Approximately 9 000 of an estimated 29 000 specimens are on display in two large display halls in the museum. Staff members of the Geoscience Museum are engaged in the research, planning and design of a new fossil exhibition. This exhibition will showcase some unique specimens in the palaeontology collection of the CGS.

The past year also saw the launching of the first holiday programme for primary school learners at the museum. The goal of the holiday programme initiative is to teach especially primary school learners the history of the earth in a fun and entertaining way. An overwhelmingly positive feedback was received from attendees and their parents regarding the holiday programme.

Two new staff members joined the museum in 2008, Ellen de Kock as Scientific Officer and Leonie Marais-Botes as Curator.

PUBLICATIONS

Editors: S.J. van Eck, B.A.(HED), Z. Nel, M.A., J.A. van Heerden, B.A.(Lib.).
Graphic designer: A. Becker, H.Nat.Dip.

The following publications were released during the year:

Memoir 97: Geology of the Vredefort Impact Structure: A guide to sites of interest by R.L. Gibson and U.W. Reimold
Bulletin 139: Principles for mainstreaming gender equality in the South African rural water services sector by U.A. Rust
Bulletin 140: Preferential flow modelling in a vadoze zone using Macro 5.0 by K.A. Majola
Explanation: Sheet 2628BA. The geology of the Delmas area (1:50 000) by S.A.B. Laubscher and C. Lubbe
Explanation: Sheets 3322CD and 3422AB. The geology of George and environs (1:50 000) by D.L. Roberts, J.H.A. Viljoen, P. Macey, L. Nhleko, D.I. Cole, L. Chevallier, L. Gibson and F.D.J. Stapelberg
Explanation: Sheet 2429AA. The geology east of Mokopane (1:50 000) by N. Baglow and G. Brandl
Explanation: Sheet 2627DB. The geology of the Vereeniging area by P.J.A. Bosch and M.S. Cronwright
Explanation: Sheet 2531AC. The geology of the Witrivier area (1:50 000) by M.S. Cronwright, L.J. Robb and P.J.A. Bosch
Explanation: Sheet 3318DC. The engineering geology of Bellville and environs, Western Cape, South Africa (1:50 000) by F.D.J. Stapelberg
Explanation: Sheet 2930CB. The engineering and geotechnical conditions for the Pietermaritzburg 2930CB 1:50 000-scale map sheet by N.P. Richards, G.A. Botha, P. Schoeman, B.M. Clarke, M.W. Kota and F.N. Ncgobo
Seismological Series 41: Catalogue of earthquakes in southern Africa and surrounding oceans for 2005 by I. Saunders and D.L. Roblin
Annual Report of the Council for Geoscience 2007/08
Annual Technical Report of the Council for Geoscience 2007/8 by R.R.M. Price
GeoIndaba 2006
South African Committee for Stratigraphy (SACS). Catalogue of Lithostratigraphic Units. Volume 10 by M.R. Johnson
South African Committee for Stratigraphy (SACS). Lithostratigraphic Series No. 50. Lithostratigraphy of the Msikaba Formation (Cape Supergroup) by M.R. Johnson
35th International Geological Congress 2016: Bid Document by the Council for Geoscience of South Africa, the Geological Society of South Africa and the South African National Committee of the IUGS
International Association of Seismology and Physics of the Earth's Interior (IASPEI) General Assembly 2009. Booklet
Council for Geoscience, 2008. GEOClips Newsletter, 24, June 2008.
Council for Geoscience, 2008. GEOClips Newsletter, 25, September 2008.
Council for Geoscience, 2008. GEOClips Newsletter, 26, December 2008.
Council for Geoscience, 2008. GEOClips Newsletter, 27, March 2009.

2008-0500 **NATIONAL CORE LIBRARY**

Core Library Manager: J. Mathebula.
Project team: R.R.M. Price, B.Sc.Hons (Database Manager)
Primary objective: *to curate the borehole core collection and make it available to researchers.*
Duration: Ongoing.

Motivation

Boreholes are expensive to sink, and all material acquired as a result of drilling exercises must be managed for the good of the country.

Progress

During the year a number of borehole core were donated to the National Core Library. The largest of these donations was a collection of core from platinum exploration programmes which had been drilled by Impala Platinum Ltd. These core were transported to Donkerhoek by Impala Platinum Ltd.

A number of holes were donated by JCI/Randgold, but were transported from a storage shed at City Deep at the expense of the CGS. Towards the end of the process of transporting the core, new tenants of the shed discarded the core which had not already been moved. The management of JCI/Randgold were not able to supply logs and localities of the boreholes and work will have to be done to match the core with information available on the Coredata database.

Core received at Donkerhoek during the year:

Durban Harbour, South Pier (previously stored at Pietermaritzburg). (Tertiary–Quaternary)
Canelands, KwaZulu-Natal (Ecca Group)
KE 32 07 14 - Ogies (Ecca Group)
PC 113 (Onverwacht 509 JR) (Ecca Group)
LMV 8 (Elandsfontyn 349, Malmesbury District) (glass sand)(previously at Bellville)
Boreholes CH1 and CH3 from Coulter 391 JU, Malelane area (Barberton Sequence)
Boreholes MH2 and MH6 from Mhlati 170 JU, Malelane area (Barberton Sequence)
Impala Platinum Ltd: 123 holes. Only original holes are listed below, and many have two or more deflections. These holes intersect the Rustenburg Layered Suite.

Blaauwbank	168	JS	7 holes
Danspan	139	KS	1 hole
De Kroon	444	JQ	1 hole
Elandsfontein	440	JQ	5 holes
Fortdraai	517	KS	1 hole
Grasvally	293	KR	4 holes
Hoekfontein	432	JQ	3 holes
Kameeldoorn	71	JS	5 holes
Loskop Suid	53	JS	3 holes
Mphatleles Location	457	KS	4 holes
Nonnenwerth	421	LR	36 holes
Palmietfontein	208	JP	11 holes
Rietfontein	70	JS	3 holes
Rooikraal	188	JS	2 holes
Ruighoek	169	JP	14 holes
Uitvalgrond	444	JQ	1 hole
Volspruit	326	KR	22 holes
Zoetveld	294	KR	4 holes
Zwarthoek	501	KS	4 holes
Zwartkoppies	296	JQ	1 hole

As a result of the deployment of staff of the core library at the Logistics Unit, very little core could be transferred to trays for storage in the Core Library, and most of the core transported is stored in a temporary shelter.

Samples taken from the Gautrain tunnel are also stored at the National Core Library. These have been collected from the tunnel and delivered to the CGS by Professor Carl Anhaeusser of the University of the Witwatersrand.

The National Core Library had seventeen visitors examining borehole core during the year.

2008-0374 SAGEOLIT

Sageolit (the South African Geological Literature Database) has developed, over the last 15 years, into a competitive database for external users, maintaining its functions as an administrative tool for internal use by CGS staff. Sageolit is a module of GEODE and is constituted of data stored in a number of Oracle tables. Sageolit records are tagged 'SL' in Oracle to distinguish them from records belonging to other databases. The number of Sageolit records added during the year was 5 325.

Tables also link the Cadastral database and SACS database to Sageolit, which allow searching on Sageolit records using farm data and lithostratigraphic unit names. The following records were added to the farm-links and lithostratigraphic-links tables during the year:

Farms links	2 360
Lithostratigraphic unit links	3 724
Total	6 084

The “Interim Reports Table” lists all CGS reports, both submitted and in progress. The primary function is to uniquely allocate report numbers and record basic data, and to transfer the information to Sageolit when reports are submitted. This table can also be used to track work in progress.

Analysis of current status of Sageolit records:

Type of document recorded	Number of records
Aerial photographs	397
Books	9 230
CDs	268
DVDs	46
Documents on CD	2 020
Files	1 270
Government publications	2 298
Magazine articles	4 042
Peer-reviewed journals	31 965
Unclassified journals	87 841
Negatives	57
Published maps	53 211

Type of document recorded	Number of records
Plans, sections, etc. (approx.)	32 520
Printed satellite images	203
Prospecting permits	56
Reports	23 714
Reports, with borehole logs	2 145
Soekor borehole logs	28
Theses	749
Unpublished maps	14 101
Video cassettes	6
Sageolit records on GEODE table ‘Data_Sources’	264 147
Total of links, uncompleted reports and Sageolit records on Data_Sources table.	270 672

In addition, 1 687 documents were scanned for clients and stored on the server. Each document image will be listed on Sageolit for easy retrieval, and records will be distinguished from the original listing (which references the hard copy) by:

i) the contents of the document identity (Doc_ID) field, which contains the file name;
ii) the medium, which indicates whether it is a digital copy, and
iii) the repository locality, which in the case of digital images, will indicate that the document is stored on the server.

KWAZULU-NATAL

Statutory work carried out by staff of the KwaZulu-Natal Unit is listed under 'International' at the beginning of this report.

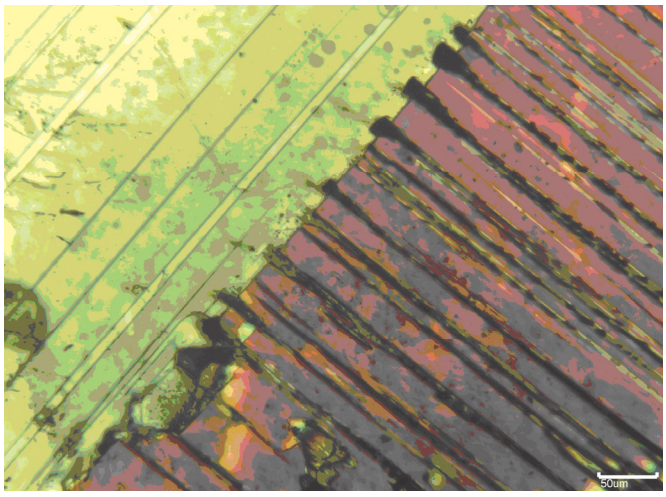
LABORATORY

2005-0889 **WHOLE-ROCK AND MINERAL GEOCHEMISTRY OF THE MAIN ZONE AND PLATREEF INTERSECTED IN BOREHOLE MO-1 ON MOORDKOPJE 813 LR**

Project leader: F. Roelofse, B.Sc.Hons(Geol.), B.Sc.Hons(Metall.), B.Tech.(Qual.).
Project team: M. Cloete, Ph.D., Prof. L.D. Ashwal, Ph.D. (University of the Witwatersrand).
Primary objective: *to characterise the Main Zone and Platreef on the farm Moordkopje 813 LR in order to elucidate the magmatic evolution of the Northern Limb of the Bushveld Complex.*

Motivation

Despite numerous studies on the magmatic evolution of the Bushveld Complex, its evolution as a whole and in particular that of the Northern Limb, remains poorly understood. In 2005 Ashwal and co-workers made the most recent significant contribution to the understanding of the magmatic stratigraphy of the Northern Limb of the Complex by constructing a data set of nearly continuous geophysical and geochemical measurements from a study of the 3-km-deep Bellevue borehole core MO-1. This borehole intersected the entire Upper Zone to depth and almost half of the Main Zone. This project will characterise the remainder of the magmatic succession of the Northern Limb from the mid-Main Zone down to the Platreef. This work was partly funded by the A.G. Bain Fund of the GSSA.



Photomicrograph showing exsolution lamellae of orthopyroxene in clinopyroxene (dark) protruding into an adjacent plagioclase crystal in a gabbronorite from the base of the Main Zone. The texture is thought to be the result of the infiltration of melt into a nearly solidified crystal mush.

Progress

During the year Rb-Sr and Sm-Nd isotope data were collected from whole rock and mineral separate samples in intervals exhibiting reversed differentiation trends (as exemplified by increasing Mg # upwards) within the Main Zone, but the team ran into unexpected analytical difficulties and the work is still in progress.

Initial measurements indicate significant Sr-isotopic disequilibrium between co-existing plagioclase and orthopyroxene in some samples, which initially may suggest that these minerals crystallised from isotopically distinct magmas. Unfortunately, Nd-isotope data is still not available and it will have to be seen whether isotopic disequilibrium also exists in the Sm-Nd system. The existence of isotopic disequilibrium between co-existing minerals would suggest that whole-rock isotope data be interpreted with caution.

Conclusions

The work is still in progress, and analytical results are awaited.

Future activities

Completion of the project is envisaged when all the isotope data are available.

2007-0952 **XRF ANALYSIS OF PEATS AND SEDIMENTS OF LAKE ST LUCIA**

Project leader: H.C.C. Cloete, B.Sc.Hons.
Project team: P-L. Grundling, M.Sc. (Peatlands for Wetlands Forever), M. Cloete, Ph.D.
Primary objective: *to establish a standard analytical method for peat by X-ray fluorescence spectrometry at the CGS and to determine the chemical composition of the peat and sediments of Lake St Lucia.*
Project duration: 2007/8 to 2010/11.

Motivation

The current method used to analyse peat at the CGS is based on a combination of methods gathered from literature, but the method was not fully tested as there are no local peat reference materials. Piet-Louis Grundlingh of Peatlands for Wetlands Forever, who is investigating water movement through the wetland and peat formation at St Lucia for a Ph.D. degree, had been contacted in order to obtain peat samples for the development of a standard XRF method. In exchange for his assistance with the sampling, the CGS had placed some piezometers around the Mfabeni wetland during April 2007.

Specific elements of the project will be:
– Development of a standard analytical method of peats at the CGS;
– Investigation of the peat layers to determine whether the underlying clay had a marine or terrestrial origin;
– Investigation of the sandy layer in the peat at the Holocene and Pleistocene boundary to determine whether the sand was transported by wind or water, and
– Investigation of the various ash, diatomite, coal and Fe-Mn nodule layers to determine their origin.

Progress

Literature studies indicated a growing interest in peat owing to its important role in the climate and environmental research as peat lands are uninterrupted records of past environmental and climatic conditions.

Two field trips to St Lucia were undertaken during the 2007/8 financial year. During the first field trip, ten piezometers were installed after hollow-stem auger drilling by the Water Geosciences Unit's drilling team. Other sampling activities included filling five 25-litre buckets with different types of peat for experimental purposes, and drilling with a peat drill and sampling the core every 25 cm or 50 cm. Five peat drill core were sampled with the depth varying from 2 to 10 m, and pH and eH readings were also taken.

The new Anatech USA SCE 100 oxygen plasma asher for low temperature ashing of organic matter-rich samples.

During the year an oxygen plasma asher was installed. The oxygen plasma asher allows low-temperature ashing of samples in a partial vacuum to preserve the mineralogy, and to retain some elements which would otherwise be lost by high-temperature ashing. The oxygen plasma asher will be used for the mineralogical characterisation of the clay layer from peat core C4 by XRD and particle size distribution of the ash and clay layer from peat core C2.

Future activities

Owing to the partial vacuum required for the plasma chamber, on re-introduction of air into the sample chamber the ashed sample floated in the sample chamber and stuck to its walls. A slow-release vacuum pump system was installed on top of the asher and different combinations of oxygen flow rate and the wattage for the plasma are to be investigated for the optimal ashing of the peat samples. After establishing this combination, the available samples will be ashed and then analysed by XRF and XRD.

2007-0955 **THE CHEMICAL INTERACTIONS BETWEEN THE GEOLOGICAL ENVIRONMENT AND THE BIOLOGICAL COMPONENTS WITHIN LARGE DRAINAGE BASINS**

Project leader: L.J. Jordaan, M.Sc.
Project team: M.C. Rademeyer, B.Sc., L.P.D. de Wet, Ph.D.
Primary objective: *to quantify the transport of chemical components through large drainage basins from the geological environment to within the biological components.*
Duration: 2007/8 to 2010/11.
Budget: R57 250.

An increase in abundance of blue-green algae at the inlet of Loskop Dam is related to a serious decrease in the water quality of the Olifants River.

Motivation

The project aims to find ways of linking fish to specific environments. The approach is based on the assumption that fish living in a specific dam should be in equilibrium with that dam. This implies that there should be a chemical correlation between the dam sediments, the water and the fish. The chemical composition of a fish can therefore be used to trace the water that it lived in and the drainage basin that supplies the dam. The geological or anthropogenic origin and pathways of pollutants and toxins can thus be established.

Progress

Excellent progress was made on the project until July 2008, when maintenance issues forced the closure of the Radiogenic Isotope Laboratory. The ICP-MS facility also closed in November 2008 owing to the same problem. The focus of the project shifted to other types of analyses, field work and limited data interpretation. Water and sediment sampling were completed while fish sampling progressed well in spite of problems in obtaining permits for netting in some provinces.

Conclusions

Initial interpretation of Sr isotope ratio data showed a remarkable correlation between dam water and the fish from the same dam. This correlation was investigated in four large drainage basins, namely the Olifants River basin where the study was initiated owing to irregularities at a fishing competition, the Crocodile River basin, the Mgeni River basin and the Orange/Vaal River basin. Data obtained showed clearly that fish within a specific dam all have the same Sr isotope ratio in their fin bones regardless of species, age, sex and condition. This correlation can therefore be used as a forensic tool to identify fish that do not fit into the natural pattern. The Sr isotope ratio generally increases with distance from the source within tertiary drainage basins and is determined by the prevalent geology of the formations being weathered. In large rivers such as the Vaal, where pollution also plays a role, the pattern is much more complicated.

Future activities

Most of the required water, sediment and fish sampling have been completed and the project can progress with chemical analyses and interpretation.

2008-0987 **CARBON-DIOXIDE SEQUESTRATION BY INDUSTRIAL MINERAL CARBONATION: EVALUATION OF INDUSTRIAL ALKALINE WASTES AND THEIR LEACHATES**

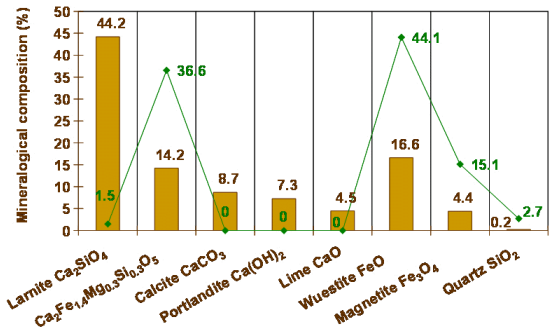
Project leader: F.J. Doucet, Ph.D., Chem. Eng., Pri.Sci.Nat.
Primary objective: *to identify suitable industrial alkaline wastes for long-term CO_2 sequestration, and to subsequently develop and test small-scale industrial dissolution and carbonation processes for the most promising wastes.*
Duration: 2007/8 to 2010/11.
Budget: 2008/9: R22 888.

Motivation

Although South Africa is currently not required to reduce its CO_2 emissions, it is a signatory to the United Nations Framework Convention on Climate Change and to the Kyoto Protocol, and its participation in the international effort to lower CO_2 emissions will become mandatory sometime after 2012. The total CO_2 emission in South Africa currently accounts for over 440 million tonnes per annum.

A combination of several climate change mitigation measures is required to effectively reduce atmospheric emissions of CO_2 from human activities. CO_2 sequestration by mineral carbonation of alkaline wastes is a recognised promising option for the permanent and safe storage of CO_2, although no economically viable processes have been successfully developed as yet.

The overall objective of this project involves the theoretical and experimental evaluation of a range of readily available alkaline wastes and the early development of promising technological approaches and processes that can effectively dispose of CO_2 by chemically binding it with the wastes to form stable carbonates.



X-ray diffraction pattern showing the conversion of calcium-containing phases (except for brownmillerite) from steel slag following leach treatment. This illustrates the mineralogical composition of untreated (histogram) and treated (green lines and lozenges) slags and offers direct evidence of calcium dissolution and its availability for further carbonation.

Progress

Eleven alkaline wastes with theoretically desirable properties for CO_2 sequestration were identified and acquired from three industrial sectors (Paper recycling; Steel-making, and Platinum mining). Preliminary dissolution experiments were performed. Steel slags were shortlisted as they were found to be the most reactive materials. This study has therefore narrowed its focus on three basic oxygen furnace slags (BOF) and one electric arc furnace (EAF) slag generated at various steel mills in South Africa.

The cumulated 'effective' CO_2-specific sequestration capacity (calculated on the basis of dissolved calcium and magnesium) of the four slags was found to be 253 000 tonnes CO_2 per annum, which was 25.2% lower than the 'theoretical' capacity (estimated on the basis of total calcium and magnesium content in slags). This cumulative sequestration volume was estimated on the basis of fresh slag production in a single year and did not include previously dumped material which can be measured in millions of tonnes. Based on the total amount of the four slags which was generated over the last ten years, an estimated 2 418 000 tonnes of CO_2 could theoretically be sequestered in existing slag dams.

The most promising leaching process developed to date at the CGS allows rapid, near-complete leaching of calcium and magnesium from slags for subsequent carbonation and has the additional benefit of generating a non-dissolved residue with possible commercial value.

Future activities

Further development and optimisation of accelerated mono- and multi-stage leaching and carbonation procedures will be carried out, with emphasis given on the kinetic and mechanistic aspects of chemical reactions, and the structure, physico-chemical and mechanical properties and stability of formed carbonated products.

2008-0999 **ONGOING SAMPLE PREPARATION SERVICES**

Project leader: D.N. Marajh, B.Sc.Hons.
Project team: S.P. Zondi, T.C. Khazamula, L.L. Semelane, M.M. Ramoshaba, S.M. Mgamlana, I.M. Phahlane, T.J. Mbonane.
Primary objective: *to provide basic sample preparation services such as crushing, splitting and milling.*
Duration: Ongoing.

Motivation

The sample preparation process entails extracting a compositionally representative portion from the rocks or soils sample submitted, and reducing it to a fine homogeneous powder. This powder is then the subject of other analytical techniques, such as X-ray diffraction, X-ray fluorescence and ICP-MS analysis.

Progress

The Sample Preparation Section prepared 3 872 samples for crushing, 12 350 for milling, 3 397 for splitting, 14 931 for sieving and 16 035 for drying of samples for the current financial year. On average 494 samples per week were prepared during the reporting period.

Conclusion

It is essential that the Sample Preparation Section must cater for the growing demand for faster service delivery for both clients from inside and outside the CGS, which requires well-trained and experienced staff.

Future activities

The Sample Preparation Section is currently in a transition stage of relocating to a new crushing facility which will allow better sample flow rate and sample management.

2009-1038 **SECONDARY MINERALS OF THE BUSHVELD COMPLEX**

Progect leader: M. Atanasova, M.Sc.
Project team: Prof. B. Cairncross, Ph.D. (University of Johannesburg), H. Windisch.
Primary objective: *to document the occurrence of secondary mineralisation that appears as microminerals from selected localities in the Bushveld Complex.*
Duration: 2008/9 to 2010/11.

Motivation

The Bushveld Complex of South Africa is famous as the largest layered complex in the world and for its vast reserves of platinum, chromium and other economic deposits. Apart from these elements, the Bushveld Complex has also been a source of secondary mineralisation. A few of these occurrences have been published but most remain relatively unknown to mineralogists and geologists, and others interested in South Africa's mineralogical heritage. This project will add to the database of knowledge on the mineralogy and genesis of the Bushveld Complex. The publication will complement existing literature on the Bushveld Complex and will be a useful reference to geologists and mineralogists. It will also appeal to the general public, inspire wider appreciation of our country's mineral heritage and promote responsible mineral collecting.

Azurite with malachite from Vergenoeg. Field of view 3,1 mm.

Progress

During this first year of the project, the work mostly entailed identification of mineral specimens and species, site field visits and specimen collection, as well as a literature study. The progress report includes an introduction to the project, geological overview of the Bushveld Complex and brief notes on secondary mineralisation, microminerals, micromounting and mineral collecting. Five of seventeen localities with secondary mineralisation are presented at this stage, namely Argent, Boekenhouthoek, Buffalo Fluorspar, Edendale and Houtenbeck. These are introduced by notes on the location, the history of discovery and exploration, and a basic overview of the geology of the area,

followed by a chapter on the site mineralogy, with mineral descriptions and colour and SEM photographs.

Future activities

Continue with the identification of mineral species, visits to sites, literature surveys and writing site descriptions for the remainder of the localities in the Bushveld Complex.

2002-0332 **ONGOING ANALYSIS, ANALYTICAL CHEMISTRY LABORATORY**

Project leader: L.J. Jordaan, M.Sc.
Project team: H. Maritz, B.Sc.Hons, A.N. Shabalala, B.Sc.Hons, M.T. Lehaha, B.Tech., L.M. Mokete, B. Tech., L.L. Sathekge, Nat.Dip., R.H. Sello, R.M. Papo, M. Vuma.
Primary objective: *to provide analytical services.*
Project duration: Ongoing.

The new Mercury Analyser which has been fully commissioned. The instrument can determine the Mercury concentration in both liquids and solids in parts per billion, with very little sample preparation.

Motivation

The CGS requires chemical analyses of rocks, soils and water to make interpretations on local and international resources, to verify geological mapping, to identify exploration targets and to quantify environmental hazards.

Progress

During the reporting period the Analytical Chemistry Laboratory showed significant growth in infrastructure. The installation and commissioning of a new ICP-MS instrument, a Mercury analyser and a perchloric acid laboratory were completed. Challenges included the shut-down of the entire ICP-MS and sample preparation facility from November 2008 owing to administrative delays in the installation of the laboratory air filtration system, problems with contractors, as well as delays in procurement procedures.

Conclusions

It is essential that the Analytical Chemistry Laboratory caters to the needs of all its clients both within and outside of the CGS. This implies a stable and dedicated staff component, serviceable modern instruments and participation in commercial and research projects.

Future activities

The Analytical Chemistry Laboratory initiated an expansion programme to cater for the analyses of soil samples from the regional geochemical mapping programme. The installation and commissioning of additional sample preparation facilities will be completed in 2009/10. The Laboratory will align all analytical procedures with SANAS 17025 accreditation requirements.

5030 **ONGOING PETROGRAPHIC SERVICES**

Project leader: F. Roelofse, B.Sc.Hons(Geol.), B.Sc.Hons(Metall.), B.Tech.(Qual.).
Project team: Z. Sithole, B.Sc.Hons, S.D. Kgaditse, S.A. Dikgomo, T.S. Monyayi.
Primary objective: *to provide a thin section service and related petrographic services to researchers.*
Duration: Ongoing.

Motivation

The study of rocks and minerals under the optical microscope or the more advanced electron microscope is one of the fundamental investigative procedures in geology and the petrographic study of rocks is frequently one of the first analytical methods employed in geological investigations. The availability of high-quality petrographic preparations such as thin and polished sections is one of the fundamental necessities in a geological research institute.

The Discoplan-TS that was acquired during the year.

Progress

The production of the section was higher than the previous financial year, since about 1 157 products were produced. This amount excludes work performed for external clients, which showed a significant increase over the previous financial year. The scientific personnel of the section also contributed to other research projects within the organisation.

Conclusions

This service will continue to be offered as a basic component of the operations of the CGS Laboratory.

5036 ONGOING MINERALOGICAL ANALYSIS: X-RAY DIFFRACTION

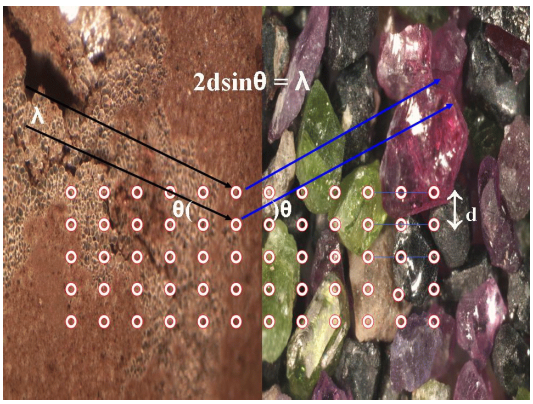
Project leader: M. Atanasova, M.Sc.
Project team: T. Roelofse, B.Sc.Hons, K. Enoch, B.Sc.Hons, C.Reay, B.Sc.Hons, N. Dlamini, B.Sc.
Primary objective: *to provide mineralogical analysis to the CGS and general public*.
Duration: Ongoing.

Motivation

Mineral identification and material characterisation are required for a broad range of applications, programmes and projects in which the CGS is currently involved. Mineralogical evaluation is essential for the description and compilation of geological maps, mineral exploration, identification of environmental hazards for risk assessment, and economic evaluation of mineral resources.

Progress

XRD services include bulk mineralogical analysis and detailed clay fraction studies. Routinely phase analyses are reported as qualitative phase identification and semi-quantitative evaluation of XRD traces, where quantitative Rietveld analysis is available on request. Geological and geotechnical interpretation of mineralogical data is provided to assist clients in the evaluation of data.

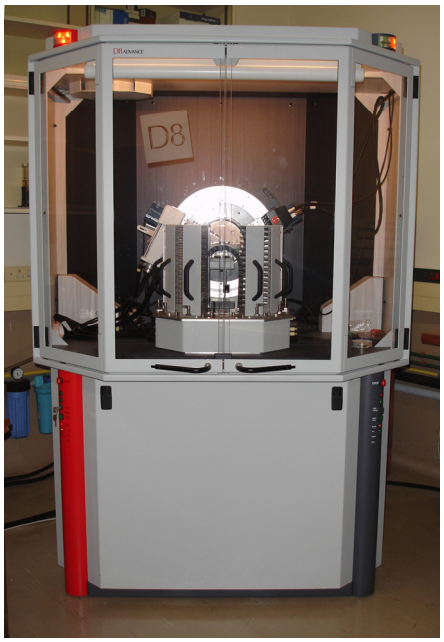


Bragg's Law: 2d.sin2 =8.

A total of 2 723 samples were analysed during the year. Analytical work on approximately 977 samples was provided for various statutory projects of the CGS. These included the Industrial Minerals Map of South Africa (2005-0861) and Mineral Carbonation (2008-0987), and various method development projects of the analytical sections of the Laboratory. Major projects involve the industrial minerals sector – brickmaking and ceramics applications, construction and road building, the environmental sector – dust analysis, asbestos investigation, water purification systems, animal nutrition, minerals development, high-temperature engineering, mineral exploration and small-mine developments.

Most of the work was performed on the Bruker D8 Advance purchased during 2007. This system uses the latest powder diffraction technology and has a modular design and versatile configuration. With its silicon strip detector, ultra-fast diffraction measurements are performed while still maintaining good angular resolution and peak shape. The system produces high-resolution X-ray powder diffraction data, as well as fast and reliable results.

During the reporting year a new benchtop ED-XRF spectrometer was purchased for the Laboratory. The S2 RANGER is precalibrated for element analysis from everyday routine samples to totally unknown materials.



Bruker D8 Advance XRD system.

Future activities

The unit will continue to develop methods and procedures to expand analytical applications and services to attract new market sectors. In adopting the latest developments in X-ray diffraction technology, instrumentation and software, and mastering the vast range of additional applications they offer, new knowledge and skills will be acquired and developed. This will align the CGS with the leaders in advanced research in the fields of applied mineralogy and crystallography and their application in mineral exploration, mineral processing and environmental sciences.

5039 **ONGOING LABORATORY ANALYSES AND SERVICES: ROUTINE XRF ANALYSIS**

Project leader:	H.C.C. Cloete, B.Sc.Hons.
Project team:	N. Shongwe, Nat.Dip., K.I.G. Burger, M.E. Tsaagane, M.J. Matji.
Primary objective:	*to provide chemical analyses by X-ray fluorescence spectrometry*.
Duration:	Ongoing.

Motivation

X-ray fluorescence spectrometry (XRF) is the emission of characteristic 'secondary' (or fluorescent) X-rays from a material that has been excited by bombarding it with high-energy X-rays. At the CGS it is used for the chemical analysis of rocks, soils, ceramics and building materials, and for research in geochemistry.

Progress

Two X-ray fluorescence (XRF) spectrometers are used for the analysis of a wide range of samples:
(a) PANalytical Axios, a wavelength sequential XRF spectrometer equipped with a 4 kW Rh-tube. It is mainly used for the determination of major-element oxides such as SiO_2, TiO_2, Al_2O_3, Fe_2O_3(t), MnO, MgO, CaO, Na_2O, K_2O, P_2O_5 and Cr_2O_3 on fusion disks and trace elements (As, Ba, Bi, Br, Ce, Co, Cr, Cs, Cu, Ga, Ge, Hf, La, Mo, Nb, Nd, Ni, Pb, Rb, Sc, Se, Sm, Sr, Ta, Th, Tl, U, V, W, Y, Yb, Zn, Zr) on pressed powder wax pellets. A total of 4 800 samples were analysed.
(b) PANalytical MagiX, a wavelength simultaneous XRF spectrometer equipped with a 4 kW Rh-tube. The samples from the stream-sediment sampling project and the Ghana project are analysed by the MagiX on pressed powder wax pellets. Twelve thousand samples were analysed in comparison with 7 400 during the 2007/8 financial year.

The PANalytical Axios wavelenght dispersive XRF spectrometer.

Most of the XRF section's work is in support of the geochemical mapping project and various statutory projects. Analyses were carried out for the Ghana project, and for clients in the ceramic and exploration industries.

Conclusion

In spite of the loss of a scientist for five months, the XRF team provided analytical services to the CGS and commercial clients at a larger scale than the previous financial year.

Future activities

In preparation of the ISO certification of the Laboratory Unit, standard analytical packages on both the MagiX and Axios spectrometers are to be reported and standard operating procedures formalised.

5182 **ONGOING CERAMIC INVESTIGATIONS**

Project leader:	M. Atanasova, M.Sc.
Project team:	A.D. Mabela, N.Dip. (Ceram.Tech.), J. Friedland, B.Sc.Hons, K.S. Khumalo, P.B. Mchunu.
Primary objective:	*to i) identify raw materials for use in the ceramics industry; ii) optimise their use by mix development; iii) assist the ceramics industry in process control; iv) solve technical, ceramic and production problems in the ceramics industry, and v) assist small-scale entrepreneurs to set up ceramic-product factories.*
Duration	Ongoing.

Motivation

The Ceramics Laboratory focusses on investigating clays, which, although not a very precious material, occur abundantly and play a vital role in the economy. The main activities of the Ceramics Laboratory are the evaluation of clays to determine suitability for possible uses, site investigations of clay deposits, mix development and process control for existing manufacturers such as tile and brick plants. These activities involve analytical procedures such as physical evaluations, flexural strength determinations and dilatometry, which is the measurement of thermal expansion over a given temperature range. This is important in the ceramics industry, especially for determining the compatibility between a glaze and the clay body to which it is applied.

The physical evaluation entails a laboratory simulation of a manufacturing process to test the suitability of a material or process. The steps of the physical evaluation are the same as those for the envisaged production process, but include measurements such as flexural strength, water absorption, shrinkage, and the identification of problems such as lamination, cracking, black coring and melting. The investigation usually begins with the production of laboratory-scale equivalents of a ceramic product, by dry pressing, extrusion, slip casting or hand shaping from finely ground wet clay. These are dried and subsequently fired to determine the optimum firing temperatures. The fired samples are also tested for flexural strength.

A physical investigation can show that a given material is not suitable for ceramic production. In many cases, naturally occurring clay is unsuitable for manufacturing, and the addition of other materials such as sand, feldspar or other clay materials is required. Raw materials are usually investigated individually for mineralogical and chemical, as well as physical properties. Subsequently mixes are developed to optimise properties, which can be used for manufacturing ceramic products such as sanitary ware, bricks, tiles and many more products.

In a manufacturing plant it is vital that the compositions of the raw materials and the processes are consistent over time. The Ceramics Laboratory offers process control to a variety of production plants. This involves sampling, mineralogical and chemical analyses and the plotting of analysis results to show trends.

Progress

Approximately 500 samples were submitted for XRD analysis contributing and approximately 350 samples were submitted for XRF analysis.

The key focus area was in the brick and tile industry. Process control was performed for various companies, which entailed providing chemical, as well as mineralogical analyses of raw materials and mixes. Results were presented graphically to determine drifts or possible deviations from desired compositions. Occasional advice was given for small production problems experienced in the production plant. Mineralogical, chemical and full physical investigations were performed on about 20 clays for statutory work purposes.

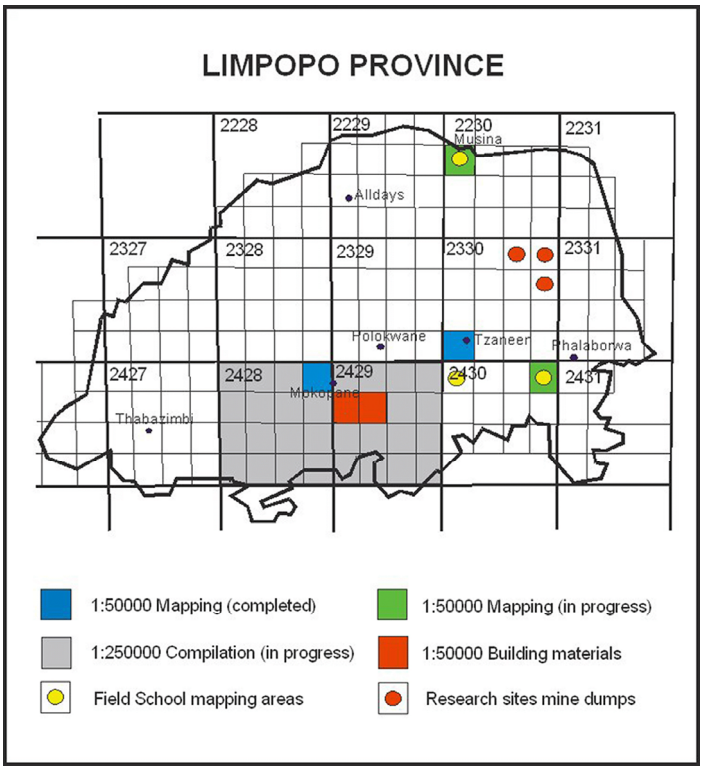
An investigation was undertaken at Mapochs Mine to determine possible uses of the clay-rich materials in the overburden. A study was carried out on the effect of sample size and milling time of clay samples on grain size distribution and subsequently on the XRD results. A mix development study was carried out to determine the effect of various mineral proportions on the physical properties of resulting laboratory-scale bricks. Repeatability of dilatometry measurements in the ceramics laboratory was investigated with various sets of test runs. This also included the effect of different firing temperature gradients.

Future activities

Requests for dilatometry are increasingly exceeding capacity, therefore the purchase of a second dilatometer is strongly considered. The purchase of an autoclave designed specifically for the ceramics industry is being considered, as there have been numerous requests for this service by various clients.

LIMPOPO UNIT

The Limpopo Unit, based in Polokwane, carries out geological mapping of the province, and in addition, the unit is actively involved in providing geological information to prospectors to assist them in their applications for DME prospecting permits for a variety of minerals on available ground. Enquiries from the public generally involve either the mineral identification or investigation of a mineral and the groundwater potential of specific farms or areas.



Locality map for Limpopo Unit mapping projects

2006-0899 **GEOLOGICAL FIELD MAPPING SCHOOL**

Project leader: N. Baglow, B.Sc.Hons.
Project team: G. Brandl, Ph.D., P. Bosch, M.Sc.
Primary objective: *to develop skills by training junior geologists in practical field mapping.*
Duration: Ongoing.
Budget: R40 995.

Motivation

Some years ago a need was identified for a field mapping school. In order to remedy the lack of practical mapping skills amongst inexperienced geologists joining the CGS, and in view of the CGS's mandate and commercial project requirements, a field school was seen as a means of efficiently addressing this issue.

Progress

A field school was held from 9 to 20 March 2009.

Conclusions

New scientific staff joining the Central Mapping Unit was encouraged to join the field school. By focussing on geologists likely to utilise the skills imparted to them, the field school fitted well into the CGS training strategy. The Limpopo Province has a varied geology and reasonably well-exposed outcrops, a suitable climate and good accessibility.

Although the field school is open to staff members from other units, newly graduated geologists are now assigned to the Limpopo Unit for one year in the mapping programme (see map sheet reports below), which has a dominant training theme. The field school is in effect the introductory module to the extended training programme.

Field School trainees collecting data at Legalameetse.

For the mapping exercises of the field school, a study area that is geologically well known was chosen. Fundamental map and aerial photograph interpretation skills were covered in office exercises before actual field training was undertaken.

The Downs area, within the Legalameetse Nature Reserve south of Tzaneen, covers a section through the uppermost part of the Wolkberg Group, Langkrans and Black Reef Formations, and the basal part of the Malmani Subgroup. Quartzite, dolomite, mudstone and basalt are the main lithologies. The study area is part of the Mhlapitsi fold and thrust belt, which is characterised by a number of large-scale synclinoria and anticlinoria. The students were exposed to the potential of digital mapping techniques.

On completion of the training the participants were each tasked with producing a report and making a presentation to their colleagues on an assigned aspect of the field work.

Future activities

The school is repeated annually in order to integrate new geologists into the overall CGS mapping programme. It is intended that the school itself will continue as a module at the beginning of the more rigorous extended field-mapping training programme, but the introductory module will also be available to other CGS geoscientists as an independent exercise.

2008-0975 **1:50 000-SCALE GEOLOGICAL MAPS 2428BB TINMYN, 2230AC MUSINA, 2330CC TZANEEN AND 2430BB MICA**

Project leaders: N. Baglow, B.Sc.Hons, G. Brandl, Ph.D.
Project team: I. Barry, B.Sc.Hons, D. Boyd, B.Sc.Hons, G. Nene, B.Sc.Hons.
Primary objective: *to study the geology of the area with particular emphasis on its structure, mineral potential and the groundwater characteristics of the area, and to maintain organisational capacity in terms of understanding a variety of geological environments.*
Duration: 2007/8 to 2009/10.
Budget: R363 605.

An impressive occurrence of mica, about 1 m in diameter, in pegmatites near Mica.

Motivation

The area was selected for its geological variation and suitability for use as a training ground for junior field geologists in the expanded Field School programme (see report on Field School).

Progress
The Tinmyn (east of Mokopane) and Tzaneen maps, and accompanying explanations, were completed.

Field work around Mica centred on the granitoids of the Mashishimale Suite that intrudes the Makhutswi Gneiss. Lithologies within the suite are more varied and relationships more complex than previous work had indicated.

The gneiss is characterised by a significant number of ultramafic greenstone remnants, and also hosts a well-developed pegmatite field which contains a number of economic deposits of mica and feldspar.

Mapping in the Musina area commenced during the year. Detailed work was undertaken in a number of selected areas that combined both good teaching opportunities and adding to the geological database. Units covered included the Sand River Gneiss and Messina Suites, and the Bulai and Singelele Gneisses, all of which intrude the Beit Bridge Complex. At the other end of the timescale, the post-Karoo Tshipise Fault reveals evidence of neotectonic activity.

Well-exposed dolerite dykes cross-cutting the Sand River Gneisses yield an interesting scenario of multiple intrusion.

Conclusions

Young geologists working in these areas encountered enough geological variety to significantly broaden their experience within a strongly supervised project environment, while at the same time contributing to the overall mapping programme. Emphasis was placed on igneous, metamorphic, structural and economic geology.

Future activities

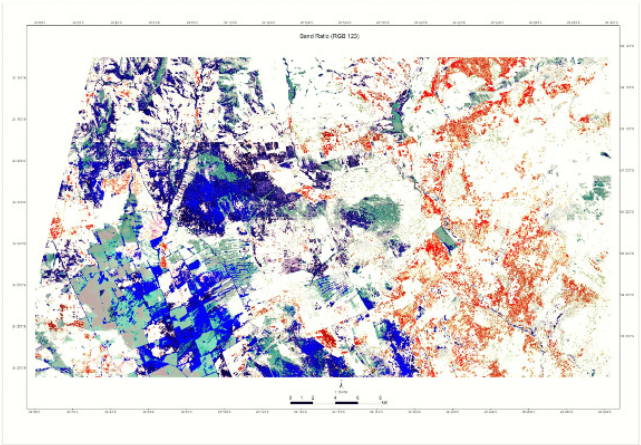
The portions of the Mica and Musina map sheets covered this year under the auspices of the Field School training will be incorporated with mapping that continues in the year ahead, leading to the final production of maps with explanations.

2006-0898 **ZEBEDIELA BUILDING MATERIALS**

Project leader: N. Baglow, B.Sc.Hons.
Project team: T. Dhansay, B.Sc.Hons, O. Miyambu, BESMEG, L. Ngcofe, B.Sc.Hons.
Project objective: *to assess the potential for clay and other building materials in the Zebediela area.*
Duration: 2005/6 to 2008/9.
Budget: R11 650.

Motivation

Regional geological mapping of the area in 2004 revealed that there are sporadic occurrences of clays, and this project was aimed at trying to quantify these on the regional scale in order to obtain a better estimate of their potential as building materials. There has been extensive housing development for local communities in recent years. In addition the project provides a platform for skills development in the fields of sampling and industrial minerals.



Aster image of the Zebediela area. Red and blue highlight areas with the greatest development of clays.

Progress

The project is now complete.

Conclusions

Previously auger holes were drilled across the map area, the samples analysed by XRD, confirming the existence of smectite, palygorskite and other clays, and the results plotted to portray their distribution. Preliminary ceramics tests yielded some encouraging results. The Aster satellite imagery of the area was examined to determine the general surface distribution of clays and a comparison was made with ground follow-up to indicate areas with potential.

2007-0990 **LIMPOPO TAILING**

Project leader: O. Miyambu, BESMEG.
Project team: H. Coetzee, Ph.D.
Primary objective: *to assess the environmental and socio-economic impacts of the selected abandoned and derelict mines towards the rehabilitation, mitigation and management of the impacts in Limpopo.*
Duration: 2007/8 to 2009/10.
Budget: R13 855.

Motivation

The research is conducted in order to contribute towards the limited amount of available information on the environmental, social and economic issues/impacts. The research will again contribute towards the sustainable development in mining, the project initiated nationally by the Department of Minerals and Energy, with the CGS, specifically staff of the Environmental Geoscience Unit, as project managers.

Sampling water along the Nsama River adjacent to Louis Moore Gold Mine.

Progress

Water was sampled from streams, rivers and dams adjacent to the mines of interest (Fumani, Osprey, Louis Moore, Birthday and Klein Letaba Gold Mines). Sampling of tailings, sediments, soils and plants continues.

Conclusions

The tailings dumps have little vegetation cover and there are signs of the material being washed away alongside the tailings dam. Lack of plant cover increases the effect of dust blowing during winter towards the community. There are signs of runoff and erosion of dumps by water; the washed materials flow alongside the dumps and eventually lead to the water bodies/rivers. Analyses of the water samples will help to determine whether the mines have an adverse impact on surrounding water bodies.

Future activities

Follow-up research to complete the project will be conducted during an M.Sc. programme that will also suggest the best rehabilitation, mitigation and management strategies.

2007-0997 **1:250 000-SCALE GEOLOGICAL MAP 2428 MODIMOLLE**

Project leader: N. Baglow, B.Sc.Hons.
Project objective: *to compile a 1:250 000-scale geological map and accompanying explanation, in order to support local mineral development and groundwater issues.*
Duration: 2007/8 to 2010/11.
Budget: R18 510.

Motivation

The first edition of this map (2428 Nylstroom) was published in 1978 but there was only an abbreviated explanation on the back of the map. Mapping of critical 1:50 000 maps has been ongoing since 1997, improving knowledge of these particular areas and lithologies. New work, such as mapping of the dolomite terrain, will be incorporated into the new map. The old map is in public demand and the lack of a detailed geological explanation has been a shortcoming.

The map covers areas that have witnessed significant small- and large-scale mining activity, rapid urbanisation in Sekhukhuneland, and the area has urgent groundwater needs.

Progress

Previously the chapter outline was completed, an inventory of existing information undertaken, and a reference list compiled. New mapping at a scale of 1:50 000 was evaluated and preliminary correlations decided upon. Mineral deposit locations have also been incorporated.

Conclusions

The general geological outline has been completed and matched with the geology on adjacent map sheets. All geological units have now been established within the context of current stratigraphic knowledge and terminology.

Future activities

A 1:250 000-scale map of the area can now be compiled, and the accompanying explanation will be finalised.

MARINE GEOSCIENCE UNIT

2002-0460 MARINE SURVEY TECHNOLOGIES

Project leader: M. MacHutchon, B.Sc.Hons.
Primary objective: *to enable the Marine Geoscience Unit (MGU) to remain abreast of current survey technology and to facilitate technical improvements and innovations within the unit.*
Duration: Ongoing.

Motivation

Capacity building in terms of available equipment is a continuing objective of the unit, especially in the use of the new survey vessel *Geo Manzi* as an effective platform for marine geophysical operations, and the increased training for the effective operation of equipment – such as the Klein 3000 side-scan sonar, multibeam and sub-bottom suites.

Progress

The following have been completed:

A survey field manual and equipment guidelines report, outlining planning, interfacing and equipment settings.
A multibeam echosounder (MBES) manual, outlining planning, interfacing and equipment settings.
An MBES processing manual.
A data flow and management report, outlining how the unit should handle data.
A manual of technical specifications of all survey equipment used by the unit.
An internal report reviewing software status of the MGU in terms of acquisition and processing.
A training programme for MGU staff and non-commercial partner organisations (IMT, SA Navy or SAHRA).

Survey	Personnel	Equipment used
SAHRA Wreck Survey	W. Hoosain, W. van Zyl, W. Kupido, SAHRA employee	Magnetometer, SSS, DGPS, Hypack
FO Well Site Survey	H. Cawthra, W. van Zyl, W. Kupido, A. Richardson	Pinger, SSS
Stat Project 0462 Survey	H. Cawthra, W. Kidwell, A. Holmwood	Multibeam Echosounder (MBES), POS MV, Hypack and Hysweep
Stat Project 1050 Survey	H. Cawthra, N. Moabi, S. Coles, W. Kidwell, W. Hoosain, W. van Zyl, W. Kupido	MBES, SSS, POS MV, Hypack and Hysweep
Ben Schoeman Survey	H. Cawthra, N. Sumner, W. Kupido	MBES, POS MV, Hypack and Hysweep
Stat Project 0753 Survey	H. Cawthra, N. Moabi, W. Kidwell, W. van Zyl, W. Kupido, B. Maritz, Cpt T. Stokes, Lt Cmdr N. le Roux, Sub Lt A. Matthew	MBES, Pinger, SSS, POS MV, Hypack and Hysweep

Conclusions

The MGU has very up-to-date equipment and software, enabling it to be a worldwide leader in the marine geoscience industry. With continued training the unit can only go from strength to strength.

Future activities

Continued maintenance of global and local trends within the marine survey industry, ensuring that the MGU keeps abreast of all changes. Comparing different techniques and equipment at international conferences such as the Oceanology International or Shallow Water Conferences.

2002-0462 **THE MARINE GEOLOGY OF BLOOD REEF**

Project leader: H.C. Cawthra, B.Sc.Hons.
Project team: M. MacHutchon, B.Sc.Hons, W. Kidwell, A. Holmwood, B.Sc.Hons, B. Smith, B.Sc.Hons, P. Young, Nat.H.Dip. (Elec. Eng), W. van Zyl, B.Sc.Hons.
Primary objective: *to i) examine the Quaternary evolution of the upper continental shelf in the vicinity of the Durban Bluff by interpretation of boomer seismic data and analysis of sequence stratigraphic relationships between units; ii) contribute to the knowledge of glacio-eustatic sea-level changes on the east coast of South Africa by means of litho- and chronostratigraphic analysis of late Pleistocene to Holocene submerged and raised deposits of beachrock and aeolianite, and iii) determine oceanographic processes operating on the shelf by the study of sub-aqueous bedforms.*
Duration: 2007/8 to 2009/10.
Budget: R576 360.

Motivation

The marine environment off Durban is Africa's busiest continental shelf area. Despite this, little is known about its geology and oceanography. The Durban Bight project has added to the knowledge of the sea-floor geology, morphology and oceanography between Durban Harbour and Umhlanga Rocks. Prior to the onset of the Blood Reef aspect of this ongoing research, very little was known about the continental shelf to the south of the Durban Harbour entrance, the Bluff, an area that is heavily utilised for various anthropogenic activities (marine outfalls, offshore SBM platform, recreational). Scientifically this region is very interesting as it is a transition zone between a wide and narrow continental shelf. Detailed geophysical and geological mapping and sampling of the shelf area will help advance the understanding of this complex region's evolution.

Progress

A full suite of geophysical data has been acquired, processed and interpreted, including single- and multibeam bathymetry, and side-scan sonar and boomer (medium penetration) seismics. The shoreline of the Bluff Ridge has been mapped and sampled by standard mapping techniques and the offshore region (Blood Reef Complex) mapped and sampled by SCUBA diving. Coverage of all constituent lithologies of the area facilitated the production of a detailed geological map spanning the supratidal zone to the outer continental shelf, illustrating the late Quaternary deposits of the Bluff Ridge and associated offshore Blood Reef Complex. Three units of aeolianite (palaeodunes) have been identified in the study area indicating prevailing winds to be from the southeast and northwest. These deposits clearly have foreset dips which reflect an angle of repose typical of this type of lithology (approximately 30°). Identification of nannofossils in aeolian samples indicates an approximate age of late Pleistocene. Thirteen units of beachrock (palaeocoastlines) were mapped, reflecting the change in sea level since Oxygen Isotope Stage 5c (The Eemian High) until the Recent. Sediment samples obtained from the shelf sands and bioclastic fields have yielded interesting results.

Conclusions

This project is the first study of its kind performed by the MGU. The seamless onshore-offshore mapping addresses the transition zone between raised beach deposits etched into older basement and submerged lithologies, both studied independently in similar geological environments all over the world. Three units of aeolianite (palaeodunes) and thirteen units of beachrock (palaeocoastlines) have been identified.

Future activities

Eight rock samples of aeolianite and beachrock have been submitted to the geochronological laboratory of the Université du Québec à Montréal for radiometric dating by Optically Stimulated Luminescence of the feldspar crystals. These results will allow the unit to address key questions related to the evolution of the Bluff Ridge, Blood Reef Complex and adjacent continental shelf and its applicability to existing global and local sea-level curves. The Blood Reef research area has potential for contributing interesting palaeo-sea-level data as it reflects both sea-level highstand and sea-level lowstand data for the late Pleistocene–Holocene period.

2003-0753 MARINE GEOPHYSICAL SURVEY OF THE PORT ELIZABETH HARBOUR APPROACH

Project leader: W. van Zyl, B.Sc.Hons.
Survey leader: M. MacHutchon, B.Sc.Hons, H. Cawthra, M.Sc., N. Moabi, B.Sc.Hons, W. Hussein, B.Sc.Hons, W. Kupido, W. Kidwell.
Primary objective: *to obtain geological and bathymetric data for strategically important South African ports.*
Duration: Ongoing.
Budget: R494 000.

Motivation

This is an ongoing project for the South African Navy in co-operation with the Institute for Maritime Technology and requires detailed maps of sea-bed sediments on the approaches to key strategic harbours. The present priorities are those harbours that will host events for the 2010 World Cup, namely Port Elizabeth, Durban and Cape Town. Port Elizabeth harbour was surveyed in 2007–08, and the survey of the harbour approach is a continuation of this project. The outputs from the surveys will be side-scan sonar images of the sea bed delineating areas of rock and sand, sediment-thickness maps obtained from sub-bottom seismic data, and multibeam digital terrain models (DTM) of the sea bed. The surveys will also provide data for the proposed Offshore Mapping Programme.

Progress

The 20 days allocated for surveying in the current year was achieved in February 2009, towards the end of the statutory year. Processing of side-scan sonar and sub-bottom seismic data is complete. Interpretation of the data and the side-scan mosaic was presented to IMT in an interim report. Owing to the volume of data and the time necessary to process the data, not all multibeam data have been processed. The processed data in the form a DTM will be presented in a revised report early in the new statutory year.

Conclusions

Data quality on the side-scan sonar and pinger was very good in this survey. The over-the-side pole mount for the pinger, used for the first time on *Geo Manzi*, was stable and without excessive vibration. However, the multibeam data were not optimal and noise was present in the data; removing the noise took longer than anticipated. Two factors are suspected to be the cause of the excessive noise, a slight wobble in the MBES pole and overheating of the MBES LCU (sonar-processing unit located in the cabin). Currently the MBES pole is being stiffened and solutions are being discussed with Reson on resolving the heat problem on the LCU. Hopefully this will result in cleaner data on future surveys.

Future activities

The Strategic Harbour Surveys is an ongoing project with 20 survey days allocated to the project each year. Future surveys will include Cape Town and Durban harbours and further surveying of Port Elizabeth will also be required.

2002-0829 THE MARINE GEOSCIENCE UNIT DATA CURATION

Project leader: P. Young, Nat.H.Dip.(Elec. Eng).
Project team: H. Cawthra, B.Sc.Hons, C. Bosman, B.Sc.Hons, W. Kidwell, M. MacHutchon, B.Sc.Hons, W. van Zyl, B.Sc.Hons.
Primary objective: *to manage marine geoscientific data and prevent data loss.*
Duration: Ongoing.
Budget: R104 000.

Motivation

The Marine Geoscience Unit has acquired data which require large amounts of storage space and subsequent strategic management to prevent its loss. Historically, project data tended to be stored in a distributed manner for the project duration. Individual backups to removable storage such as CDs, DVDs and portable hard drives required large

amounts of removable media creating data duplication and management complexity. Increasing data volumes led to this scenario worsening. This project ensures that data is correctly managed so that information can be supplied to clients in a sufficient manner.

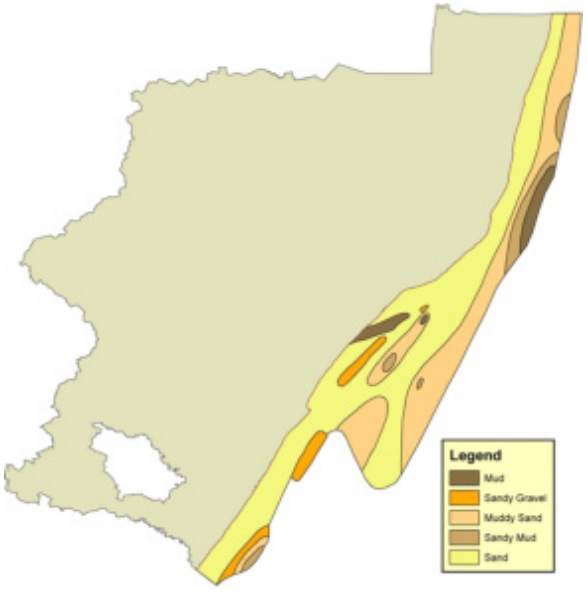
Progress

Durban Marine Geoscience Unit file server.

The file server acquired in January 2006 has allowed data to be stored centrally in the Durban MGU. Data backup scheduling and management has been easier during 2008/9. Less data duplication occurred and retrieval was easier. Original removable storage for single PC data backups has been redeployed more efficiently in 2008/9, reducing overall total data backup volumes and costs. The high-speed network with wireless capability continues to allow users easy collaboration and sharing of data and internet services. The built-in hardware firewall of the wireless router, combined with the wireless network encryption, provides a secure, mobile working environment while offering mobile operation from anywhere within the Durban MGU. The uninterruptible power supply has automatically shut the server down preventing data loss during the Eskom load-shedding power cuts of 2006/7, but has also prevented data loss during university power cuts which were also frequent during 2008/9, when Eskom load shedding was not as frequent.

A standardised file- and directory-naming convention used by the MGU in Cape Town was implemented at the end of 2008. Using standardised data storage structures in Durban and Cape Town will contribute towards future ISO accreditation for data management compliance. File server data management is ongoing.

Surficial seafloor maps developed by Dingle, Goodlad, Martin, Rogers, Birch and Bremner at the Joint Marine Geoscience Unit/University of Cape Town Geophysics Research Unit are being digitised. The work concentrates on KwaZulu-Natal, but will extend to include all of South Africa and will be disseminated via the CGS GeoPortal to the marine research community. Currently these data are being used as part of a desk-top study to plan for data collection on the second African Coelacanth Ecosystem Programme (ACEP) cruise on the RV Algoa.



GIS vector map of KwaZulu-Natal sediment texture digitised from maps produced by Birch *et al.* (1986).

Conclusion

The correct configuration of the server and the continuous management of the server and data have allowed a transition to an environment of digital data collaboration. As the MGU is a custodian of large amounts of digital data, this type of environment is of huge benefit.

A more active dissemination of scientific data to the research community and the public is required, possibly via the CGS GeoPortal. This will require that all marine survey work undertaken conforms to a standard GIS format which is being discussed as part of data curation. The standardised naming convention which is already fixed and the adoption of ESRI ® metadata standards will form part of this goal.

Conclusion

The correct setup for the file server with the hardware vendor's support and the continuous management of the server and the data have allowed a transition to an environment of digital data collaboration. As custodians of large amounts of digital data, the MGU benefits from this type of environment.

More active dissemination of scientific data to the research community and the public is required. This can be achieved by supplying GIS data via the CGS GeoPortal. This will require that MGU data conform to a standard GIS format. The standardised naming convention is already set up, and the adoption of ESRI ® metadata standards would form part of this goal.

Future programme

Archiving of data will be prioritised according to future project needs and converted to the new data-storage naming convention. Integration with the CGS LAN to make use of the CGS metadata discovery tool also needs to be prioritised. This will allow for the integration of Marine GIS data with CGS terrestrial geological data.

The networking capabilities of the MGU's geophysical equipment will allow for the addition of newly acquired digital data to the database. Sharing digital data over the high-speed network will be possible, as well as the dissemination of data to stakeholders.

An opportunistic systematic mapping programme for data dissemination has also arisen. GIS-based information derived from rock samples trawled off Durban in the KwaZulu-Natal offshore environment will form part of this data. Stakeholders may include the Oceanographic Research Institute, the University of KwaZulu-Natal (UKZN) and Enviromap, a Durban-based environmental consultancy.

GIS data from the proposed African Coelacanth Ecosystem Programme (ACEP) and the Sodwana Bay coral coring project could also be archived and disseminated to the scientific research community and the public as part of the Marine Geoscience Unit's data curation programme.

2007-0977 **THE EVOLUTION OF THE WESTERN MARGIN OF SOUTHERN AFRICA: A COMPLEX AND CONTROVERSIAL GEOLOGY**

Project leader: R. Wigley, Ph.D.
Primary objective: *to review and summarise all available information, both unpublished and published, on the regional geological history of the western continental margin of southern Africa from continental break-up to the modern depositional environment.*
Duration: 2008/9.

Motivation

***Geo Manzi*, moored at the NAVY jetty in Port Elizabeth harbour.**

Very little of the research undertaken on the western margin of southern Africa over the last 40 years has been published in the academic literature. For a number of reasons, in part linked to the economic resources along this margin, much of the research undertaken regarding the evolution of the western margin of South Africa has only been published in local 'grey literature', which is not readily available to a wider market.

By publishing a peer-reviewed article, this information becomes an easily accessible abbreviated reference source for anybody interested in this subject.

Progress

The manuscript is essentially complete and will be forwarded to co-authors for their input.

Conclusions

This project is almost completed and will be submitted to a peer review journal in the near future.

Future activities

Corrections and input from co-authors will be reviewed, and a manuscript will be prepared for submission, which will summarise the western margin of southern Africa, including the bathymetry, geomorphology and palaeo-drainage systems.

2009-1049 OFFSHORE SURFICIAL SEDIMENT MAPPING PROGRAMME: FEASIBILITY REPORT

Project leader: R. Wigley, Ph.D.
Primary objective : *to ensure the applicability, usefulness and relevance of creating an updated Offshore Surficial Sediment Mapping Programme.*
Duration: Ongoing.
Project budget: R126 000.

Motivation

Surficial sediment charts were produced twenty years ago at a scale of 1:5 000 000, but are still used by organisations to plan government policy. This statutory project will see these maps re-issued using additional survey data and by sourcing sampling data from work undertaken in the last two decades.

A surficial sediment chart may, *inter alia*:

provide baseline data from which SANBI can implement protection of marine areas
assist with strategic decisions regarding fisheries policy by Marine and Coastal Management
provide baseline data for planning of offshore renewable developments
provide baseline data to be used in exploration for marine resources.

The planned objective for this project will be to produce a new and updated map of the continental margin and slope within the extended continental shelf for southern Africa. This project is closely related to the proposed offshore mapping project 2009-1050, but concentrates on the identification of the nature of the surficial sediments.

A two-fold approach has been proposed, which firstly collates available information from sources within the CGS and from commercial and public domain sources such as academic theses and published literature and, secondly, uses the information obtained from this data collation effort in conjunction with the Offshore Mapping project and other relevant survey programmes to create surficial sediment maps.

Progress

During the office relocation, numerous relevant data sources were identified and collated for scanning. Preliminary meetings were held with a number of potential stakeholders to assess interest and availability of data for the project.

Conclusions

Relevant stakeholders have displayed considerable interest in the possibility of updated surficial sediment charts and, therefore, more time is required to assess exactly what data are available and how it can be collated.

Future activities

All relevant stakeholders having access to possible sources of sediment and surficial characteristic data and will be contacted. A workshop with stakeholders will be organised to discuss requirements and potential collaboration.

A feasibility study will be completed to move this project forward.

2009-1050 STRATEGIC OFFSHORE MAPPING PROGRAMME

Project leader: K. Smith, B.Sc.Hons.
Project team: M. MacHutchon, B.Sc.Hons, W. van Zyl, B.Sc.Hons, S. Coles, B.Sc.Hons, H. Cawthra, B.Sc.Hons, W. Hussein, B.Sc.Hons, N. Moabi, B.Sc.Hons, W. Kupido, W. Kidwell.
Primary objective: *to produce offshore geological maps.*
Duration: Ongoing.
Budget: R572 000.

Motivation

At present, South Africa's mapped geology covers less than 1 per cent of the available offshore area, which is presented on a single 1:250 000 sheet. An understanding of the marine geological environment, both surface sediments and solid geology, is essential for the country in term of strategic planning. The sea-bed mapping programme will produce high-quality, offshore geology maps with the initial aim of completing the offshore sections of the map for the Cape Town area.

All available data and interpretations from the statutory projects of the MGU, external research cruises and some commercial projects, with prior permission, will be compiled in ArcGIS ®. The historical data and its interpretation will be assessed for quality and scientific value, providing training opportunities for staff members. A variety of techniques will be used, increasing interpretation and GIS skills within the MGU.

After collating and compiling the existing data into the database, areas for further marine surveys will be identified. There will be a requirement for the involvement of most MGU personnel, who will develop skills through their involvement in the project.

The resultant geological maps will provide essential information not only to the CGS, but also to other marine-based organisations such as MCM, SANBI, SAEON, SAHRA and the SA Navy.

The objectives for this financial year were:

to compile new data sources
to review data produced by work undertaken in the mid-1990s
to carry out a marine survey programme, using *Geo Manzi* and its geophysical equipment, which meets the objectives of the mapping programme as well as addressing requirements of at least five other government departments
to determine a strategy and survey programme for coastal areas based on both scientific and national needs.

Progress

The sourcing and compiling of historical data sets is ongoing, which is shared with ATP Project ST-2009-1049. During the recent office relocation, a large number of new maps were discovered which will be scanned and added to the GIS database, which was constructed during the 08/9 annual tecnical programme.

The completion date for *Geo Manzi* was originally scheduled for March 2008, and as such a number of statutory projects were planned with the use of *Geo Manzi* in mind. *Geo Manzi* was only first put into the water in September 2008 in Simon’s Town and was deemed too unstable to be used for survey in open waters at that time.

While the vessel was in Simon’s Town in October, the unit attempted to carry out the survey work in False Bay, as planned, but there were continual interruptions for modifications to the vessel, problems with the vessel and time spent discussing and rectifying these problems with the boat builders. These delays took up the majority of the survey time allocated to the project and at the end of the four weeks the only survey which had been done was of the inside of Simon’s Town harbour.

The processing of the acquired multibeam bathymetry and side-scan sonar data is complete. Interpretation of the data is still to be finalised. The survey report is still to be completed and will be presented early in the new statutory year.

Conclusions

Data quality on the side-scan sonar and multibeam sounder was very good on this survey. The Navy are very interested in the data that were acquired. A vast amount of training on the set-up of equipment was carried out while the vessel could not be used for survey, which will greatly benefit the MGU.

The compilation of marine data sets will continue indefinitely, providing invaluable information not only for the CGS but other marine-based organisations from outside the CGS.

Future activities

The systematic offshore mapping programme will continue indefinitely, mapping areas of interest around Cape Town. *Geo Manzi* is being modified currently which will lead to greater survey coverage in future surveys and more training opportunities for the MGU.

2009-1052 REEF HABITAT MAPPING OFF THE WEST COAST OF SOUTH AFRICA

Project leaders: W. Hoosain, B.Sc.Hons, N. Moabi, B.Sc.Hons.
Primary objective: *to review and update offshore surficial sediment maps from the Orange River to Cape Agulhas.*
Duration: 2008/9.
Budget: R7 600.

Motivation

This project was initiated as part of a greater scheme of the South African National Biological Institute (SANBI) to develop systematic spatial planning for biodiversity and resources. The objective of SANBI researchers is to produce a refined marine habitat classification and maps of marine habitats along the west coast of South Africa. The MGU will be reviewing offshore surficial sediment maps from the Orange River to Cape Agulhas, which will aid in the classification of marine habitats and support decision making with respect to resource use and conservation.

Systematic spatial planning for biodiversity and resource use is constrained by the absence of a refined marine habitat classification and maps of marine habitats. There is a requirement for updated surficial sediment maps which are often used as biodiversity surrogates. These maps underpin assessments of marine biodiversity for unconsolidated sediments and provide valuable information for spatial planning. As these maps are essential for informed decision making, SANBI requested that information gathered during the past 20 years be incorporated into the updated maps. Maps showing biodiversity patterns and threats to biodiversity are then overlaid on the sediment maps. They support decision making around resource use, conservation and protected-area planning. The draft National Protected Areas Expansion Strategy (NPAES) has highlighted several information gaps, and a map of marine ecosystems and habitats was listed as one of the five spatial layers that require the most urgent attention. This layer needs to be significantly updated and approved as important decisions are based on this information.

Progress

The project is in the final phase of completion. The database has been created within the relevant restrictions of the scope of the study. The idea was to create a feature that would allow easy depiction and description of the marine data available to compile a sediment distribution map that would assist SANBI and MCM to map marine habitats in the area. This project is, however, part of a bigger initiative that involves mapping the entire marine territory of South Africa. This is a more long term goal compared to the short term deliverables involved in this project. Also, as the MGU continues to build on its marine database with improvements in technology, and the quality of data improves with time this database will soon expand and fill-in the great void in the knowledge of the marine resources. At this stage a project report has been completed and the relevant data required by the stakeholders have been made available to them by the Marine Geoscience Unit.

Conclusions

The data collected will be made available to SANBI and MCM to utilise the development of their offshore marine habitat mapping project. This will benefit fisheries industries and the conservation of marine species and habitats. The database will not only assist interested parties but also facilitate a better way for the MGU to store and catalogue the data available.

Future activities

It is hoped that work will continue with both MCM and SANBI in their initiatives to develop a detailed marine habitat map for all of South Africa's marine resources. This is only one step towards the greater goal of all stakeholders involved.

MINERAL RESOURCES DEVELOPMENT

2002-0167 **SOUTH AFRICAN COAL DATABASE**

Project leader: M.M. Schalekamp.
Project team: N. Mcilrae, M. Solomon.
Primary objective: *to prepare, capture and manage information on coal deposits derived from borehole core logs, and to make this information accessible to a wide range of stakeholders.*
Duration: Ongoing.

Motivation

In terms of current legislation the CGS maintains a coal database. The coal database is part of the CGS's corporate database GEODE and interfaces with other systems, allowing easy access to users.

This facility enables a centralised point of collection for most of the data available on the geology of the coal deposits of South Africa. The availability of this information in digital format makes it easy for the information to be disseminated in a user-friendly format, enabling further research work on the geology of the coal deposits, as well as facilitating planning of the optimal use of the country's coal resources and land management.

Progress

During the year 909 logs were prepared, 865 header details were coded and captured, 7 223 lithologies for 278 boreholes were captured, 573 logs were digitally converted and all the data have been loaded onto the database. The coal database now contains 110 576 boreholes with 2 793 463 lithologies and 1 569 455 analyses.

Conclusions

The coal database forms part of GEODE, the corporate database of the CGS. It is a database of strategic importance as it plays an important role in enabling further research work on the geology of coal deposits in South Africa, and facilitates proper planning of the optimal use of the country's mineral resources.

Future activities

The coal database will form part of the planned GEODATA PORTAL which will provide the technology infrastructure required to make data contained in the CGS's various databases accessible to interested parties outside the organisation.

2002-0168 **COREDATA DATABASE**

Project leader: M.M. Schalekamp.
Project team: M. Solomon, N. Mcilrae.
Primary objective: *to capture geological information from borehole core logs and to make this information accessible to a wide range of stakeholders.*
Duration: Ongoing.

Motivation

The CGS has built up a large collection of borehole core logs of South African geological strata over a period of more than 60 years, and is continuing to increase this collection in order to ensure that borehole information is managed in such a manner that it is easily accessible to all users. COREDATA provides easy access to this collection.

Progress

During the year 169 borehole logs were prepared for capture into the database, while 101 headers were coded and captured. The borehole core log database now contains about 85 000 entries.

Conclusions

COREDATA, the borehole core database, is one of the modules of GEODE, the corporate database of the CGS. It is a database of strategic importance as it plays an important role in enabling research work on the geology of South Africa and facilitates proper planning of the optimal use of the country's mineral resources.

Future activities

Ongoing work will increase the amount of information contained in this database.

2004-0865 **MINERAL RESOURCES FOR SUSTAINABLE DEVELOPMENT IN THE SOUTHERN AFRICAN CONTEXT**

Project leaders: A.Y. Billay, Ph.D. (sub-programme 1), S. Frost-Killian, M.Sc. (sub-programme 2).
Project team: J. Cole, M.Sc., P. Cole, M.Sc., S. Foya, Ph.D., R.N. Hansen, M.Sc., S. Strauss, M.Sc., D. van der Walt, B.Sc.Hons, D.L. Ehlers, B.Sc., C.B.A. van der Westhuizen.
Primary objective: *to generate mineral exploration targets.*
Duration: Ongoing.
Budget: 2008/9: R188 432.

Motivation

The main objective of this project is to generate mineral potential targets by integrating multi-data sets including geophysics, geochemistry, satellite images, mineral occurrences/deposit data, structures and other relevant geological information using GIS. This can help mineral resource development and stimulate exploration investment by reducing the risk involved in exploration, as well as public service organisations of a country to define prospective land and to weigh mineral potential against competing demands for land use. The CGS believes that additional discoveries will contribute to the economic growth of South Africa and the other SADC regions.

Progress

The project is subdivided into two sub-programmes.

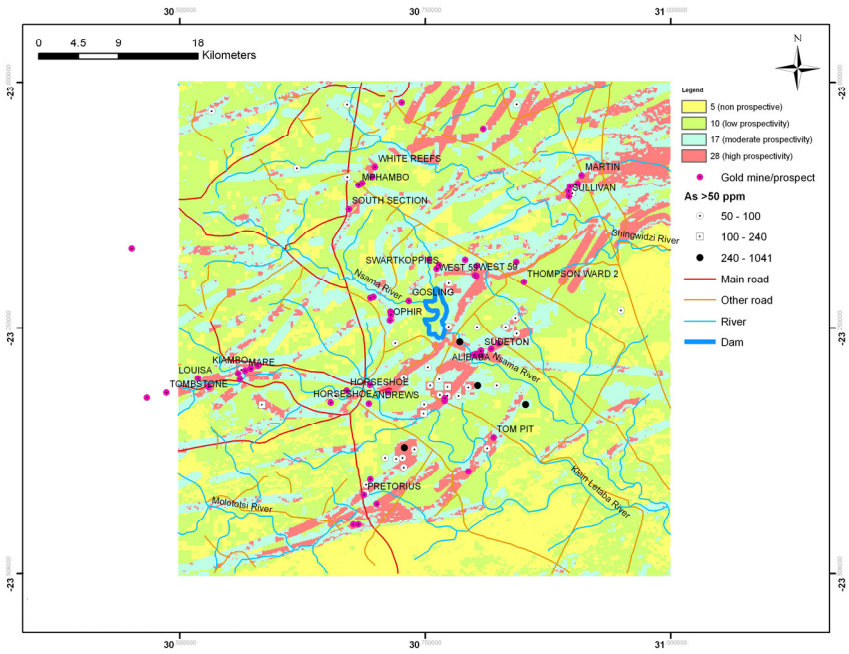
Sub-programme 1:

Mineral prospectivity mapping (target generation) by integration of geology, geophysics, geochemistry, remote sensing and satellite imagery, using GIS) - this is the Primary Focus for 2008/9.

The area of study for sub-programme 1 (for the fiscal year 2009/10) is the Giyani Greenstone Belt. The relevant data sets have been collected, processed and integrated. The technical report with maps and relevant data, as well as the final output prospectivity map, has been produced.

Sub-programme 2:

Mineral resources for sustainable development in the southern African context and the associated Global Mineral Resource Programme (GMRAP), a co-operative programme between the USGS, CGS and other professionals throughout southern Africa.



Prospectivity map of the Giyani Greenstone Belt.

A member of the team attended a workshop to assess the Kupferschiefer copper potential of Germany and Poland. At the workshop, colleagues and collaborators discussed the initial results of the GMRAP assessment for undiscovered copper reserves within southern Africa which were presented at the GSSA-SEG conference held in Johannesburg in July 2008. From feedback on the preliminary results from stakeholders in Zambia and the Democratic Republic of Congo (Zambian Copper Belt), it has been decided that the copper assessment for the region (DRC and Zambia) should be revisited as the preliminary results are felt to be extremely conservative. This re-assessment is set to take place in early 2010 and it is

hoped that the results will better reflect the potential for undiscovered copper in the region. The re-assessment will delay the projected completion of the project to beyond 2010.

Conclusions

For sub-programme 1, the data integration method applied for this project area has outlined several potential linear zones (see Fig. 1) that require follow-up work on selected areas by the CGS. The report is available to the public and various interested exploration and mining companies to target the delineated areas (zones).

For sub-programme 2, preliminary results for the potential undiscovered copper resources within the southern African region have been discussed and analysed. The assessments for PGEs are still being processed and the results are eagerly anticipated. Work on this sub-programme will be intermittent for 2009/10.

Future activites

The project will continue in the 2009/10 project year. The Amalia-Kraaipan Greenstone Belts will be explored further for gold occurrences. The project team will be involved in GMRAP and will analyse preliminary results of the southern African copper assessment.

2008-1054 **MINERAL COMMODITY UPDATE, A PUBLICATION ON PLATINUM GROUP METAL MINERALISATION**

Project leader: N.Q. Hammond, Ph.D.
Project team: M. Matshivha, B.Sc.Hons, R. Malan.
Primary objective: *to produce a Mineral Resources Series publication covering platinum group metals*.
Duration: 2010/11.
Budget: 2009/10: R32 000.

Motivation

In the process of providing up-to-date information on the mineral resources of South Africa, the CGS published a Mineral Resources Handbook in 1998 aimed at stimulating interest, research and investment in South Africa's mineral deposits. As much new information has become available, and new developments are taking place in the platinum industry, it is imperative that this information be made available to the public.

Progress

A number of people from both academia and industry have offered to contribute to various chapters of the PGM publication. Some contributions have been received while others are still pending.

Future activities

A follow-up on prospective contributors who are yet to submit their contributions will be pursued to ensure their contributions are received before the June 2009 deadline.

2004-0861 **INDUSTRIAL MINERALS MAP OF SOUTH AFRICA**

Project leader: G.F.J. Horn, M.Sc.
Project team: R. Opperman, B.Sc.Hons, A. Kenan, M.Sc., P. Kgwakgwe, B.Sc.Hons, T. Zwane, B.Sc.Hons, C.J. Vorster, M.Sc., R. Malan, A. Andres.
Primary objective: *to add information on industrial mineral deposits, mines and occurrences to the databases of the CGS, with the aim of producing industrial mineral maps, mineral exploration and target-generation maps, commodity resource estimations, and other products.*
Duration: 2004/5 to 2011/12.

Motivation

There is a strong perception that South Africa is over-explored with regard to metalliferous ores and under-explored with regard to industrial minerals. It is therefore not surprising that exploration for new base-metal deposits in South Africa by large corporations has declined over the past 10 years. On the other hand, most industrial mineral mining companies are small- to medium-size enterprises with limited venture capital. If the large value-added potential of industrial minerals, from newly mined raw products through beneficiated mineral products to finished industrial products is considered, it is evident that beneficiation will be directly transferred to the industrial sector of the South African economy, where most of the products find their markets. It is in the industrial sector of the economy that industrial minerals contribute most to job creation and poverty alleviation through their large value addition potential.

It is the objective of this project that the entrance risk for existing and new small- and medium-sized companies will be lowered by identifying and, within limits, characterising existing and new industrial minerals mining opportunities. It is believed that the project will:

(i) contribute to knowledge of the geology of industrial mineral deposits and occurrences,
(ii) pro-actively provide information to avoid sterilisation of mineral resources, in that information can be accessed by, or compiled for, local and national development agencies,
(iii) assist in mineral resource and ore characterisation and thus contribute to more optimised mineral resource utilisation in deposits,
(iv) train geoscientists in mineral resource assessment and use the acquired technical and scientific knowledge in projects where knowledge transfer can assist in the establishment of a sound and viable small-scale mining sector,
(v) participate in research programmes in NEPAD/SADC-related projects and participate in knowledge transfer with SADC countries, and
(vi) create geological products that will lower the risk of prospective local or international investors in South Africa's minerals industry.

Slate Mine, North West Province.

Progress

More than 650 mineral deposits occur within the borders of the North West Province and approximately 42 000 km was travelled in order to conclude the mapping in this province. A total of 488 deposits were investigated, the remainder being inaccessible owing to the absence of farm owners from the land, permission for entry not granted, farms being part of game or nature conservation areas, and some deposits could not be found. Mineral commodities for which geological data were captured include fluorite, limestone, calcrete, construction sand, aggregate, quartz sand, quartzite suitable for filtration and glass applications, pyrophyllite, andalusite, magnesite, dimension stone, REE-bearing carbonatitic rock and nepheline syenite.

Conclusion

In addition to the symbolised locality indication of mineral occurrences and deposits, information on infrastructure (water supply, electricity networks, roads) and simplified regional geology will be indicated on the map, as industrial minerals are dependent on these parameters.

The SAMINDABA module of the GEODE corporate database will provide 1:250 000-scale maps of the provinces, on which all known industrial mineral occurrences and deposits will be indicated. Client-specific maps and products, however, can be generated at any scale. Furthermore, important deposit characteristics, including deposit localities, exploration data, stratigraphy

Dimension stone quarry north of Marikana, North West Province.

and ore-body information (dimensions, ore-body attitude, depth, overburden, structure and texture, mineralogy and host rock:ore body relations) that are part of the SAMINDABA data, will be strictly adhered to during the capturing and accumulation of information from literature and field visits for each occurrence or deposit. The correlation of characteristics between deposits is important because this will allow identification and definition of mineral provinces.

Limited sampling was done at each deposit or occurrence, depending on the ore body accessibility and available analytical data. Analyses will be used to characterise the mineral commodities under investigation and will augment other databases, including the laboratory's geochemistry database.

Future activities

The project could deliver products that will contribute to the CGS's objectives of carrying out national resource estimations, publishing maps as contributions to commodity surveys and exploration programmes, assisting with the development of exploration models, contributing to due diligence reporting, and optimising mine development. The project will contribute to successful strategic decisions of national and provincial government agencies and local authorities with regard to the development of infrastructure without sterilising mineral deposits of importance. Information could also contribute to the endeavours of small- and medium-size mining companies, and assist with transfer of technical and scientific information to the previously disadvantaged individuals and communities.

2007-0995 **LIMESTONE RESERVES OF SOUTH AFRICA**

Project leader:	S. Frost-Killian, M.Sc.
Project team:	M. Tsanwani, B.Sc.Hons, C.J. Vorster, M.Sc., G.F.J. Horn, M.Sc.
Primary objective:	*to i) improve existing knowledge on the available limestone reserves; ii) summarise limestone deposits and distribution, and iii) produce a summary document and map for distribution to the DME.*
Duration:	2008/9 to 2009/10.
Budget:	2008/9: R3 040.

Motivation

The Minerals Development Unit has been requested by the Department of Minerals and Energy to compile a comprehensive report summarising the limestone reserves of South Africa, with information on the various types of deposits and the current known and predicted reserves and production. This was motivated by the high demand for cement, which is expected to continue beyond 2010, and the resulting shortage of limestone in South Africa.

Limestone deposit from the Limebank Formation, Gamtoos Group.

Progress

The project involves a search for all available data on the reserves and past and present production of limestone in South Africa. A preliminary report on the limestones of South Africa, with particular emphasis on the cement industry, was compiled in 2007/8 using published sources of data, the South African Minerals Database (SAMINDABA), and internet sources.

In the past project year, the team has concentrated on obtaining actual reserve and production information from all companies currently active in the sector. By using actual reserve and production information, the team hopes to be able to predict, with some degree of accuracy, what reserves of limestone are still available in South Africa.

A GIS project has been set up and all available data sets have been added. The 1:1 000 000 geology map of South Africa (digital) has been simplified, however, all attributes from the original data set have been retained. This will allow the team to highlight all geological units prospective for limestone deposits.

A preliminary report on limestone occurrences and deposits, the host rocks in which they occur, and the uses of limestone have been compiled. The team will continue to build on this base to produce a final report and map at the end of the 2009/10 project year.

Conclusions

From the initial study, potential reserves of limestone in South Africa are estimated at approximately 18 000 million tonnes. Only a quarter of limestone producers have responded to queries regarding their reserves and production, with no data received from producers in four of the nine provinces. From the limited data obtained, the estimated reserves on properties currently being mined and held under license are 1 849 million tonnes (excluding inferred resources outside the licence areas). From information obtained, the team hopes to make a more accurate assessment of potential limestone resources, extrapolating information from licensed properties to areas of similar geology and grade.

Future activities

From information obtained in the initial phase of the project the team will make a more accurate assessment of potential limestone resources and identify prospective areas for limestone mining.

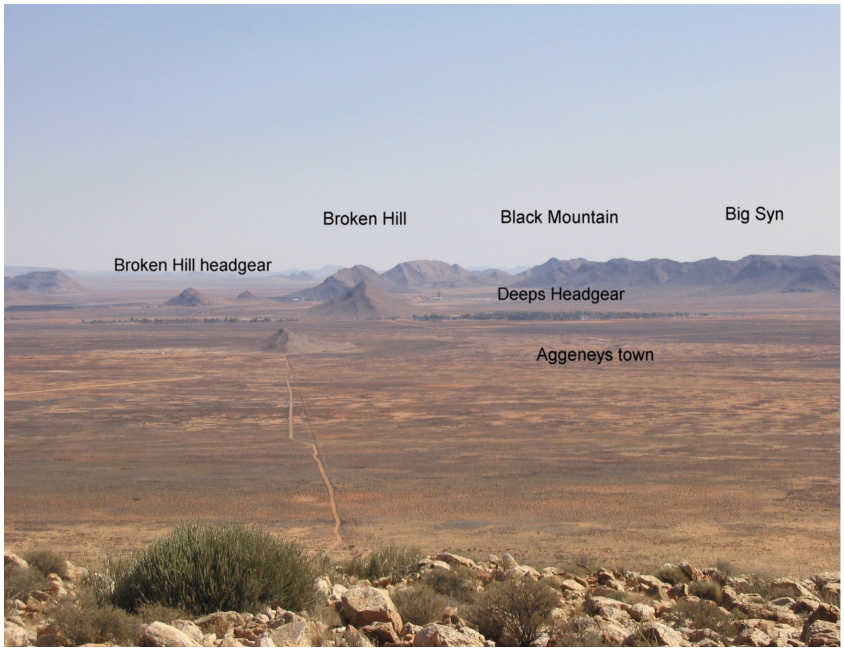
2002-0034 **1:250 000-SCALE METALLOGENIC MAP 2918 POFADDER**

Project leader: A. Agenbacht, M.Sc., W.R. Oosterhuis, B.Sc.Hons.
Project team: R. Malan, C. Vorster, M.Sc.
Primary objective: *to produce a 1:250 000-scale metallogenic map for sheet 2918 Pofadder, with an explanation.*
Duration: 2008/9 to 2009/10.

Motivation

The 1:250 000-scale metallogenic maps provide a valuable visual display of the mineralisation over a large area, which is very important for land-use planning, mineral exploration, future development and stimulating new mining activities. They also add updated information to the SAMINDABA database.

The manuscript, accompanying the map, documents the mining and mineral potential of the Pofadder 2918 map area with descriptions of the genesis of similar types of deposits. Extensive references are provided for more in-depth information. A large variety of economic mineral deposits and occurrences are shown on the Pofadder map sheet, of which the most important deposits are the zinc-lead-copper ore bodies at Aggeneys, Gamsberg and Putsberg.



View of the Aggeneys area.

Progress

The project is well advanced and almost ready for publication. To date the manuscript has been scientifically edited and corrected and new information on the Salt River (Geelvloer) zinc-copper-lead prospect has been added.

Future activities

Photos and figures need to be added electronically to the manuscript and the map legend needs to be finalised. The goal is to complete both the manuscript and map for publication within the 2010/11 financial year.

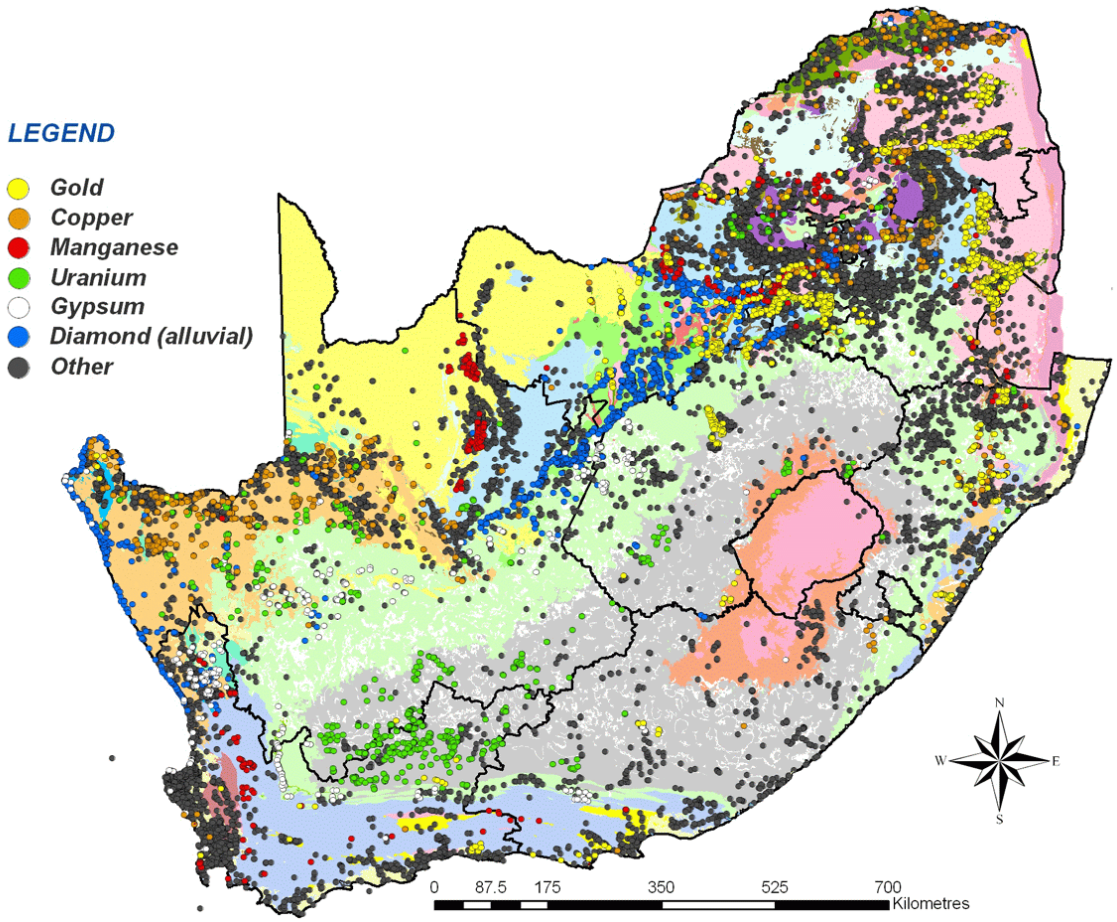
2002-0166 **SAMINDABA (SOUTH AFRICAN MINERAL DEPOSITS DATABASE)**

Project leader: C.J. Vorster, M.Sc.
Project team: P.A. Endres.
Primary objective: *to acquire data on the mines, mineral deposits and mineral occurrences of South Africa, and to provide accurate data to the public.*
Duration: Ongoing.
Budget: R349 000.

Motivation

Access to information to identify opportunities is essential in the building of the economy. Numerous mineral resource appraisals, reports, maps and mineral data have already resulted from this database; these activities furnish the government and the mining industry – small, medium and large – with mineral resource information and advice for informed decision making relating to mineral policy and developmental issues, and to promote economic geological activity. The sterilisation of mineral deposits has been prevented during the planning of permanent surface structures such as townships, dams, roads, pipelines and railway lines. SAMINDABA plays a positive role in rural development and poverty eradication.

SAMINDABA is also a database for the compilation of metallogenic maps and explanations, designed to facilitate mineral reconnaissance exploration by way of ore deposit modelling and target identification, and to stimulate the mining industry in general.



South African Mineral Deposits Database.

Progress

During the 2008/9 programme year, the number of records on SAMINDABA increased to 18 800. The 'Derelict and Ownerless Mines Database' now contains 6 000 records.

A DVD entitled 'Digital Metallogenic Map of Precious Metals, Chrome, Diamonds and Gemstones in the Republic of South Africa and the Kingdoms of Lesotho and Swaziland' has been published.

Conclusions

SAMINDABA is part of GEODE, the corporate modular database of the CGS and is aimed at assisting in research and mineral exploration within the borders of the Republic of South Africa.

Future activities

SAMINDABA information will be made available through the Internet by means of the GEODATA portal. This portal will provide the technology infrastructure required to make data in the CGS's various databases accessible to internet users.

Field work and research will be carried out to further enhance and update SAMINDABA as well as the 'Derelict and Ownerless Mines' Database.

2005-5582 SMALL-SCALE MINING PROGRAMME

Project leader:	F.E.D. Senzani, M.Sc.
Project team:	M. Makhado, B.Sc.Hons, N.S. Mayekiso, B.Sc.Hons, C. Mohale, B.Sc.Hons, C. Zermatten, B.Sc.Hons, D. Katemaunzanga, B.Sc.Hons, K. Kgwakgwe, B.Sc.Hons, T. Zwane, B.Sc.Hons, T. Mudau, B.Sc.Hons.
Primary objective:	*to (i) assist small-scale miners to access the mainstream mining industry; (ii) facilitate compliance with legislation and regulations governing the industry, and (iii) assist rural communities to participate actively in the exploration for natural resources.*
Duration:	Ongoing.
Budget:	2008/9: R10 000 000.

Motivation

The Small-Scale Mining Programme is intended to reduce poverty in underdeveloped rural communities through sustainable development and exploitation of small-scale mining enterprises. This is achieved by extending streamlined institutional support and technical expertise to developers of deposits amenable to small-scale mining through pre-feasibility or feasibility studies. It is critically important that such assistance be provided to the small-scale mining and quarrying sub-sectors, which are particularly vulnerable to geoscientific risk. The geoscientific risk inherent in their mining ventures is decreased by extending finance, scientific and managerial expertise to small-scale miners who can demonstrate a bona fide lack of resources. This approach has distinct advantages as it is more accessible to mostly poor and needy communities and, therefore, offers a high impact mechanism of poverty alleviation through minerals development. It is hoped, therefore, that this assistance will enable aspiring small-scale miners, most of whom often lack the scientific ability to lower the geoscientific risk inherent in their projects with their own resources, to acquire a bankable mining proposal which can be used to apply for initial venture capital from traditional lending institutions such as banks.

Progress

By 31 March 2009, technical investigation had been approved for 195 projects (mining and beneficiation) by the Small-Scale Mining Board of the Department of Minerals and Energy. Thirty four project phases have been completed as follows:

Prospecting Rights, Mining Permits and Mining Rights	2
Feasibility Studies (from prospecting)	16
Monitoring	10
Environmental Management Plans	5
Social and Labour Plans	1

One hundred and sixty one (161) projects are still in various stages of implementation.

Future activities

The small-scale mining programme has been terminated indefinitely. The future of the programme will be determined in conjunction with the Department of Minerals and Energy.

SEISMOLOGY

2002-0475 **COLLECTION OF SEISMOLOGICAL DATA AND MAINTENANCE OF THE SOUTH AFRICAN NATIONAL SEISMOGRAPH NETWORK (SANSN)**

Project leader: J. Steyn, M.Dip.Tech.(Elec.Eng).
Project team: F.A Delport, B.Tech.(Elec.Eng), T.R. Kometsi, Nat.Dip.(Elec.Eng), G. van Aswegen, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons, P. Adamos, Nat.Dip.(Elec.Eng).
Primary objective: *to maintain and operate the SANSN ensuring that high-quality seismic data are received at the National Data Centre (NDC) for analysis and timely publication of earthquake information.*
Duration: Ongoing.

Motivation

Maintenance of the South African National Seismograph Network is necessary in order to produce high-quality seismic data from the 21 remote seismograph stations deployed throughout South Africa, and to ensure high station availability. These data are used to produce seismic information for quarterly and annual bulletins and seismic hazard maps.

Progress

The project team continued to use the data communications system implemented during previous years which enables the seismograph systems to send seismic data in real time to a central facility for analysis. The team ensured that these methods remained relevant by implementing computer hardware and software upgrades. This technology enables data analysts to access seismic data immediately after a seismic event. Network performance is monitored through an internet-based interface allowing the operator to monitor parameters such as instrument down-time and data transmission delays.

Conclusions

The seismograph stations of the South African National Seismograph Network are capable of detecting seismic occurrences throughout southern Africa. By using the latest data communication techniques, data analysts can publish earthquake information almost immediately. Station performance can be monitored on a continuous basis allowing rapid detection and repair of faults.

Future activities

The technical team will continue to investigate methods of data transmission in order to reduce transmission costs. The team is currently implementing and optimising the auto location software which will ensure immediate release of earthquake information after data have been received from the network stations.

2002-0184 **SEISMOLOGICAL MONITORING AND ANALYSES AND MAINTENANCE OF DATABASE OF SOUTH AFRICAN SEISMICITY**

Project leader: I. Saunders, Nat.Dip.
Project team: L. Akromah, Nat.Dip., B. Sutherland, T. Molea.
Primary objective: *to report on the seismic activity of the earth's crust in South Africa.*
Duration: Ongoing.
Budget: R1 278 895.

Motivation

The continued operation of the South African National Seismograph Network (SANSN) is essential for providing reports on the seismic activity of the Earth's crust in South Africa. The information obtained is distributed in the form of quarterly bulletins and catalogues. The seismological activity monitored by SANSN provides the valuable data that are required for Seismic Hazard Analysis and insurance claims. Seismological data from the SANSN are preserved in a National Earthquake Database and are presented in catalogues of southern African seismicity.

The SANSN provides a continuous record of seismic activity in southern Africa. Analysis of recorded waveforms presents static and dynamic parameters of the focal point of the seismic activity and also provides information on the part of the Earth’s crust transmitting the shock waves. These data reveal the properties of materials through which the seismic waves propagated.

The SANSN is the only vehicle capable of accurately reporting on the distribution of seismic focal points and the distribution of seismic activity. SANSN provides a calibrated uniform magnitude scale of recorded events, and the information is stored in digital format, which allows researchers the opportunity to examine seismic data when more advanced analytical tools become available.

The data obtained by analysis of waveforms is shared with various scientists both nationally and internationally and contributes to the geoscience mapping and physical geohazards thrusts of the CGS.

Progress

Earthquake activity in South Africa for the period January to December 2008 was released by ad hoc reporting and quarterly seismological bulletins. The client database for bulletin distribution was expanded from 34 to 40 and now includes most of the geological surveys in southern Africa. Large teleseismic earthquakes have been routinely included in the seismological bulletins from January 2008.

Future activities

The focus of the 2009/10 programme will be on including additional phase readings to resolve the depth of large earthquakes within South Africa's borders, and the use of manual data selection to include stations near large recorded earthquakes.

Table 1: List of earthquakes with M_L>3 in South African territory for the period January to December 2008.

Date	Time	Region	Magnitude(ML)
2008/2/13	18:45:46.1	Lydenburg area	3.2
2008/2/19	22:15:8.8	Bushmanland	3.5
2008/2/21	3:1:20.7	Offshore South Africa	3.2
2008/2/21	16:53:32	Thohoyandou	3.7
2008/2/25	6:6:26.4	Kruger National Park	3.6
2008/2/28	6:16:49.1	Qudeni area	3.6
2008/4/4	16:59:7.7	Machadadorp	3.1
2008/5/17	2:27:8	Swartwater area	3.1
2008/9/22	17:10:2.2	Buffelspruit area	3.1
2008/11/19	12:5:22.4	Kendrew area	3.4
2008/12/20	8:3:56.6	Offshore, Cape St Lucia	3.6

Table 2: List of earthquakes with M_L $ 3.5 in southern Africa for the period January to December 2008.

Date	Time	Region	Magnitude(MB)	Magnitude(ML)
2008/1/2	8:3:39.2	Mozambique		3.5
2008/1/17	13:22:47	Mozambique		3.9
2008/1/20	19:41:11.8	Mozambique		4
2008/1/21	4:49:8.6	Comores	5.3	
2008/1/21	17:28:34.1	Comores	5.4	
2008/1/25	14:25:33.4	Tanzania	4.6	
2008/2/3	9:34:10	Lac Kivu, DRC	6.1	
2008/2/3	13:12:14	Mozambique		5.8
2008/2/3	15:9:52.8	Mozambique		3.6
2008/2/3	18:55:23.2	Mozambique		4.8
2008/2/3	23:10:21.4	Mozambique		4
2008/2/4	21:11:48.1	Mozambique		3.5
2008/2/4	24:51:47.1	Mozambique		3.5
2008/2/14	4:7:46.3	Lac Kivu, DRC	5.3	
2008/2/18	3:53:7.7	Mozambique		3.7
2008/2/18	3:53:16.9	Mozambique		3.6
2008/2/23	7:11:2.5	Mozambique		3.7
2008/3/6	9:35:34.9	Tanzania	5.4	
2008/3/6	19:47:0.1	Zambia		5.7
2008/3/15	4:26:20.7	Zimbabwe		5.9

2008/3/24	3:1:51.9	Mozambique		4.3
2008/3/28	25:8:54	Mozambique		5
2008/3/29	2:9:39.3	Mozambique		5.4
2008/3/31	5:24:31.6	Mozambique		5.3
2008/4/4	11:52:29.4	Mozambique		4.7
2008/4/5	24:11:7.7	Mozambique		3.8
2008/4/11	17:26:23	Mozambique		3.6
2008/4/20	9:30:45.5	DRC	5.4	
2008/4/26	16:48:47.6	Namibia		6.1
2008/4/26	18:11:19.3	Namibia		5.8
2008/4/29	8:43:50.9	Mozambique		5.7
2008/4/30	18:37:11.2	Mozambique		3.9
2008/5/1	3:5:10.6	Namibia		5
2008/5/5	18:20:32.6	Mozambique		4
2008/5/8	21:15:24.6	Mozambique		3.9
2008/5/14	17:29:20.1	Mozambique		3.6
2008/5/18	3:30:51.6	Mozambique		3.9
2008/5/22	24:16:17.6	Mozambique		3.9
2008/5/26	19:8:0.3	Mozambique		3.6
2008/5/26	21:29:27.6	Mozambique		4.3
2008/6/5	21:36:26.7	Mozambique		3.6
2008/6/8	15:54:45.6	Mozambique		4.5
2008/6/16	18:9:15.1	Mozambique		4.3
2008/6/19	9:25:19	Lake Tanganyika	4.7	
2008/6/26	14:55:44.7	Mozambique Channel		5.1
2008/6/28	24:58:27	Mozambique		3.5
2008/7/2	3:1:28	Tanzania	4	
2008/8/2	5:11:59.2	Mozambique		3.8
2008/8/7	11:58:58.4	Mozambique		3.6
2008/8/16	22:21:44	Botswana		3.6
2008/8/27	8:46:18.4	Comores Islands	6	
2008/8/30	7:10:10.4	Mozambique		4
2008/9/9	2:43:5.9	Lake Tanganyika	4.1	
2008/9/11	11:49:29	Mozambique		3.6
2008/9/15	17:50:49.7	Tanzania	5.1	
2008/10/9	23:34:56	Mozambique		3.7
2008/11/5	2:5:50.5	Mozambique		4.3
2008/11/19	17:24:56.9	Tanzania	4.1	
2008/11/25	17:5:38.8	Mozambique		6.3
2008/11/25	24:3:52.7	Mozambique	3.9	
2008/12/3	12:7:14.3	Mozambique		4
2008/12/6	18:41:35.5	Botswana		4.8
2008/12/14	11:43:8.4	Lake Tanganyika	4.7	
2008/12/20	4:12:24.7	Mozambique		4
2008/12/21	20:10:31	Lake Kariba		4.5

Table 3: List of mining-related earthquakes for which ML$4 for the period January to December 2008:

Date	**Time**	**Region**	**Magnitude(ML)**
2008/3/8	6:20:12.2	Far West Rand gold mines	4.1
2008/11/23	3:52:43.1	Klerksdorp gold mines	4.4
2008/12/15	3:34:38.4	Klerksdorp gold mines	4

2006-5606 **OPERATION AND MAINTENANCE OF THE PRIMARY (PS39 – BOSHOF) AND AUXILIARY SEISMIC STATIONS AT SUTHERLAND AND IN THE ANTARCTIC – (AS35)**

Project leader: J. Steyn, M.Dip.Tech.(Elec.Eng).
Project team: M.R.G. Grobbelaar, B.Sc.Hons, F.A Delport, B.Tech.(Elec.Eng), R.T. Kommetsi, Nat.Dip.(Elec.Eng), G. van Aswegen, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons, P. Adamos, Nat.Dip.(Elec.Eng).
Primary objective: *to operate and maintain the Comprehensive Test Ban Treaty (CTBT) seismic stations at Boshof, Sutherland and the SANAE base in the Antarctic according to the requirements of the Treaty, and to ensure a continuous flow of seismic data from the remote sites to the International Data Centre (IDC) based in Vienna.*
Duration: Ongoing.
Budget: R370 000.

Motivation

As the technical point of contact regarding the Comprehensive Test Ban Treaty (CTBT), the CGS is designated as the technical point of contact with respect to seismological and infrasound matters and also the operator of a National Data Centre which functions within the framework stipulated by the Comprehensive Test Ban Treaty Organisation (CTBTO). The CGS manages the various components of the project and ensures continuous data flow and availability from the seismograph facilities. Apart from the CGS's active participation in CTBT matters, the operation of such a NDC and analysis of seismic data, obtained from the local and neighbouring National Data Centres which all form part of the IMS, contribute towards international co-operation and enhance the corporate image of the CGS.

Progress

Technicians from the CGS operate and maintain the data communications and data-processing equipment which are deployed at the remote seismic station in Boshof. A 'Configuration Change Notification', two 'Outage Requests', 56 'Problem Reports' and 12 'Monthly Reports' were generated and communicated with the IMS's Operational Centre (IMS Ops).

The CGS continuously contacts the experts at the Air Force Technical Application Centre (AFTAC) concerning discussions and resolutions in rectifying problems at the PS39 seismic site. Problem messages regarding the VSAT data communications equipment are conveyed by the VSAT operator, AIS Engineering.

The main reason for most of the outages was due to AC power failure at the borehole site. The communications equipment is backed up by an uninterrupted Power Supply unit, but the unit could only supply power for approximately one hour after failure. The AC load shed conditions often lasted for periods of up to three hours. An AFTAC technical delegation plans to visit the central facility in the new financial year to install upgraded power systems that will address the power outage issues at the site.

Conclusions

The station had been certified on 24 December 2004 and the CGS had entered into an agreement with the CTBTO. The station did not experience outages related to defective data communications or acquisition equipment, and the outages recorded during the year were all related to AC power outages. This matter will be monitored as the power supply upgrade in the new financial year should address the power outage issues.

Future activities

As this is an ongoing project, the CGS will maintain equipment to improve operations and suggest system configuration changes to the IMS Operational Centre ensuring high-quality data availability from the PS39 seismic station. The AFTAC delegation has requested that the CGS team visit the site quarterly to take measurements of the ground resistivity. This is intended to configure a trend with regard to the efficiency of the grounding that has been implemented.

2006-5620 **INFRASOUND STATION IS47**

Project leader: J. Steyn, M.Dip.Tech.(Elec.Eng).
Project team: F.A. Delport, B.Tech.(Elec.Eng), D.L. Roblin, B.Sc.Hons, T.R. Kometsi, Nat.Dip.(Elec.Eng), G. van Aswegen, Nat.Dip.(Elec.Eng), P. Adamos, Nat.Dip. (Elec.Eng).
Primary objective: *to operate and maintain infrasound station IS47 in Boshof as part of South Africa's commitment to contribute infrasound data to the International Data Centre (IDC) based in Vienna.*
Duration: Ongoing.
Budget: R370 000.

Motivation

The CGS has been appointed as the technical point of contact and awarded the contract to operate and maintain the infrasound station (IS47) in Boshof as part of South Africa's commitment to contribute infrasound data to the International Data Centre (IDC) based in Vienna, Austria. The station is one of the instruments used in the Global Monitoring System as part of the verification regime to detect atmospheric pressure changes which may occur after a large explosion.

Infrasound station IS47 is one of the 60 infrasound stations of the International Monitoring System (IMS) of the Comprehensive Test Ban Treaty Organisation (CTBTO). Infrasound technology (very low frequency soundwaves) is important in the detection of atmospheric nuclear explosions and complements the other technologies chosen by the CTBTO, such as seismic, hydro-acoustic and radionuclide, for monitoring adherence to the CTBT. As a signatory to the Treaty, South Africa is under obligation to work with the CTBTO, and the CGS is privileged to have a major role in this international co-operation.

Progress

Since the infrasound station's certification in 2005 by the Preparatory Technical Secretariat, it has been operated and maintained by the CGS's technical personnel. Routine maintenance has been carried out. Lightning protection units were installed at the site, which resulted in no damage to telemetry equipment after installation.

Conclusions

The operation and maintenance of the station offers CGS staff the opportunity to gain experience in maintaining the assortment of equipment used. The station has performed well and no outages were experienced as a result of power failures. The equipment deployed at the Central Recording Facility is backed up by a large bank of batteries. It was noted that the battery bank and other batteries of the various infrasound elements were due for replacement based on the age of these batteries. During the AFTAC technical delegation's visit to PS39 the opinion was expressed that the acid fumes emanating from the aged battery banks could damage some of the new equipment. Therefore, CTBTO was approached and requested to replace the batteries.

Future activities

Regarding operations and maintenance of the station the CGS is committed to ensure a high level of station availability. Future progress may commence in the analysis of the received data at the National Data Centre. The latest version of processing software was recently installed on the NDC computer which will enable the use of the products of the IMS/IDC.

2009-0060 **ONE-DIMENSIONAL VELOCITY MODEL FOR USE BY THE SANSN IN EARTHQUAKE LOCATION**

Project leader: V. Midzi, Ph.D.
Project team: I. Saunders, Nat.Dip., M. Brandt, M.Sc., T. Molea.
Primary objective: *to determine a one-dimensional velocity model for South Africa that would result in improved location of earthquakes by the South African National Seismological Network (SANSN).*
Duration: 2008/9.
Budget: R5 000.

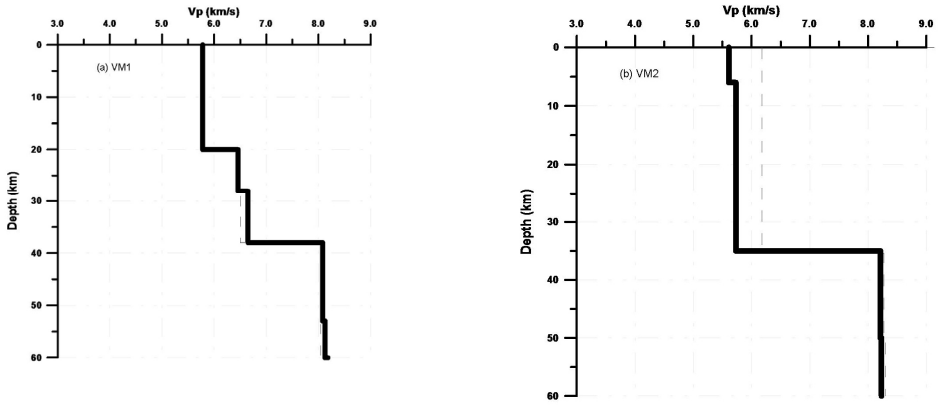
Motivation

Reliable local earthquake locations depend on many factors of which a major one is the velocity model. Locating earthquakes using unreliable models contributes, in part, to the uncertainties of active fault mapping and unexplained scatter of seismic locations. In order to continually improve locating abilities, it is necessary to always improve on the

model, when possible. The SANSN has been using a model based on a velocity structure study mainly located on the Kaapvaal Craton. With the availability of good-quality data it was found necessary to determine a 1-D velocity model for South Africa by inverting travel times of well-recorded and located events in southern Africa.

Progress

The simultaneous inversion for velocity and hypocentre parameters was carried out using the program VELEST. The method involved the calculation of a minimum 1-D velocity model, which represents the least squares solution of travel time residuals. A critical factor in all inversion problems is the initial model. Two starting models were selected from results of previous studies, the current model being used by the SANSN and the old model developed for use by SANSN in the early days of seismic instrumentation. The inversion process led to the determination of two final models of which model VM1 was selected as the better model that could be used by the SANSN in earthquake data analysis.



Final velocity models.

Conclusion

A new model has been obtained through inversion of travel time data. Testing of the model showed that it results in an improvement of locations. Station corrections of all the stations used in the inversion process showed that the velocity structure in the region is very heterogeneous. Thus it is necessary to consider implementing the use of more accurate spherical earth models.

Future activities

A report will be submitted to an international journal for publication after which the velocity model will be adopted by the SANSN in their data analysis.

2006-5619 **INDIAN OCEAN TSUNAMI WARNING SYSTEM**

Project leader: J. Steyn, M.Dip.Tech.(Elec.Eng).
Project team: F.A Delport, B.Tech.(Elec.Eng), T.R. Kometsi, Nat.Dip.(Elec.Eng), G. van Aswegen, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons, P. Adamos, Nat.Dip.(Elec.Eng).
Primary objective: *to contribute seismic data to the International Data Centre as part of South Africa's obligation to the establishment of the Indian Ocean Tsunami Warning System.*
Duration: Ongoing.
Budget: R1 100 000.

Motivation

An earthquake on Sunday, 26 December 2004 off the northern tip of Sumatra caused a tsunami that left a 10-nation arc of destruction in Southeast Asia. In order to co-ordinate South Africa's response, an inter-ministerial committee comprising the Minister for Provincial and Local Government as Chairperson, and the Ministers of Foreign Affairs, Health, Social Development and Water Affairs and Forestry, supported by senior officials, met on 31 December 2004.

The CGS was designated by the South African Government to act as the scientific and technical point of contact for tsunami-related seismic issues. As the CGS operates and maintains an advanced seismological network capable of detecting earthquakes capable of recording events that may cause tsunamis, five of the South African National Seismograph Network stations were dedicated to contribute seismic data towards an international data centre.

Progress

Data from five of the South African National Network Seismograph Stations continue to be sent in real time to the International Data Centre (IDC), which is currently hosted by the GeoForschungsZentrum Potsdam (GFZ) in Germany, as part of South Africa's contribution towards the establishment of the IOTWS.

Conclusions

As the CGS was designated to contribute high-quality seismic data to an International Data Centre, state-of-the-art equipment was deployed in order to achieve this challenge. Technical staff maintains and constantly develops and implements aids to optimise network performance.

Future activities

The CGS will promote IOTWS preparedness and awareness programmes as part of an educational effort. This initiative falls within the framework and objectives of working group 6 of the ICG and the CGS commenced in supporting this initiative.

2009-1047 STATISTICAL IDENTIFICATION OF SEISMOGENIC ZONES

Project leader: J. Ramperthap, B.Sc.Hons.
Primary objective: *to develop software to delineate seismogenic zones and calculate seismic hazard parameters.*
Duration: 2008/9.

Motivation

Knowledge of seismogenic zones – areas likely to cause earthquakes – and their relevant hazard parameters are required in the assessment of seismic hazards.

Progress

A study of methods employed in the identification of seismogenic zones, based on observed seismicity, was undertaken. Software incorporating cluster analysis methodology to obtain seismogenic zones, and the subsequent calculation of the relevant hazard parameters, was written.

Conclusions

Software for zone delineation and hazard parameter calculation has been written which may be employed in the initial phases of a seismic hazard analysis.

Future activities

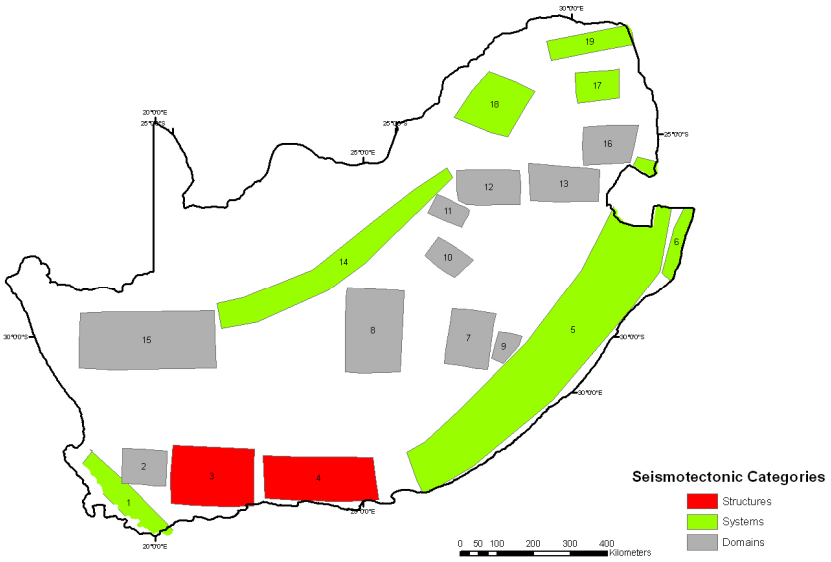
Further work may entail the incorporation of further statistical tests to obtain the zone solution.

2008-0958 ASSESSMENT OF THE MAXIMUM POSSIBLE EARTHQUAKE MAGNITUDE FOR SOUTH AFRICA

Project leader: M. Singh, B.Sc.Hons.
Project team: T. Pule, Nat.Dip.Geol.
Primary objective: *to provide a detailed account of large damaging earthquakes that have occurred and to predict their occurrence in the near future.*
Duration: 2007/8 to 2008/9.

Motivation

Seismic hazard assessments (SHA) of critical public facilities such as power stations, hospitals, schools, dams and bridges are often used to determine the likelihood or frequency of a damaging earthquake at a certain site. This work incorporates several key steps that form integral aspects in SHA, such as the development of a database with earthquake catalogues and other geoscientific data, seismotectonic model development, and the assessment of earthquake recurrence and maximum earthquake magnitudes. Multidisciplinary data are often not readily available, which causes several delays in projects, hence the need for database development. This work also highlights strong and weak points in the database which provides a starting point for further research within this field.



Seismotectonic model derived for South Africa.

Progress

Researchers performed several key steps which involved the following:

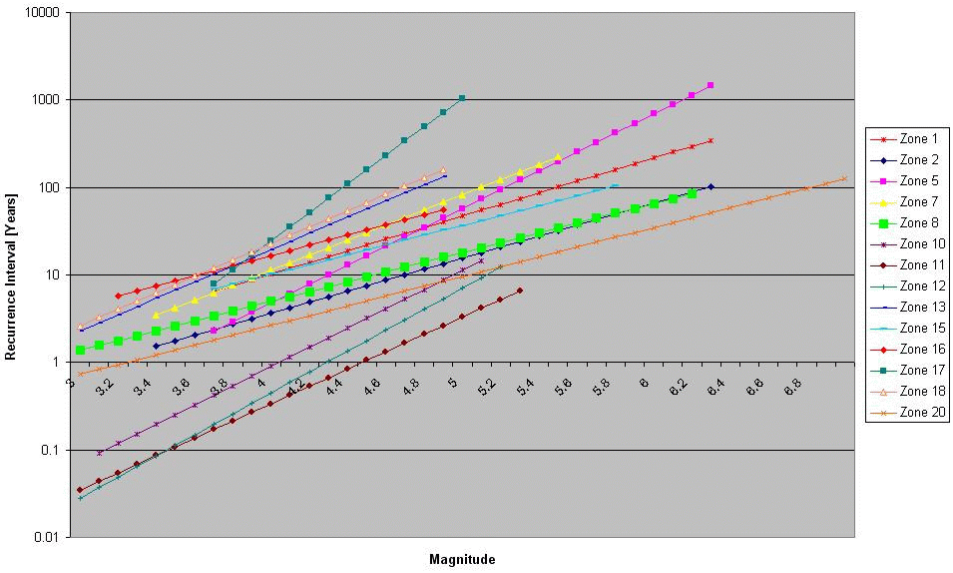
Creating a seismotectonic development database (geology, geophysics, stress data, neotectonics, reactivated faults)

Creating a database of the largest earthquakes observed, and documenting their associated effects

Qualitatively assessing the completeness of a database for seismotectonic development

Regional seismotectonic development (see Fig. 1)

Assessing earthquake recurrence intervals and maximum possible earthquake magnitudes within derived seismotectonic units (see Fig. 2)



Mean recurrence interval for specified magnitude for respective seismotectonic zones.

Conclusions

South Africa has a distinctly variable pattern of earthquake occurrence, therefore seismotectonic model development must be considered for SHA. Relatively larger controls of seismicity south of the Great Escarpment exist. This region corresponds in the south with areas transected by large aeromagnetic anomalies and large E–W-trending faults, in the west by the NW—SE-trending Wegener Stress Anomaly, radial-trending dykes and earthquake clusters and in the east by a large neotectonic domain where several large earthquakes have occurred. Central to the region are clusters of earthquake activity, often related to mining activity. Further north, seismicity is related to both mining activity and neotectonic deformation. A wealth of data now exists from this study but a concerted multidisciplinary effort to acquire data is required in order to fully understand the driving mechanisms of earthquake occurrence in the different regions.

Future activities

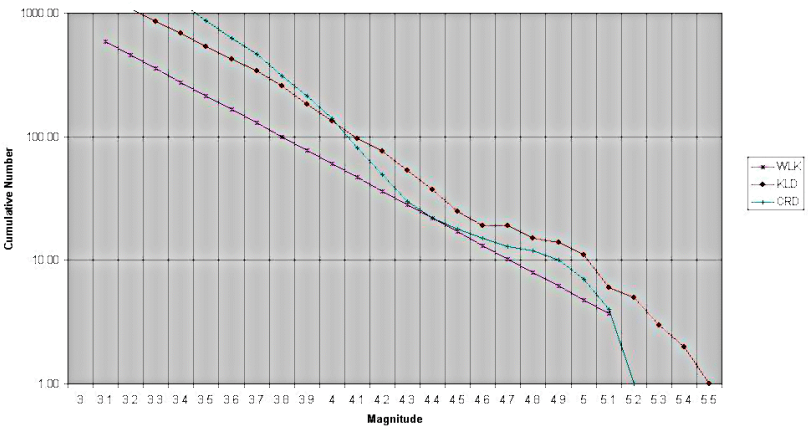
The database will be consistently updated with new information as it is acquired. Other ideas for the future include statistical identification of seismotectonic units, seismotectonic model development using historical data, correlation of data using GIS techniques and appropriate spatial weighting of layers.

2009-1048 **AN ASSESSMENT OF THE MAXIMUM POSSIBLE EARTHQUAKE MAGNITUDE FOR THE WITWATERSRAND BASIN**

Project leader: M. Singh, B.Sc.Hons.
Project team: T. Pule, Nat.Dip.
Primary objective: *to assess earthquake recurrence intervals and maximum possible earthquake magnitudes in the gold-mining districts of the Witwatersrand Basin.*
Duration: 2008/9.

Motivation

Earthquakes in the mining regions are of great concern for all stakeholders in the mining industry. Different patterns of observed earthquake activity occur in the various mining districts of the Witwatersrand Basin. Catalogues of earthquakes from the various mining regions are statistically assessed in order to compare patterns of earthquake occurrences.



Mean recurrence interval for specified magnitude for respective areas.

Progress

For the purpose of analysis, the earthquake catalogue is separated into three distinct regions corresponding to different gold-mining districts; Welkom (WLK), Klerksdorp (KLD) and Carletonville and Rand (CRD). On average the maximum possible local earthquake magnitude varies from 5.1 to 5.5. On record, the CRD region has the highest number of seismic events of magnitude less than 4. For magnitudes greater than 4 the KLD region has a higher number of events. The WLK region has fewer events on record when compared with the two other mining regions. Earthquakes smaller than magnitude 3.4 have a relatively smaller return period for the CRD region, but this trend changes with the KLD region showing the smallest return periods. The earthquakes in the WLK region have the biggest return periods. The gradients (b-values) for the three regions are similar with 1.1 for WLK, 1.0 for KLD and 1.2 for CRD. On average, earthquakes of magnitudes between 4 and 4.4 have a return time of one year and those earthquakes of magnitudes between 3 and 3.4 occur on a monthly basis.

Conclusions

The KLD region certainly has relatively larger earthquakes on record with those earthquakes occurring relatively more frequently than in the other two regions.

Future activities

This work can be further improved by studying the local faults and dykes in the mining regions and understanding to what extent they constrain the values for the maximum possible earthquake. The earthquake database has several spurious events that need to be investigated.

2008-0972 MODELLING GROUND MOTION PRODUCED BY AN EXTENDED SEISMIC SOURCE

Project leader: A. Cichowicz, Ph.D.
Project team: I. Saunders, Nat.Dip., M. Grobbelaar, B.Sc.Hons, T.R. Kometsi, Nat.Dip.(Elec.Eng), G. van Aswegen, Nat.Dip.(Elec.Eng).
Primary objective: *to assess earthquake recurrence intervals and maximum possible earthquake magnitudes in the gold-mining districts of the Witwatersrand Basin*.
Duration: 2008/9.
Budget: R318 018.

Motivation

Different approaches have been developed to simulate strong ground motion. A method for modelling strong ground motion should be able to simulate a source space-time evolution and wave propagation from a fault to the receiver. A synthetic seismogram using a wave propagation model can be calculated, but only when the velocity structure is well known. Stochastic simulation, with an assumption about ray path attenuation could be an alternative option. The fault geometry, heterogeneity of slip on the fault plane, and directivity can influence the ground motion in the far and near field. If the scenario earthquake is in the near field, a point source model is not suitable for ground motion prediction. Most often, a large fault is divided into sub-faults and each sub-fault is considered as a small point source. The waveform of a small event is time delayed, scaled, and summed to simulate the ground motion of a large earthquake. The method presented here simulates a sub-event using random vibration theory. The earthquake source is represented as a set of point sources with a source time function. The source time function of the simulated earthquake is represented as a linear combination of the source time function of the sub-events. This approach enables the inclusion of directivity into simulation of the process.

Progress

The largest earthquake of magnitude 5.3 associated with deep gold mining was recorded near Stilfontein. The earthquake was located at a depth of 2 km on an ancient normal fault. Underground investigation revealed strong fragmentation of the fault, which was well recorded by underground mining networks. The individual pulses were resolved within the S-wave train. All pulses are assumed to be associated with the failure of patches of the source region. Temporary and space variation of the dynamic properties rupture was obtained. Those measurements lead to the construction of a model of seismic source as a composition of the asperities, with additional displacement outside the area of those asperities. The inversion result was used as input to model synthetic ground motion. Synthetic spectra of an earthquake of magnitude 5.3 were obtained by using a model of the extended source and, for comparison, the point source model. The synthetic seismogram and its spectra display significant differences for the different azimuths.

Conclusions

Source complexity has a significant effect on near source earthquake ground motion. Rupture directivity and rupture heterogeneity have to be incorporated into seismic hazard assessment, which could be done through incorporation of those two parameters into ground motion prediction.

2007-0957 CRUSTAL AND UPPERMOST MANTLE STUDIES OF THE SOUTHERN AFRICAN LITHOSPHERE

Project leader: E. Kgaswane, M.Sc.
Project team: Prof. A. Nyblade, Ph.D. (Pennsylvania State University), Prof. P. Dirks, Ph.D. (University of the Witwatersrand).
Primary objective: *to investigate the nature of the crust across Archaean and Proterozoic terrains of southern Africa using 1-D shear wave velocities obtained by jointly inverting the Rayleigh wave group velocities and receiver functions.*
Duration: 2005/6 to 2009/10.

Motivation

Many studies indicate a significant amount of variability in the lower crustal structure within and between Precambrian

terranes. The study of the lower crust has globally been indicated to be an important component in the understanding of the evolution of the crust. The aim of this study was to characterise the nature of the lower crust in southern Africa using the joint inversion of surface wave dispersions and P-wave receiver functions.

Progress

For the first phase of the project, research findings entitled 'Shear Wave Velocity Structure of the Lower Crust in Southern Africa: Evidence for Compositional Heterogeneity within Archaean and Proterozoic Terrains' were submitted to the Journal of Geophysical Research for review on the 18th November 2008 and reviewer's comments were received. Processing of data for the second and third phase of the research project is in progress. The second phase involves deriving 3-D shear wave velocity variations of the shallow structure (15 km deep) of the Bushveld Complex. The third phase involves characterising the tectonic architecture of basins and terrain boundaries in South Africa using the shear wave results obtained from the first phase of the research project.

Conclusions

The main finding in the first phase of the project was that the lower crust across southern Africa shows variable velocities, but for most of the Archaean and Proterozoic terrains the S-wave velocities reach 4.0 km/s or higher over a substantial part of the lower crust (20 km deep). However, in the Kimberley terrain and adjacent parts of the Kheis Province and Witwatersrand terrain, as well as the western part of the Tokwe terrain, mean shear wave velocities of 3.9 km/s characterise the lower part of the crust along with slightly thinner crust (5 km deep). These findings indicate that the lower crust across much of the Precambrian shield has a predominantly mafic composition, except for the southwest portion of the Kaapvaal Craton and western portion of the Zimbabwe Craton, where the lower crust is intermediate to felsic in composition. The parts of the Kaapvaal Craton which are underlain by intermediate to felsic lower crust coincide with regions where Ventersdorp rocks have been preserved and suggest that the intermediate to felsic composition of the lower crust and the shallower Moho may have resulted from crustal extension and reworking during the Ventersdorp tectonomagmatic event at ca. 2.7 Ga. The crustal extension could have attenuated the mafic layering in the lower crust. The high velocities in the lower crust elsewhere could be attributable to mafic rocks preserved during suturing events (e.g. Limpopo Belt), magmatic intrusion (e.g. Bushveld Complex) and old crustal nuclei preserved against deformation (e.g. the eastern side of the Kaapvaal Craton).

Future activities

Research findings will be published in the Journal of Geophysical Research. Completion of the second and third phases of the research project will continue towards completion at the end of 2009.

2007-0956 **IMAGING THE AFRICAN SUPERPLUME**

Project leader:	M. Brandt, M.Sc.
Project team:	G. Cooper, Ph.D. (University of the Witwatersrand), S. Grand, Ph.D. (University of Texas at Austin).
Primary objective:	*to conduct research and training as part of the* AfricaArray *programme by imaging the upper mantle beneath southern Africa using seismic waves and imaging the deep mantle using seismic travel-time tomography.*
Duration:	2005/6 to 2009/10.

Motivation

This project forms part of the *AfricaArray* programme. *AfricaArray* is an initiative to promote, in the full spirit of the New Partnership for Africa's Development (NEPAD), coupled training and research programmes for building and maintaining a scientific workforce for Africa's natural resource sector. This initiative is a joint effort between Pennsylvania State University, the University of the Witwatersrand and the CGS. More information may be obtained at http://africaarray.psu.edu.

The research consists of a sandwich programme for the project leader who spends four months, from February to May, at the University of Texas at Austin, where research is carried out with a world-class seismologist. A further two months are taken up with research in South Africa.

This project involves research into the African Superplume, which is one of the most prominent and enigmatic features of the Earth's mantle. Underlying much of the southern African subcontinent, it is characterised by seismic wave velocities that are slower than those of other structures in the Earth's lower mantle. The superplume also lies beneath an area with an anomalously high topography, suggesting a geodynamic relationship between the superplume and the formation of plateaus and rift valleys in eastern and southern Africa.

A better understanding of the nature and origin of the African Superplume advances understanding the regional seismotectonics. The research will involve the use of broadband seismic data to improve images of the African

Superplume and will investigate the geodynamic relationship between the superplume and eastern and southern Africa.

Progress

A research paper has been submitted for publication in the Journal of Geophysical Research, and early results have been presented at the International Association of Seismology and Physics of the Earth's Interior (IASPEI) conference, which was held in Cape Town during January 2009. The project requires collaboration with African and international scientists as part of the *AfricaArray* Programme.

Future activities

Research results have important industrial application: a presentation to interpret the implications for Seismic Hazard Analysis will be held in July 2009.

The research results will be compiled as a Ph.D. thesis which should be submitted by July 2010.

2007-0891 **INCREASING AWARENESS OF SEISMOLOGY IN SCHOOLS**

Project leader:	M.R.G. Grobbelaar, B.Sc.Hons.
Project team:	T.R. Kometsi, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons, L. Brink.
Primary objective:	*to increase the awareness of seismology in schools by the transfer of seismological technology and knowledge.*
Duration:	2008/9.

Motivation

This project is closely linked to the *AfricaArray* programme which the CGS supports. However, while the *AfricaArray* programme focusses on the promotion of geophysics at universities within Africa, including the University of the Witwatersrand, this project focusses on the schools which produce the future geophysicists of South Africa. The CGS has embarked on this project with the aim of exposing the future generations of South Africans to seismology, and science in general, by installing seismological stations at various schools which will demonstrate that seismology is exciting and dynamic.

It was decided that this project should initially focus on schools within areas of high to moderate seismicity, such as the gold-mining regions and Ceres, as those pupils will be more familiar with earthquakes. The project has now expanded to other provinces.

This project is in line with one or more of the CGS focus areas, such as the transfer of knowledge and technology, education and development of Africa.

Progress

Owing to the lack of availability of staff, this project was not as successful as in previous years, but has continued to support Water Educational Techniques (WET), which visited many exhibitions, schools and community centres to promote geoscience and the CGS. It was decided that this project will fall under the auspices of the Marketing and Communications Unit, but the Seismology Unit will continue to support WET, especially when they invite scientists to address learners, as the CGS can reach a huged audience through WET.

Conclusion

This project targets future students in the science environment before they enroll into university and allows them to make the correct subject and career choice before they enlist for their tertiary studies.

Future activities

This project will show its results in the years to come as more and more pupils are exposed to the opportunities that are available to them within the field of seismology/geophysics.

2007-0947 ***AFRICAARRAY***

Project leader:	M.R.G. Grobbelaar, B.Sc.Hons.
Project team:	G. van Aswegen, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons, T.R. Kometsi Nat.Dip.(Elec.Eng), L. Brink.

Primary objective: *to support the objectives of the* AfricaArray *programme by installing and maintaining seismograph stations, and training African technicians.*
Duration: 2008/9.

Motivation

AfricaArray was initiated by the Pennsylvania State University and the University of the Witwatersrand, and focusses on building capacity in geophysics in Africa. This project was established through a public-private partnership of three organisations, the Pennsylvania State University, the University of the Witwatersrand and the CGS.

AfricaArray aims to effectively build a workforce of highly trained scientists to meet the long-term manpower requirements within Africa's natural resource sector and, at the same time, reverse the current brain drain of many of Africa's best and brightest scientists.

The CGS was invited to participate after representatives from Pennsylvania State University and the University of the Witwatersrand visited the CGS facilities. The CGS (the primary public stakeholder) installs seismic stations in participating countries in order to form a seismic array. Technical personnel in each country are trained by the CGS to operate and maintain the seismic stations, thus assisting the countries to become self-sufficient.

Progress

Technical personnel in each country in which stations have been installed (Angola, Mozambique, Malawi, Zimbabwe, Botswana, Namibia and Rwanda) have been trained by the CGS staff to operate and maintain the seismic stations, thus assisting these countries to become technically self-sufficient.

Future activities

The CGS will continue to provide the necessary support for the *AfricaArray* programme.

2007-0953 EFFECTS OF EXPLOSIONS

Project leader: M.R.G. Grobbelaar, B.Sc.Hons.
Primary objective: *to analyse the data obtained by monitoring explosions in order to determine relations for attenuation and yield.*
Duration: 2008/9.

Motivation

Many commercial projects have been carried out by the Seismology Unit to measure peak particle velocities of blasts at surrounding structures, and a large database of blast recordings has been collated. A literature review was conducted to examine the type of information the project should extract from the data. Various relationships and scaling laws were examined and will be calculated after testing it on other chemical explosions.

Progress

Data were collected from stations installed in temporary client networks. A combination of 4.5 Hz triaxial geophones and 1 Hz triaxial seismometers were used to monitor surface explosions of varying sizes, with the sensors placed at varying distances from the test sites. Five different test sites were used for the experiments and the local geology was briefly described. The peak particle velocity was calculated for the clients and then the following methodology was applied to the data.

The data were analysed to determine whether acoustic or air-coupled Rayleigh waves were measured and also whether locations using these waves could be used. Data required for generic scaling laws for attenuation and the determination of yield were examined. The scaling laws will cover blast parameters such as airblast travel times, peak displacement of first arrival, low frequency asymptote of displacement spectra, corner frequencies and decay rates.

Conclusion

There is an extensive wealth of information that may be obtained from the data resulting from this project. The relationships and scaling laws which will be calculated using the methods examined will be beneficial for other studies involving the attenuation of an area, as well as in forensic seismology.

Future activities

The project will aim to release these scaling laws using methods obtained from the literature. However, it is also highly advisable to conduct an infrasound analysis of the data as part of a separate project.

PREPARATIONS FOR THE IASPEI 2009 GENERAL ASSEMBLY

Project leader:	M.R.G. Grobbelaar, B.Sc.Hons.
Project team:	J. Cole, M.Sc., A. Cichowicz, Ph.D., G. Graham, Ph.D., C. de Beer, Ph.D., L. Brink.
Primary objective:	*to organise and co-ordinate the IASPEI 2009 General Assembly in Cape Town.*
Duration:	2008/9.

Motivation

The CGS won the bid to host the 2009 International Association of Seismology and Physics of the Earth's Interior (IASPEI) General Assembly. The IASPEI general assembly is held every second year, in a different country. In 2005 it was held in Santiago, Chile and in 2007 in Perugia, Italy.

The 2009 IASPEI General Assembly was the first to be held in Africa and took place in Cape Town. It was originally expected that there will be 400 to 500 participants. There were 347 participants from 60 countries registered for the assembly. Eighty three of them were students, young researchers and researchers from African countries who were partially sponsored.

The objectives of the International Association of Seismology and Physics of the Earth's Interior are:

- To promote the study of earthquakes, the propagation of seismic waves, and the internal structure, properties and processes of the Earth;
- To initiate and co-ordinate research which depends on co-operation between countries, and to provide for scientific discussion;
- To facilitate research into scientific, engineering and applied seismology, such as the comparison of instruments used in different countries, research on aerial blasts and any other seismology-related topics.

Progress

Letters of support for the bid were received from the minister of the Department of Minerals and Energy, the Geological Soclety of Southern Africa (GSSA), the South African Geophysical Association (SAGA) and the International Council of Science (ICSU). Scientists from Malawi, Mozambique, Rwanda, Namibia and South Africa participated in the local organising committee and the scientific committee.

The IASPEI Scientific Assembly was held in Cape Town, South Africa, from 11–16 January 2009. The Assembly, held for the first time on the African continent, provided a very good platform for seismologists worldwide to meet and to discuss the latest developments in seismology and physics of the Earth's interior research.

Mr Thabo Gazi gave the welcome address on behalf of Minister Sonjica. IUGG Vice-President, Dr Harsh Gupta, welcomed the participants of the assembly, and opening remarks by the IASPEI President, Dr Wu Zhongliang, ended the formal part of the opening ceremony. At the evening cocktail function, the MEC of community safety, Patrick McKenzie, gave his welcome speech, and was followed Prof. Jay Barton Jnr, a member of the CGS Board.

Three international keynote lectures were delivered at the assembly: Tom Jordan from the USA talked on ‘Earthquake Forecasting and Prediction: Progress in Model Development and Evaluation’; Raoul Madariaga from France discussed ‘Earthquake Dynamics: from source to radiation’, and Guust Nolet from France presented ‘Seismic tomography and the dilemma of the Earth's heat budget’.

The 32 symposia of the programme covered the spectrum of research related to IASPEI commissions and current ‘hot’ topics in seismology, in a total of 335 oral and 106 poster presentations. These included a session on ‘Capacity building and capturing undergraduate students to Geophysics/Seismology’, and two well-attended panel discussions convened by R. Musson on: ‘Seismic Hazard: Living with Uncertainty’ and ‘Earthquake Prediction: What the Future Holds’. Several IASPEI commission and working group meetings were organised during the Assembly.

A summer school was organised in conjunction with the IASPEI Scientific Assembly and held during the week after the conference ended, attended by 27 fully sponsored, mostly African participants. International lecturers at the school were: Prof. Aldo Zollo on ‘Real-time processing and seismic alert with examples of their implementation’, Prof. Yehuda Ben Zion on ‘Introduction to physics of earthquakes and faults’, Dr Martin Mai on ‘Source modeling for near-fault ground motion simulations’, Dr John Douglas on ‘Seismic hazard assessment and empirical ground-motion prediction’, Dr Artur Cichowicz on ‘Introduction to mining seismology’, and Prof. Colin Reeves on ‘African Geodynamics’.

SPATIAL DATA MANAGEMENT

2002-0276 **MAINTENANCE OF GIS METADATA**

Project leader: H.J. Brynard, Ph.D.
Project team: S. Noruka, B.Sc.Hons.
Duration: Ongoing.
Budget: R63 075.

A database of metadata, which is information on the source and reliability of data, must be maintained for all the spatial data that the SDM unit produces.

2002-0277 **SYSTEM AND APPLICATION MAINTENANCE**

Project leader: K. Wilkinson, Nat.H.Dip.Cart.
Project team: H.J. Brynard, Ph.D., D Sebake, M.Environ.Dev., D. Grobbelaar, Nat.Dip.
Duration: Ongoing.
Budget: R67 787.

Servers, workstations, operating system software, peripheral devices and applications in the SDM unit must be continually maintained.

2002-0277 (SDE)
DATA ADMINISTRATION FOR GEODE AND SDE
2002-0785 (GEODE)

Project leader: H.J. Brynard, Ph.D.
Project team: K. Wilkinson, Nat.H.Dip.Cart., S. Tucker, Dip.S.B.M., F. Nkosi, I.T.Dip., D. Sebake, M.Environ.Dev., S. Noruka, B.Sc.Hons.
Duration: Ongoing.
Budget: R249 385.

The spatial and non-spatial data that the SDM unit captures and maintains need to be managed and correctly administered for the effective usage thereof.

2003-0793 **DATABASE ADMINISTRATION: GEODE AND SDE**

Project leader: H.J. Brynard, Ph.D.
Project team: K. Wilkinson, Nat.H.Dip.Cart., S. Tucker, Dip.S.B.M., F. Nkosi, I.T.Dip., D. Sebake, M.Environ.Dev.
Duration: Ongoing.
Budget: R270 352.

The ArcSDE/SQL Server and Oracle databases form part of the CGS's Corporate Database and these databases must be administered and maintained so that they operate effectively.

2005-0856 **GEOPORTAL**

Project leader: H.J. Brynard, Ph.D.
Project team: S. Tucker, Dip.S.B.M., M. Roos, Nat.H.Dip.Cart.
Budget: R130 935.

The GeoPortal is maintained by staff of the SDM unit who also develops new applications.

2005-0856 **DEVELOPMENT AND IMPLEMENTATION**

Project leader: K. Wilkinson, Nat.H.Dip.Cart.
Project team: H.J. Brynard, Ph.D.
Duration: Ongoing.
Budget: R51 910.

This project involves the planning, development and implementation of a Geographic Information System for input, storage, retrieval and editing. Modelling and cartographic presentation of geologically related data is the core function of the unit and the above functions are necessary to achieve this.

GIS AND CARTOGRAPHY

Project No.	Title	Project leader and team
1:50 000 GEOLOGICAL MAPS (GIS)		
2004-0822	2429AD Zebediela East	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, H. Sello, P. Msiza, K. Wilkinson, Nat.H.Dip.Cart.
2004-0822	2429AC Zebediela West	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, M Letsoalo, P. Msiza, K. Wilkinson, Nat.H.Dip.Cart.
2002-0610	2926AB Maselspoort	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, P. Msiza, K. Wilkinson, Nat.H.Dip.Cart.
2002-0590	2926BB Thaba Nchu	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, H. Sello, K. Wilkinson, Nat.H.Dip.Cart., C.Kgari
2003-0755	2429AB Tshwene	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, M. Letsoalo, K. Wilkinson, Nat.H.Dip.Cart.
2002-0604	2527DD Broederstroom	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, C.Kgari, K. Wilkinson, Nat.H.Dip.Cart.
2002-0726	2926BA Sannaspos	H.J. Brynard, Ph.D., K. Wilkinson, Nat.H.Dip.Cart., S. Noruka, B.Sc.Hons, C.Kgari
2006-0911	3318AD Darling	H.J. Brynard, Ph.D., K. Wilkinson, Nat.H.Dip.Cart., S. Noruka, B.Sc.Hons, P. Msiza, C.Kgari
2006-0911	3318AC Yzerfontein	H.J. Brynard, Ph.D., S. Noruka, B.Sc.Hons, K. Wilkinson, Nat.H.Dip.Cart., H. Sello, C. Kgari
1:50 000 GEOTECHNICAL MAPS		
2006-0918	3418AB & AD Cape Peninsula	K. Wilkinson, Nat.H.Dip.Cart., E. Dixon, Nat.Dip.Cart.
2003-0804	3318DC Bellville	K. Wilkinson, Nat.H.Dip.Cart., E. Dixon, Nat.Dip.Cart.
2006-0919	2931CA Verulam	K. Wilkinson, Nat.H.Dip.Cart., E. Dixon, Nat.Dip.Cart.
1:250 000 GEOLOGICAL MAPS (CARTOGRAPHY)		
2002-0036	3018 Loeriesfontein	K. Wilkinson, Nat.H.Dip.Cart., D. Grobbelaar, Nat.Dip. Cart., M. Roos, Nat.H.Dip.Cart.
2002-0014	2622 Morokweng	K. Wilkinson, Nat.H.Dip.Cart., M. Magagane, Nat.Dip.Cart., M. Roos, Nat.H.Dip.Cart.
1:2 500 000-SCALE SADC GEOLOGICAL MAP		
2002-0380	SADC	K. Wilkinson, Nat.H.Dip.Cart., M. Roos, Nat.H.Dip.Cart., H.J. Brynard, Ph.D.

NORTHERN CAPE

2009-1037 **KGALAGADI POVERTY NODE RESOURCE ASSESSMENT**

Project leader: A. Agenbacht, M.Sc.
Primary objective: *to find commodities with potential economic value, including tourist attractions.*
Duration: 2008/9 to 2009/10.

Motivation

The Kgalagadi poverty node is mainly located on the Dolomitic Ghaap Plateau that was mapped during a two-year mapping programme of the CGS, at 1:50 000 scale. Previous mapping has shown that many geological features with potential resources have been overlooked.

Progress

Meetings were held with DEM and DWAF in Kimberley at several occasions. Both institutions are very interested in the development of the poverty node and the assessment of geological resources with the main aim of developing viable small-scale mining activities.

The extent and quality of limestone occurrences were evaluated, and kimberlite pipes, dykes and gravel deposits were mapped. Linear features were investigated to determine whether they were intrusions, and have water potential for possible small-scale irrigation. Alluvium occurrences were investigated for their potential in the manufacture of clay bricks.

Caves and sinkholes were located and evaluated for exploitation as possible tourist attractions.

Conclusions

The limestone deposits were found to be too small for sustainable exploitation considering the extreme capital input, and their silica content was too high, rendering them unsuitable for either lime production or cement manufacture.

Kimberlite pipes and dykes were found to have an age of 1 600 Ma, and are the oldest yet described. These intrusions are atypical evolved kimberlite to lamprophyre and have similarities to Group 1 kimberlites. Previous investigations proved that these pipes and dykes are depleted of diamonds and warrant no further investigation. In places, some of the cherty gravels along the larger drainage patterns were tested for their diamond-bearing potential with negative results.

The only clay-bearing locality encountered with any potential is the wetland associated with the permanent spring at Mariba some 15 km northeast of Kuruman. The clay layer, which is 1 m thick, could yield about 68 000 m^3 of clay. This deposit does not have any potential for large-scale sustainable exploitation but does have long-term potential if exploited at current low levels.

Five sinkholes and a small cave were encountered in the area covered by 1:50 000-scale sheet 2723DA Kono. The cave on Kono B has potential as a tourist attraction, which could generate a small income for some of the local population. The cave is associated with a large collapsed structure and well-developed dripstones of various shapes and sizes are present.

Of all the sinkholes found, only that on Annsfield seems worth investigating for potential cave development.

Future activities

Future investigations will focus on the groundwater potential of the area in order to make recommendations on small-scale, self-supporting crop agriculture. Requirements for research will be the localities of boreholes, yields,

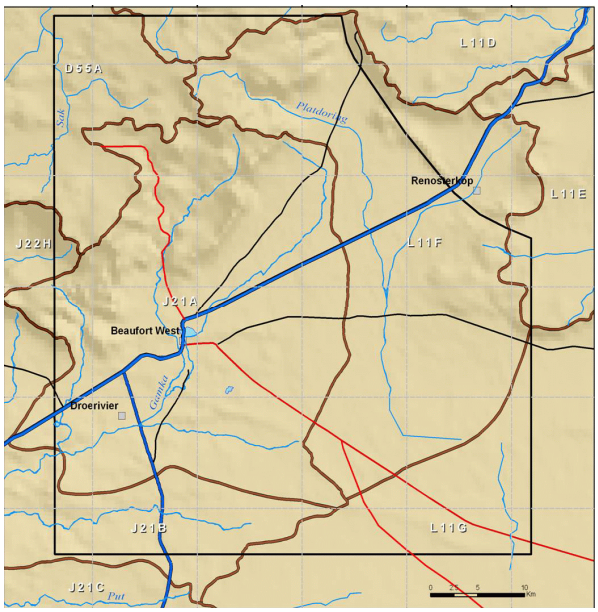
water analyses, results of pump and blow tests, water table depths and intersections, water flow directions, and piezometric contours.

A map showing all the information gathered will be produced, together with a recommendation report.

WATER GEOSCIENCES

2008-1005 **TRANSPORT MECHANISMS OF URANIUM AND THORIUM IN FRACTURED ROCK AQUIFERS**

Project leader: Y. van Wyk, B.Sc.Hons.
Project team: Y. Xu, Ph.D. (University of the Western Cape), G. Mahed, B.Sc.Hons, H. Solomon, B.Sc.Hons (University of the Western Cape).
Primary objective: *to develop a sampling and monitoring protocol for radioactive elements in fractured-rock aquifers.*
Duration: 2008/9 to 2009/10.
Budget: R37 872.



Motivation

The project was undertaken to develop a sampling and monitoring protocol for radioactive elements in fractured rock environments. The research outcomes are to support the implementation of the 'National Radioactive Monitoring Programme of DWA'. The specific objectives of the study are to:

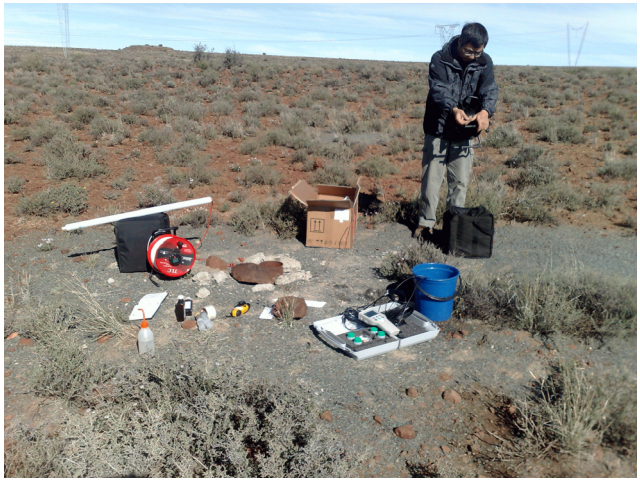
Re-evaluate the results of earlier research findings on uranium speciation and the associated anomalies (i.e. anomalies in aqueous media) at the selected study area (Beaufort West).

Apply recent advances to characterise flow regimes in fractured rock aquifer systems, with reference to 'tracing' the distribution of radioactive elements in fractured media.

Develop a local-scale sampling and monitoring protocol for radioactive elements in fractured rock formations.

Progress

An area wide hydrocensus was conducted from 6 to 18 May 2008. The field visit was undertaken to obtain as much site-specific information as possible, as well as to obtain first-hand knowledge and experience of the study area as a whole. Samples were collected for major cations/anions analysis, as well as for radioactivity. The geochemical analysis of these water samples will enable the identification of groundwater types and differentiate the potential pollution sources in the study area.



Conclusion

The town of Beaufort West and its surrounding areas are solely dependent upon groundwater, thus sustainable management of this precious resource is of the utmost importance. In order to ascertain the background hydro-geochemistry and thus compare it with future studies, a preliminary investigation into the identification of sampling points and execution of groundwater sampling has been done, which warrantees detailed work, especially south of the town in the vicinity of the mines.

Future activities

For more effective identification of flow and transport regimes in the study area, some more detailed work should be done. For example, additional groundwater sampling points for radioactivity analysis should be added in the north and the middle of the area to form a more comprehensive monitoring network. For the identification of aquifer boundaries and characterisation of anisotropy of the Karoo aquifers, some hydraulic tests such as tracer and pumping tests at selected sites should be done in order to obtain more constrained aquifer parameters for future studies.

2008-1007 **EXPLORING THE LINKS BETWEEN GROUNDWATER AND THE DWAF WATER FOR GROWTH AND DEVELOPMENT PARADIGM WITHIN AN INTEGRATED WATER RESOURCES MANAGEMENT AND SUSTAINABLE DEVELOPMENT FRAMEWORK**

Project leader: U.A. Rust, M.Phil. (Sustainable Development Planning and Management).
Primary objective: *to delineate aspects related to groundwater management in South Africa from an Integrated Water Resources Management and Sustainable Development perspective.*
Duration: 2007/8 to 2009/10.

Motivation

Globally, there is recognition of the growing importance of groundwater in water security. Groundwater as a resource does, however, present unique challenges and is not being managed optimally. In South Africa, the situation is not much different. Groundwater has a pivotal role to play in water services provision in South Africa, particularly in the rural areas of the country where poverty is rife. However, studies show that there are challenges to overcome in South African groundwater management, for instance a lack of valuing groundwater, expertise and coherent planning. It is believed that positioning groundwater within the current paradigms guiding water policy in South Africa, namely Integrated Water Resources Management (IWRM), sustainable development and Water for Growth and Development (WfGD) will assist in the management of this important and challenging resource.

A young girl collects water from a stream in KwaZulu-Natal (Photograph: Eric Muller).

Progress

The first phase of this project was a literature survey to broadly define the implications of the IWRM, sustainable development and WfGD paradigms for groundwater management in South Africa. Where applicable, African and global information was included. The following aspects were touched on in the literature survey: the importance of a focus on groundwater in South Africa, the state of groundwater management, the implications of the WfGD paradigm for groundwater management, the linkages between IWRM and sustainable development, and the implications of these linkages for groundwater management.

In particular, when groundwater management is regarded from an IWRM and sustainable development perspective, a few important aspects emerge. Firstly, the key to unlocking the potential of groundwater as a resource is management – with poor management of the resource being a far greater threat than scarcity. From a strategic management perspective this means that strategic planning, monitoring and evaluation, capacity building, innovation and technology, and networking should be considered in groundwater management. Secondly, different perspectives on sustainable development (e.g. strong versus weak sustainability, and egalitarian versus non-egalitarian sustainability) are important as these present conflicting voices in the groundwater management debate that need to be reconciled. Lastly, as groundwater is impacted by a wide range of diverse role players (both directly related to water, e.g. water management committees, and not directly related to water, e.g. the health sector and industry), inclusive participatory policy development is crucial.

Conclusions

Based on these preliminary results of the literature survey, it is concluded that constructing a sustainability indicator (e.g. an index) for groundwater management would facilitate improved management of the resource in South Africa. The next phase of the project will involve an investigation of the feasibility of such a sustainability index.

WESTERN CAPE

2002-0257 **1:250 000-SCALE GEOLOGICAL MAP 3218 CLANWILLIAM**

Project leader: J.H.A. Viljoen, Ph.D.
Project team: C.H. de Beer, M.Sc., D.I. Cole, Ph.D., D.L. Roberts, Ph.D., H.P. Siegfried, Ph.D., L.P. Chevallier, Ph.D.
Primary objective: *to revise the thirty 1:50 000-scale maps covered by the 1:250 000-scale Clanwilliam map, compile a new 1:250 000-scale geological map and to write an explanation.*
Duration: 2002/3 to 2008/9.
Budget: R37 000.

The impressive Wolfberg arch in the Cedarberg, one of the numerous tourist attractions in the area.

Motivation

The 1:250 000-scale map 3218 Clanwilliam was one of the first geological maps to be published at this scale and is now out of print. Old stratigraphic terminology had been used for the original mapping, which was carried out between 1954 and 1969, and it lacked a number of important geological subdivisions which were defined after its publication in 1973.

A full-length explanation will also accompany the map. Only a short explanation was produced on the first edition, printed on the map. Geological reports on the area requested by the Department of Water Affairs and Forestry and the Botanical Society, as well as the large number of requests for a map by tourists, made it clear that the existing map needed revision.

Progress

Mapping has been completed. The 1:250 000 geological map and the map explanation have been compiled and await editing.

Conclusions

Progress is according to plan, and the final editing of the map and its explanation is still to be done.

2005-0882 **COASTAL CENOZOIC DEPOSITS – IMPLICATIONS FOR GLOBAL CHANGE AND HUMAN ORIGINS**

Project leader: D.L. Roberts, Ph.D.
Project team: C. Dondo, B.Sc.Hons.
Primary objective: *to identify patterns of global change through geochronological, sedimentological, palaeontological and archaeological studies of coastal Cenozoic deposits, as well as via evidence of sea-level fluctuations.*
Duration: 2006/7 to 2009/10.
Budget: R195 000.

Motivation

The project seeks to identify patterns of global change through geochronological, sedimentological, palaeontological and archaeological studies of coastal Cenozoic deposits, as well as by examining evidence of sea-level fluctuations. Predictions of future trends in global change and assessments of these trends on communities, especially historically disadvantaged groups, are important aspects of this project.

Progress

Field work was carried out in July 2008 and February 2009 in the West Coast Fossil Park under the auspices of the African Origins Platform project (AOP). This project is based at the West Coast Fossil Park and is one of the cornerstones of this project.

Also, a multiple-authored poster, 'Climate change and the peopling of the southern deserts. Aeolian deposition in Equatorial West Africa during the last three Glacial Periods: implications for global climate', was presented at the 3rd Southern Deserts Conference at Molopo Lodge.

Comparison of unheated and heated silcrete. The heated silcrete produces much thinner and more refined tools which are reddish in colour. This was a major breakthrough in early modern human technology and cognition.

The third cornerstone of this project is the internationally funded (R400 000, LeverHulme Trust) project entitled 'Impacts of fluctuating margins of the southern coastline of South Africa and the emergence of modern humans'. Under this project results from OSL dating of aeolianites from Stillbaai were obtained and a paper on elephant footprints and palaeo-environments was published in a peer-reviewed journal. A paper 'West Coast Dune Plumes: Climate Driven Contrasts in Dunefield Morphogenesis along the Western and Southern South African Coasts' was presented by David L. Roberts, Mark D. Bateman, Colin V. Murray-Wallace, Andrew S. Carr and Peter J. Holmes and 'A Dating Intercomparison Study on Late Stone Age Coastal Midden Deposits, South Africa', by Mark D. Bateman, Andrew S. Carr, Colin V. Murray-Wallace, David L. Roberts and Peter J. Holmes.

The research cornerstone of this project is SAC P4, an NSF-funded archaeological/global change project based at Mossel Bay. A paper on very early human use of fire technology to improve the flaking properties of lithic raw materials was submitted to Science. This represents a major breakthrough in terms of early modern human technology and cognition.

2006-0924 **A GIS-BASED DYNAMIC BAYESIAN NETWORK SYSTEM FOR RESOURCE ASSESSMENT**

Project leader: C. Dondo, M.Sc.
Primary objective: *to develop an intelligent system based on the Bayesian Network technology for catchment management and develop expertise for artificial intelligence techniques in the Western Cape Remote Sensing/GIS Laboratory.*
Duration: 2005/6 to 2008/9.
Budget: R341 262.

Motivation

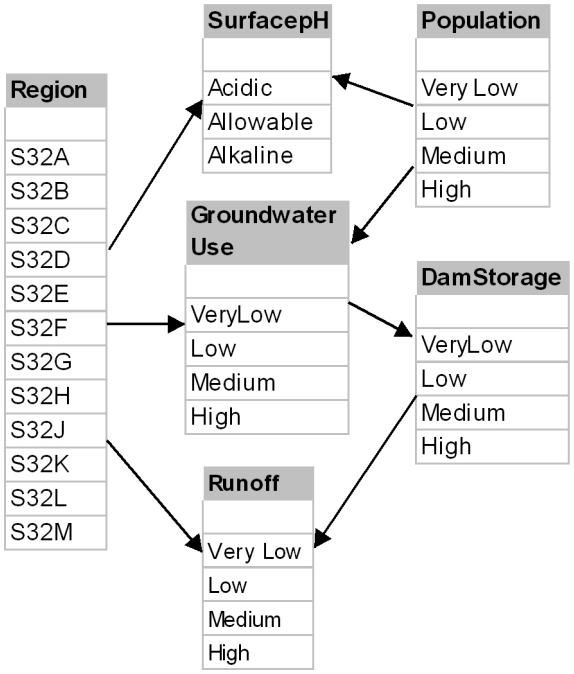
Bayesian Networks are used for the determination of cause and effect relationships in data. The strength of this technology lies in the ability to enable the performance of scenario analysis and predict the impacts of changes in the data over time or under different management options. The prediction is based on numerous qualitative and quantitative variables and these can all have different spatial and temporal scales. Measured variables and outputs from simulation models such as surface water or groundwater models can be used in analysis. This technique allows the incorporation of expert knowledge when measured data is missing, which is important in most geoscience problems where there is a paucity of data.

Progress

The software required for the modelling was developed and delivered to the CGS, and the research was submitted as part of a Ph.D. thesis to the University of Cape Town under the title 'Spatio-temporal Bayesian Networks for catchment sustainability assessment' in February 2009.

Conclusions

Bayesian Networks were applied to assess the spatial and temporal change of water conditions in a catchment. Water condition was defined as an indicator of catchment water sustainability.

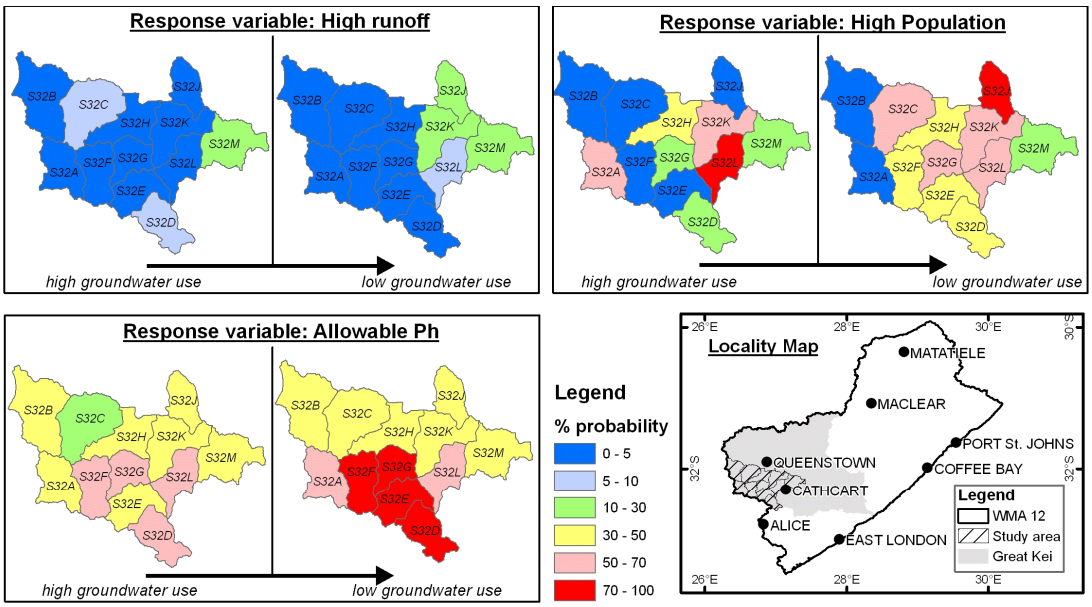


Relationships automatically created from data.

Indicators analysed include surface water and groundwater quantity, and quality and socio-economic variables. The areas of study were selected quaternary catchments in the Great Kei primary catchment. As an example, the relationships between groundwater use, dam storage, runoff, population and surface water pH are shown. From this diagram, the following results illustrate the effect of change in the use of groundwater to the following variables:
High surface water runoff;
Allowable surface water pH, and
High population.

The results show that a change in groundwater use from 'high' to 'very low' is related to the following:
slight increases in the probability of high runoff in sub-catchments S32J, S32K, S32L and small decreases in S32C and S32D;
the likelihood of high population in sub-catchments S32C, S32F, S32G, S32J, S32D, increases and it decreases in S32A, S32L, S32D, and
the probability of the surface water pH being allowable increases in S32C, S32D, S32E, S32F, S32G.

These outputs can be used to rapidly test known or possible scenarios and assist in decision making.



Effect of change in groundwater use on selected response variables.

2006-0925 **RADAR INTERFEROMETRY FOR GEOHAZARD ASSESSMENT IN SOUTH AFRICA**

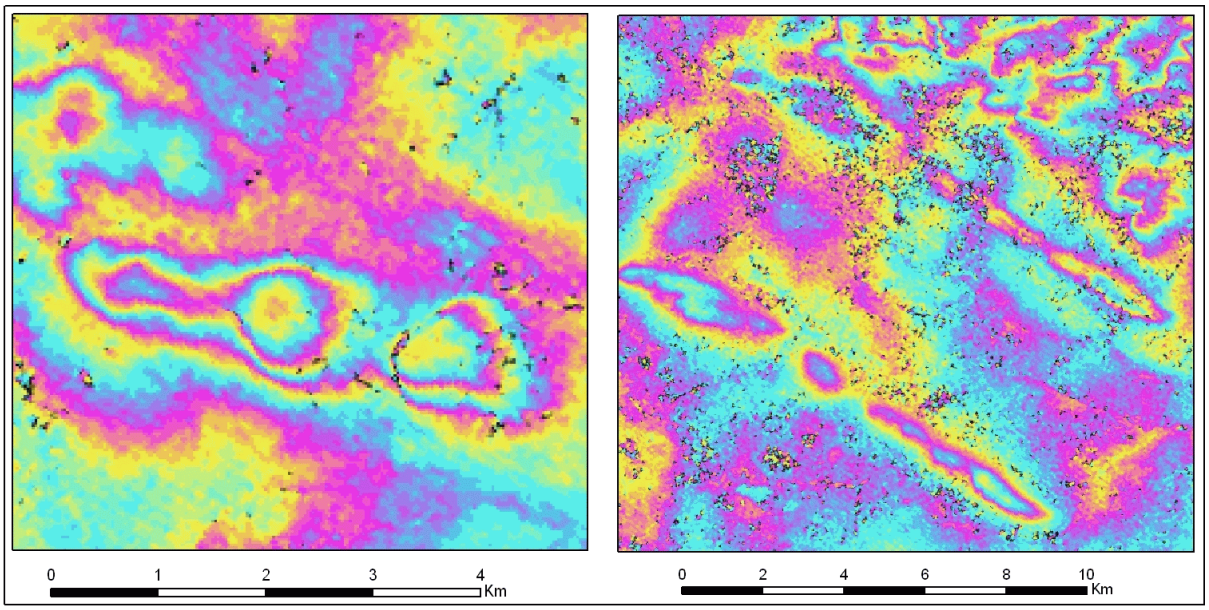
Project leader: J. Engelbrecht, M.Sc.
Primary objective: *to employ differential radar interferometry techniques for the assessment of geohazards in South Africa.*
Duration: 3 years.
Budget: 2008/9: R82 000; Total: R99 480.

Motivation

The CGS has recently expressed interest in the formation of a geohazards unit which aims to address natural and anthropogenic hazards. Radar remote sensing can contribute to a programme dedicated to the assessment of risks and hazards and can be regarded as a unique tool to obtain deformation measurements over large areas. In this regard, radar interferometry can be used to monitor centimetre- to millimetre-scale deformations on the Earth's surface and has been successfully applied for monitoring several hazards including surface subsidence, deformation following earthquake activity, landslides and volcanic activity and movements along active faults.

The interferometry technique therefore opens up many new potential applications in disciplines such as volcanology, structural geology and geotechnics and work relevant to a variety of geohazards. Radar remote sensing is an innovative technique that addresses surface deformations associated with natural geological processes and human activities, including mining. This project will build capacity in radar remote-sensing techniques which can then be used in various geological applications and geohazard assessments. The intended project will act as a stimulation of innovation and development of human capital as radar remote sensing, and radar interferometry, in particular, has presently only received limited exposure in South Africa. Additionally, the contribution of this technique to programmes dedicated to hazard and risk management will be invaluable.

The project will include the monitoring of surface subsidence caused by mining activities in the Mpumalanga Province and monitoring movement along faults in the Eastern Cape Province. Detection of movement along faults will indicate that seismic hazard assessment is possible.



Progress

The development of radar remote-sensing technologies for applications in the field of geosciences commenced with a project aimed at mapping open water bodies to assist in the prediction of mine water decant. Following successful completion of the project, the focus was shifted to exploiting fully polarimetric radar data for the geosciences. This involved the use of fully polarimetric radar data for quantifying soil moisture content.

With these projects completed, a solid basis was established on the use of radar remote-sensing data and the type of information that can be extracted from such data sets. The knowledge of radar remote-sensing data has evolved to a level where more advanced radar image-processing techniques could be used to address specific geoscientific areas of concern. In this regard, exploiting radar data through a technique called radar interferometry is of particular relevance for the field of geohazards assessment. Therefore, the title of the project has been changed to 'Radar Interferometry for Geohazard Assessment in South Africa'. The project is the subject of research towards a Ph.D. at UCT. The project duration of three years will include the processing of all historical data sets over two areas of concern, as well as the acquisition and processing of data captured by state-of-the-art sensors from the German Aeronautic and Space Agency, the European Space Agency and the Japanese Aerospace Exploration Agency.

The project proposal was presented to the Committee of Assessors at UCT and the proposal was accepted for a Ph.D. study. Additional proposals were submitted to the European Space Agency and the German Aeronautic and Space Agency (DLR) with the aim of qualifying for the use of their radar remote-sensing data. The proposals have been accepted and allow access to archived data sets, as well as to newly acquired data to be used in this project. Data sets acquired since 1995 will be used in the study area in the Mpumalanga Province. Additionally, several new data sets have been captured and delivered. A field visit to the area influenced by mining subsidence has also been

conducted. Initial data processing revealed several surface deformation features that may be an indication of surface subsidence. This includes features resembling subsidence basins as well as linear deformation patterns, possibly indicative of longwall collapse. Field verification will be needed to verify the existence of these features on the ground.

Conclusion

Radar interferometry techniques will be developed with the aim of measuring and monitoring surface deformation features related to geological and anthropogenic causes. The foundations for the project have been laid with a literature study, and a Ph.D. proposal has been accepted. The first of the image acquisition phases of the project has been completed and initial results on surface deformation quantification are encouraging.

Future activities

Verification of deformation features in the field will be completed.

2009-1035 **DEVELOPMENT OF HYPERSPECTRAL REMOTE-SENSING TECHNIQUES FOR GEOLOGICAL MAPPING**

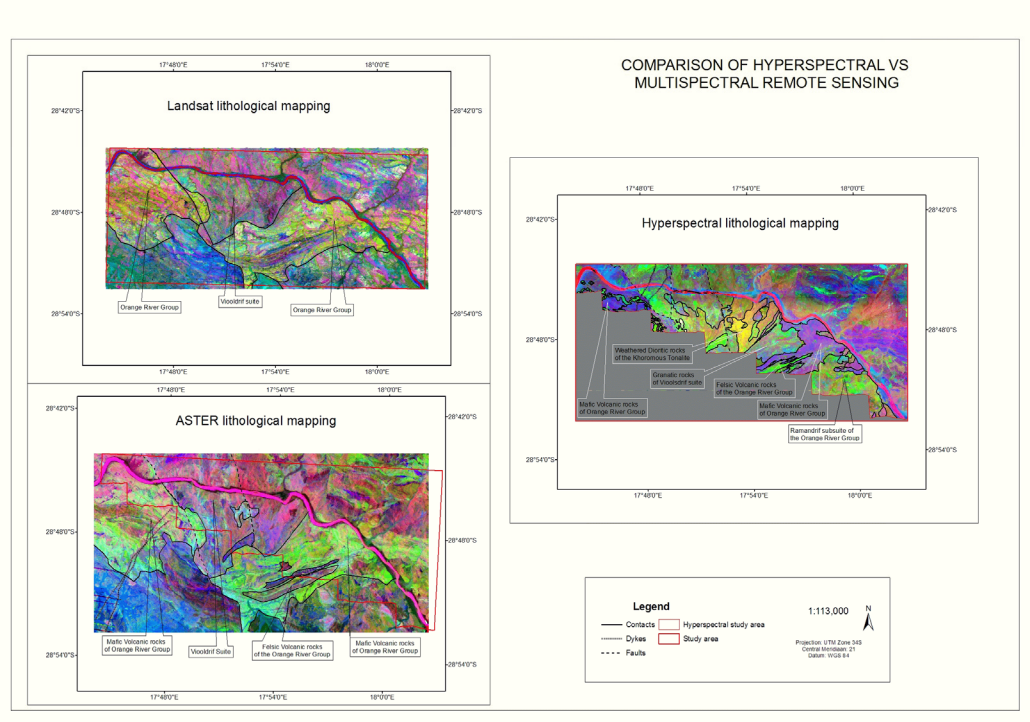
Project leader: L. Ngcofe, M.Sc.
Project team: H. Minaar, M.Sc., L. Chevallier, Ph.D.
Primary objective: *to investigate the potential of hyperspectral remote sensing towards geological mapping.*
Duration: 2008/9 to 2009/10.
R82 000.

Motivation

The application of remote sensing in geology is playing an important role in geological mapping, especially in areas with limited infrastructural access and harsh environmental conditions. It provides an opportunity to analyse and map surface geology in a relatively short time and at low cost.

Hyperspectral remote sensing is a relatively new technology that needs to be investigated for its full potential in the identification of geological features. This research will therefore:

determine whether hyperspectral data can better identify lithological units than available multispectral techniques
develop hyperspectral techniques for geological mapping
establish new methodologies that will improve large-scale geological mapping.



Progress

The detailed report on the comparison of multispectral (Landsat and ASTER) images with hyperspectral images has been completed. The results revealed that more information can be retrieved when using hyperspectral data than multispectral data. The hyperspectral data showed new information which was also omitted from the 1:50 000-scale geological map 2817DD Nous.

Conclusion

Hyperspectral investigation is a new research method for mapping geological lithologies. New geological information was revealed which had not been readily acquired from traditional mapping methods. The research has produced reliable and accurate results and is therefore recommended for further geological mapping investigations.

Future activities

Hyperspectral data will be captured to enhance lithological mapping in the area covered by 1:50 000-scale sheet 2817DD Nous. Other geological investigations such as mineral mapping need to be researched using this technique, which will provide more geological information.

APPENDIX

REPRESENTATION ON COUNCILS, COMMITTEES AND WORKING AND STUDY GROUPS

Action Group of the Western Cape Wetland (L. Gibson)
Advisory Committee on the West Coast Biosphere Project (D.L. Roberts)
Board of the Council for Geoscience (T. Ramontja)
Board of the Petroleum Agency of South Africa (T. Ramontja)
Central Basin Technical Working Group (L. Strachan)
Central Energy Fund Governance and Nomination Committee (T. Ramontja)
Council of the Southern African Society for Quaternary Research (SASQUA) (G.A. Botha, Treasurer)
Committee for Heads of Research and Technology (COHORT) (Formerly Committee of Heads of Science Councils (CHSC) (T. Ramontja)
Eastern Basin Technical Working Group (S. Esterhuyse)
Far Western Basin Technical Working Group (D. van Tonder)
Fossil Fuel Foundation (T. Ramontja)
Geological Society of South Africa:
- Committee of the Limpopo Branch of the Geological Society (N. Baglow, G. Brandl)
- Geoconservation and Geotourism Committee (D.J. Barnardo, Chairman, R.R.M. Price)
- Committee of the Mineralogical Association of South Africa (MINSA) (M. Cloete)
- Committee of the Limpopo Branch of the Geological Society (N. Baglow)
- Committee of the Western Province Branch of the Geological Society (C.H. de Beer, A. Faull)
- Co-editor of the Geological Society of South Africa-Council for Geoscience, Geology Text Book (Geology of South Africa) (M.R. Johnson)
- Editorial Board of the South African Journal of Geology (SAJG) (M. Cloete)

Government Task Team on Mine Water Management and Mine Closure (L. Strachan, H. Coetzee)
International Union for Quaternary Research (INQUA), Member of the Commission on Coastal and Marine Processes (G.A. Botha)
International Union for Quaternary Research (INQUA)
- Member of the Commission on Coastal and Marine Processes (G.A. Botha)
- INQUA Terpro sub-commission on Palaeoseismology and Active Tectonics (M.L. Goedhart – South African representative)

Institute of Directors (IOD) (Member: T. Ramontja)
Makana Council Housing and Industrial Development Working Group, Grahamstown (M.L. Goedhart)
Management Committee of the Far West Rand Dolomitic Water Association of the Chamber of Mines (G.J. Heath)
Mining and Exploration Geology. Technical Review Group (SGG), South African Qualifications Authority and Department of Minerals and Energy (Member: C. Forbes)
Museum Park Board of Directors (D.J. Barnardo)
National Dolomitic Risk Management Working Committee (NDRMWC) (Member: G.J. Heath)
National Research Foundation Open Research Programme. Advisory Panel for Bushveld Complex Research (Member: M. Cloete)
National Science and Technology Forum (NSTF). Science Councils and Statutory Bodies (Member: P. Zawada)
Nelson Mandela Bay Municipality – Disaster Management Advisory Committee (M.L. Goedhart)
Palaeontological Society of Southern Africa (Vice President, editor of newsletter: J. Neveling)
Research Group in Mining Activities for the Succulent Karoo Ecosystem Plan for Conservation - International (D.I. Cole, L. Chevallier)
South African National Commission for UNESCO's Focal Point for the International Geoscience Programmes (P. Zawada)
South African National Committee for the International Union for Quaternary Research (INQUA) (G.A. Botha, Chairman)
South African National Committee for the International Year for Planet Earth (IYPE) (G.A. Botha)
South African Commission for Stratigraphy
- Task Group for the Cenozoic. (G.A. Botha, Secretary)
- Task Group for pre-Bushveld and Swazian Rocks. (N. Baglow, Secretary, G. Brandl)
- Task Group on Waterberg and Soutpansberg. (G. Brandl, Chairman)
- Task Group for Jurassic and Cretaceous Rocks (J.S.V. Reddering, Secretary)

South African National Research Institutions Consortium (SANRIC) (L. van der Merwe)
SSHAC Senior Seismic Hazard Assessment Committee. (G.A. Botha, M.L. Goedhart)
Steering Committee of South Africa's Shelf Claim Project led by the Petroleum Agency of South Africa (T. Ramontja, Alternate: P. Zawada)
Steering Committee of the Water Research Commission (WRC)
- Deep Artesian Groundwater Exploration for Oudtshoorn (J.H.A. Viljoen)
- Protocol for assessing the sustainability of springs (L. Strachan)
- Sandveld: Reserve determination (J.H.A. Viljoen)
- The state of community consultation in the provision of water services (U.A. Rust)
- Field Investigations to Study Fate and Transport of Dense Non-Aqueous Phase Liquids (DNAPLs) in Groundwater (S. Esterhuyse)

Field investigations to study the Fate and Transport of Light Non-Aqueous Phase Liquids (LNAPLs) in Groundwater (S. Esterhuyse)
Recharge Processes of Table Mountain Group (TMG) Aquifer Systems (K.F. Netili)
Steering Committee for the South African Environmental Observatory Network (SAEON) (Member: P.K. Zawada)
Steering Committee of the National Radioactivity Monitoring Programme (NRMP) (L. Strachan)
Water Services Sector Leadership Group (WSSLG) Gender Task Team (U.A. Rust)
Western Basin Technical Working Group (H. Coetzee, N. van Wyk)
Wonderfonteinspruit Action Group (H. Coetzee, D. van Tonder)
Working Group of the Water Research Commission Strategic Planning for Groundwater Studies in the Eastern Cape (L.P. Chevallier)
Working Group of the Cradle Water (J. Groenewald)

INTERNATIONAL CO-OPERATION

Advisory Committee of International Association of Gondwana Research (G.H. Grantham)
Council of the International Seismological Centre (ISC) (G. Graham)
Commission for the Geological Map of the World (CGMW)
Working Group on Common Standards for Digital Geological Data and Data Structures, Digital Data Dissemination (DIMAS) (Member: H.J. Brynard)
Committee of Association of African Women Geoscientists (A. Faull)
Editorial Advisory Board Africa Geoscience Review (G.S. de Kock; M.R. Johnson; D.I. Cole)
Editorial Board of Gondwana Research (G.H. Grantham)
Geology Subcommittee of the Mining Sector Co-ordinating Unit of the South African Development Community (SADC)
Hydrogeology Working Group (L.P. Chevallier)
Regional/National Geological, Mineral and Bibliographic Databases Working Group (D.J. Barnardo)
Stratigraphy Working Group (Chairman: F.J. Hartzer)
International Association of Geoanalysis (Member: G.H. Grantham) International Association of Hydrogeologists (IAH) (L. Strachan)
International Association on the Genesis of Ore Deposits (IAGOD)
Southern African representative of the Industrial Mining Working Group (G.F.J. Horn)
International Mine Water Association (IMWA) (L. Strachan)
International Commission on Stratigraphy (ICS)
Subcommission on Precambrian Stratigraphy (Corresponding member: F.J. Hartzer)
International Subcommission on Stratigraphic Classification (ISSC) (SACS representative: M.R. Johnson)
International Geological Map of the World (IGMW)
Co-ordinator for the Tectonic Map of Africa (Subequatorial chief compiler: G. de Kock)
International Union for Quaternary Research (INQUA)
Commission on Coastal and Marine Processes (Member: G.A. Botha)
South African National Committee (Chairman: G.A. Botha)
International Union for Quaternary Research (INQUA/ISSS) Paleopedology Commission (G.A. Botha)
National Committee for the International Union of Geodesy and Geophysics (IUGG) (J. Cole)
National Committee of the International Union of Geological Sciences (IUGS) and the International Geological Correlation Programme (IGCP) (S. Frost-Killian)
Steering Committee on Ghana Project (Representative: G.H. Grantham)
South African Scientific Representative to Working Group B of the Preparatory Commission for the Comprehensive Nuclear-test-ban Treaty Organisation (G. Graham)
South African National Committee for the International Year for Planet Earth (IYPE) (G.A. Botha, S. Frost-Killian)

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