Council for Geoscience

ANNUAL TECHNICAL REPORT of the Council for Geoscience 2007/8

Council for Geoscience

ANNUAL TECHNICAL REPORT

FOR THE YEAR ENDED 31ST MARCH 2008

compiled by

R.R.M. Price, B.Sc.Hons,Pr.Nat.Sci.

Council for Geoscience
SOUTH AFRICA

Linguistic editing and layout
Information and Collections Management Unit

The Council for Geoscience was established in term of the Geoscience Act (Act 100 of 1993), and is listed as a Schedule 3A Public Entity in terms of the Public Finance Management Act (Act 1 of 1999).

ISBN 978-1-920226-13-8

Copies of this report can be obtained from the Council for Geoscience, 280 Pretoria Street, Silverton, Pretoria, or by mail from the Publications Shop, Council for Geoscience, Private Bag X112, Pretoria 0001, Tel: 012 841 1911.

Internet address: http://www.geoscience.org.za

Front cover:

A view of the Mweni Pinnacle from the top of Mweni Pass, on the Lesotho–KwaZulu-Natal border. The immense cliffs of Drakensberg Formation basalt, viewed from this altitude, add a new dimension to geotourism in South Africa. The CGS supports geotourism in South Africa through the Geosites Project, with the aim of alleviating poverty in rural areas. The local community benefits by supplying chalets at the start of hiking trails. Photo: Roger Price

Back cover:

Mfihlelo Falls on Waterfall Bluff along the Transkei Wild Coast is one of two falls on this 5-km-long coastline that spills directly into the sea. The falls are about 70 m high. Of about 12 waterfalls worldwide that discharge into the sea, three occur along a 35 km coastline in this area. The steep sea-facing bluff originated along the Goso Fault. As marine erosion undercuts the foot of the cliffs, the sandstone spalls off along vertical joints, evident in the opposite cliff section, and maintains the bluff face. The sandstone is the Devonian Msikaba Formation, formed on a shallow, tidal-marine shelf.
Photo: Koos Reddering

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FOREWORD

The past year was successful for the Council for Geoscience (CGS) in several areas of endeavour. The organisation has successfully executed its statutory programme, as well as its commercial operations both locally and abroad. However, the year brought several challenges, the main issue being the problem of high staff turnover, especially of scientists. A worldwide shortage of geologists, to a great extent driven by the expansion in the oil, gas and minerals industry, has resulted in the CGS having difficulty in appointing and retaining qualified geoscientists. Young geoscientists in particular are highly sought after. The CGS has instituted the following measures to address the problem:

- Establishment of a geological field-mapping school to train young geoscientists in geological mapping, a core function of the CGS. A proposal for collaboration with the Mining Qualification Authority (MQA) Sector Education Training Authority (SETA) was submitted.
- Development of an intensive two-year mentoring programme for young scientists.
- Recruitment of geoscientists from Africa and countries such as India and the United Kingdom in cases where local candidates are not available.

A key challenge remains the baseline funding received, which is insufficient to cover statutory geoscience investigations. This shortfall compels the organisation to commercialise many of its activities, which leads to many local geoscientists having to work in other countries, rather than on geoscience issues in South Africa.

There is a gradual decline in the availability of large geological mapping programmes funded by the World Bank or the European Union. Although the CGS wishes to continue its involvement in these programmes, it recognises that the infrequent and erratic availability of these programmes is not favourable to the CGS's operational model and consequently the organisation has developed new funding sources. Of particular importance is the significantly escalated level of services that the CGS has provided to Eskom as part of the New Build programme for increased electricity generation. The CGS is pleased to be involved in this strategically important area of activity and expects to render even greater assistance to Eskom in the future. The CGS will realign its operations in order to ensure that it can give its full commitment to Eskom.

During the year considerable progress was made in reviewing the role of the organisation in addressing the development needs of the country. This was done in recognition of the need for the CGS to play an increasing role in assisting the process of land and infrastructural development, in order that the impact of geohazards is minimised.

The first phase in the upgrading of five stations of the South African National Seismograph Network (SANSN) has been completed, and data are now sent in real time from these stations to an international data centre in Indonesia as part of South Africa's contribution towards the Indian Ocean Tsunami Early Warning System (IOTWS). The CGS also promotes 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 Intergovernmental Coordination Group.

The CGS and its precursors have been mapping the South African land mass for more than 100 years, during which time geological, geophysical, metallogenic and geochemical information has been collected and presented in the form of maps. This service has underpinned the mineral-exploration industry, as well as the land-use development issues. The role of the CGS as a national geoscience institution is important to the economic development of the country. However, knowledge of the surrounding sea bed, which has an area of 1,5 million km^2 (South Africa's land area is 1,2 million km^2), is minimal and it is expected that South Africa will seek to extend its territory seawards in terms of the Law of the Sea when its submission to the United Nations is tabled in May 2009. The sea bed is known to contain resources such as phosphate, manganese, gas hydrate, carbonate and base metals, and is also the environment in which the country's fish stocks are sustained. Increasing interest is being shown in the sea bed from which renewable sources of energy can be produced. There is little doubt that the sea bed surrounding the country is the next frontier for exploration, so the CGS has embarked on a series of activities to highlight the importance of systematic offshore mapping. Submissions to the Government in this regard will be made during the next financial year.

The Small-Scale Mining Programme of the CGS, in partnership with the Department of Minerals and Energy, continued during the year. The objective of the programme is to assist in the elimination of barriers, and the facilitation of access to the mainstream mining industry by small-scale miners. Emphasis was placed on creating and increasing wealth in a sustainable manner, especially for rural communities. By the end of the year 171 projects had been approved for technical investigation and purchase of equipment under the auspices of the Small-Scale Mining Programme.

Work has commenced on GIS-based mineral-deposit mapping, using existing extensive databases, including geology, structures, geochemistry, remote-sensing imagery and geophysics, to generate mineral potential and predictive maps of various metallogenic regions. It is hoped that target areas identified by this technique will result in the promotion of the small-scale mining sector and other mineral industries and, in particular, promote the creation and growth of new oppor-

tunities. A copper-potential map has been completed for the copper-rich area of the Limpopo Province. The project will continue with a study of the gold potential of greenstone belts.

Considerable investment has been made in recapitalising the scientific equipment of the CGS, varying from geophysical and analytical laboratory equipment to the building of a near-shore survey vessel. The impact of these investments has, for example, increased the rate of geochemical-sampling analysis tenfold. Investments have also been made in Information Technology infrastructure, with the modernisation of email and back-up servers, and the improvement of bandwidth.

The CGS is in the process of finalising the procurement of a multipurpose drill rig to assist with drilling and sampling related to the assessment of mineral deposits for the Small-Scale Mining Programme of the Department of Minerals and Energy. The drill rig will enhance the capacity of the CGS to conduct assessments and to fast-track the development of new small-scale mining operations. The drill rig can perform several techniques using one piece of equipment, a major advantage in reducing site-specific logistics.

An important and innovative development has been involvement in the compilation of a carbon dioxide geological storage atlas. Carbon dioxide capture and storage (CCS) is one of the recognised mitigation measures for the lowering of greenhouse-gas emissions. Assessment of the potential for CCS in South Africa requires a detailed investigation into potential carbon dioxide storage sites. The CGS is compiling this atlas together with the Petroleum Agency of South Africa, and the work is sponsored by Sasol, Eskom, PetroSA, Anglo American plc and the South African National Energy Research Institute (SANERI).

Important progress has been made on the compilation of a geological map of the SADC region. This is a benchmark geoscience product for the region and will contribute significantly to mineral and groundwater exploration. The map is expected to be published in August 2008.

The Witwatersrand Water Ingress Project, conducted on behalf of the Department of Minerals and Energy, relating to the problem of mine water in the Witwatersrand gold-mining area, has reached a critical juncture, with the completion of a draft strategy document for the management of ingress and decant of mine water in gold mines in the Witwatersrand and the Klerksdorp–Orkney–Stilfontein–Hartbeesfontein areas. This proposed strategy will be published for public comment before it is refined and adopted for implementation as an official Government strategy document.

The CGS has recognised the increasing need to integrate all its support operations, such as finances and human resources, and an Enterprise Resource Planning (ERP) system will be implemented. This will give management an up-to-date view of its financial status, scientific project planning and other resources, and will enable the organisation to use its management information in a more proactive and strategic way.

The CGS has won the bid, on behalf of South Africa, to host the General Assembly of the International Association of Seismology and Physics of the Earth's Interior (IASPEI) in 2009, which will be held at the Cape Town International Convention Centre. This is the first IASPEI General Assembly to be held in Africa, and is endorsed by the Minister of Minerals and Energy, the International Council for Science, the Geological Society of South Africa and the South African Geophysical Association.

The CGS also plans to make a bid, on behalf of the country, to host the International Geological Congress (IGC) in 2016. This prestigious event is held every four years and attracts more than 7 000 visitors from around the world. The bid will be made at the next IGC in Oslo, in 2008.

The CGS has also forged a strong scientific and institutional collaborative relationship with Algeria by assisting that country in restructuring, developing and implementing a new geological survey-type institution.

A corroborative project with two Japanese institutions, JOGMEC (Japan Oil, Gas and Metals National Corporation) and AIST (National Institute of Advanced Industrial Science and Technology), is currently in progress as part of the Japan-South African JIPSA Programme and focuses on the assessment of rare-earth elements in South Africa.

An agreement between the CGS and the Korea Institute of Geoscience and Mineral Resources (KIGAM) is at an advanced stage, focusing on the scientific study of selected alkaline and carbonatite deposits and their associated mineralisation in South Africa.

THIBEDI RAMONTJA
CEO

INTERNATIONAL

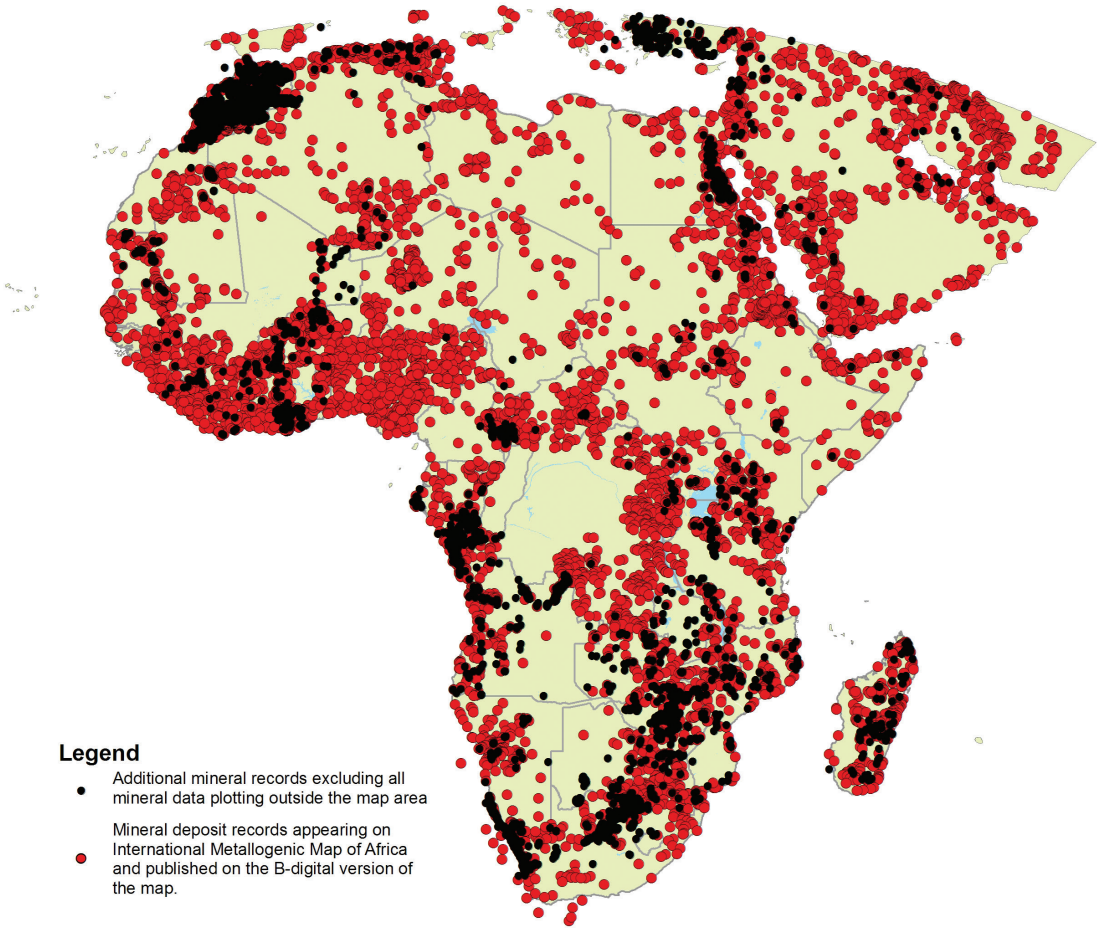
0133
INTERNATIONAL METALLOGENIC MAP OF AFRICA 1:5 000 000 — DATABASE MAINTENANCE

Project leader: S. Frost-Killian, M.Sc.
Project team: W.R. Oosterhuis, B.Sc.Hons.
Primary objectives: *to i) advance existing knowledge of mineral deposits in the SADC and NEPAD regions by enlarging the database; ii) improve the reliability of the data by verification and editing; iii) contribute towards capacity building and improving knowledge of deposit models in Africa, and iv) contribute information to other projects in accordance with the objectives of the CGS.*
Duration: Ongoing.
Budget: 2007/8: R1 000.

Motivation
The Africa Minerals Database was designed during the compilation of the International Metallogenic Map of Africa at a scale of 1:5 000 000. In view of anticipated thrusts of the CGS, and the current use of the data for a variety of projects, it is important that the data be kept up-to-date and relevant.

This is particularly important for the innovative manipulation and interrogation of the data to produce a variety of products, including prospectivity maps, as well as to advance our knowledge of the origin and evolution of mineral deposits. The maintenance of the database is a continuous process for as long as the CGS sees working in Africa, and being involved in NEPAD and SADC, as key thrust directions.

Africa Minerals Database - Mineral point data.



Progress
The 1:5 000 000-scale International Metallogenic Map of Africa was published in June 2002 by the Council for Geoscience 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 format of the digital product and comments have been received from current users. Sales of the digital data have been continuous through the year. The map and associated digital data have been used for the production of both country-specific and more regional maps, reports and publications (in planning). Clients include the large mining houses, mining juniors, consulting companies, other science councils, the Department of Minerals and Energy, university libraries and departments, and import-export companies. Many of the current clients are from South Africa, the USA, Canada and Australia.

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.

The maintenance and updating of the database has continued. Assistance was given to various units within the CGS for various projects for clients throughout Africa. The CGS is participating in an ongoing collaborative project with the United States Geological Survey (USGS), the USGS Global Mineral Resource Assessment Project (GMRAP). To date assessments of copper, PGEs and potash in the southern African region are in progress and the results are currently being analysed. Data was extracted from the Africa Minerals Database for this purpose and proved to be very useful for the analysis of known areas of mineralisation.

Conclusion
The release of the digital dataset has generated interest within the mining community at large. It is hoped that the publication of the map and digital dataset 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.

0487

CORRELATION BETWEEN THE KAROO SUPERGROUP OF SOUTH AFRICA AND THE GONDWANA SEQUENCE OF INDIA – A STRATIGRAPHIC COMPARISON OF WEST AND EAST GONDWANALAND

Project leader:	D.I. Cole, Ph.D.
Project team:	S.G. Mukhopadhyay, B.Sc., S.S.K. Mukhopadhyay, B.Sc., S.P.K. Parui, B.Sc., M.R. Choudhuri, Ph.D. (Geological Survey of India), J. Neveling, Ph.D.
Primary objectives:	*to (i) produce a detailed correlation at formation level between the Karoo Supergroup in South Africa and the Gondwana Sequence in India for the period from Carboniferous to Jurassic, (ii) evaluate potential economic deposits, particularly coal.*
Duration:	1999/2000 to 2007/8.
Budget:	Total: R241 987.

Motivation
The project commenced in November 1999, following meetings at ministerial level between the Department of Minerals and Energy of South Africa and the Department of Mines of India, with the aim of establishing collaborative projects between the two countries. This project was to be undertaken by geologists from the CGS and the Geological Survey of India (GSI). The importance of the project is directly related to the dependence of South Africa and India on Permian coal for their energy resources and for use in the manufacture of steel. Correlation of the Karoo–Gondwana strata will assist in identifying new exploration opportunities for coal and other commodities such as uranium and heavy minerals, and lead to a better knowledge and understanding of Southern Hemisphere coal.

Reconstruction of Gondwana during Permo–Triassic times showing distribution of basins investigated by the Correlation Project.

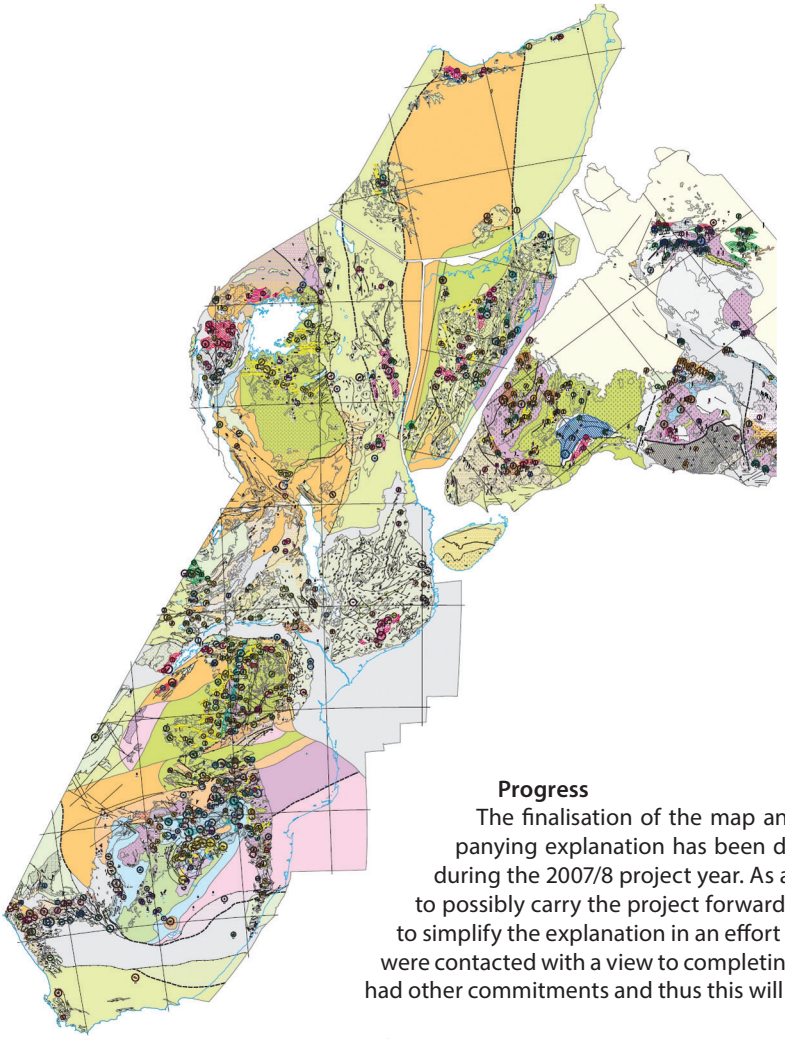
Progress
The draft manuscript of a publication was completed, and will include chapters covering Basin Development and Tectonics, Stratigraphy, Biostratigraphic Correlation, Magmatism, Palaeogeography, Coal, other commodities, and conclusion and recommendations.

Conclusion
The project has achieved its objectives and represents the first attempt to correlate Karoo-type strata between East and West Gondwanaland. Coal reserves in India (214 billion tons) are four times larger than those of South Africa (55 billion tons) mainly because the seams are considerably thicker.

0499

INDO-SOUTH AFRICAN BILATERAL PROJECT NO. 3: PRECAMBRIAN CRUSTAL EVOLUTION AND METALLOGENY OF PENINSULAR INDIA AND EASTERN SOUTHERN AFRICA

Project leader: S. Frost-Killian, M.Sc., N. Rajendran, M. Tech. (India).
Project team: CGS: S. Frost-Killian, M.Sc., G.S. de Kock, Ph.D., L.G. Wolmarans, B.Sc.Hons, C.B.A. van der Westhuizen, B.A.(HED). GSI: N. Rajendran, M.Tech., S.K. Biswas, Ph.D., D. Ganguly, M.Sc., M.W. Haque, M.Sc., J.L. Narang, M.Sc.
Primary objectives: *to produce an integrated 1:5 000 000-scale tectonometallogenic map, brief explanation, and an associated three-layer GIS database (geology, metallogeny and tectonic features) of the entire study area, with the Precambrian geology restored to its original Gondwanaland break-up position.*
Duration: 2002/3 to 2008/9.
Budget: 2007/8: R17 325.



Motivation
This project is one of the earth-science collaborative efforts entered into between the GSI and the CGS as part of a wider programme of cooperation between the two countries. This project has involved the collaboration of Indian and South African scientists in developing a tectonometallogenic framework for the Precambrian crust part of the Indian and African crustal fragments which were once amalgamated with the Gondwana Supercontinent.

This study will serve as a basis for the development of future mineral-exploration programmes in the Indo-African region, and will lead to a better understanding of the tectonic settings and metallogeny of the Indian and African cratonic areas.

Progress
The finalisation of the map and GIS is in progress. Work on the accompanying explanation has been delayed owing to a lack of staff availability during the 2007/8 project year. As a result, a decision has recently been taken to possibly carry the project forward to 2008/9. A decision has also been made to simplify the explanation in an effort to get it completed on time. Other authors were contacted with a view to completing the explanation before June 2008, but all had other commitments and thus this will probably not be possible.

Conclusion
Cooperation between the two organisations has been excellent, and it is hoped that this study will serve as a basis for the development of future mineral exploration programmes within the Indo-African region. The CGS has obtained permission to extend the project into the 2008/9 project year. The GSI deadline is currently June 2008, and further extensions need to be negotiated.

Future activities
Owing to a lack of staff availability in the short term, the projected completion date for this project is unknown.

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 of the Karoo Supergroup.*
Duration: 2002/3 to 2007/8.

Motivation
The Elliot Formation contains some of the world's earliest dinosaur and mammal fossils, but the fossil fauna of this formation is surprisingly poorly known and generally described as depauperate — that is, stunted in development. Following a review of fossils from the Elliot Formation which revealed new dinosaur taxa, a collaborative investigation was launched to investigate the fossil fauna and palaeo-environmental conditions of the Elliot Formation.

Progress
During 2007/8 field excavations continued in the northern Free State, expanding the current palaeontological field database. These localities yielded a diverse sauropodomorph dinosaur fauna from an interval that normally displays a low diversity and is dominated by the primitive prosauropod dinosaur Massospondylus. New forms have been described and the presence of an unusual fossil fauna was recorded in a short manuscript that was submitted for publication in a peer-reviewed scientific journal.

Conclusion
It is postulated that the vertebrate fauna from the Spion Kop area reflects the presence of an unusual micro-environment associated with streams that are larger and of a more permanent nature than the typical fluvial setting of the upper Elliot Formation. The proposed riparian gallery forest would have supported a more diverse fauna of large herbivores than normally was the case for the upper Elliot Formation.

Future activities
Fieldwork and fossil excavation will continue in the northern Free State, while also being extended to fossil localities further south. This project will focus on the final preparation and description of collected fossil material in the laboratory.

0881
INVESTIGATION OF CHANGES IN FOSSIL FLORA AND ASSOCIATED INSECTS ACROSS THE PERMO–TRIASSIC BOUNDARY

Project leader: B. Gastaldo, Ph.D. (Colby College, Maine).
Project team: J. Neveling, Ph.D., R. Adendorff, Ph.D. (Albany Museum), C. Labandeira, Ph.D., C. Looy, Ph.D. (both Smithsonian Institution), M. Bamford, Ph.D. (Bernard Price Institute for Palaeontological Research).
Primary objective: *to investigate changes in the fossil flora and associated insects in the fossil record in the strata spanning the Late Permian and Triassic of the Karoo Supergroup.*
Duration: 2004/5 to 2007/8.

Motivation
The world's most complete terrestrial record of the late-Permian mass extinction is found in the Beaufort Group. Although a significant amount of research was focused on the vertebrate palaeontology and geology of this interval, little is known about the palaeoflora and broader ecological trends spanning this boundary. As a result a multinational and multidisciplinary research team was funded by the National Science Foundation (NSF) of the United States to investigate the changing trends in fossil flora and associated insect fauna from the Permian to the Triassic. The research is highly topical and globally relevant as it provides a standard against which to measure terrestrial palaeofloral trends.

Progress
A number of field trips to the KwaZulu-Natal, Free State and Eastern Cape Provinces have been completed since the start of this project. During the year research focused on sedimentological problems in the Late Permian sequences exposed in the Free State and Eastern Cape, and additional fossil samples were collected. Interim research results flowing from this fieldwork were presented at an international conference held in the United States. The results of a sedimentological study on the Early Triassic Katberg Formation exposed north of Middelburg were submitted for publication in the Journal of Sedimentary Research.

Conclusion
Fieldwork carried out during the course of this project showed the post-extinction, Early Triassic record of palaeoflora to be more diverse than previously thought. A detailed comparison of plant-fossil localities revealed the impact of taphonomic filters and depositional regime on the fossil record. Further sedimentological studies of the lowermost Katberg Formation revealed two distinct sandstone geometries which are considered to represent two distinct fluvial systems. In addition to isotopic data derived from carbonate nodules found in channel deposits and siltstone-rich palaeosols, this is indicative of deposition during repeated periods of landscape aggradation, equilibrium and degradation. These aggradational-degradational cycles are correlated with repetitive shifts between seasonally wet and arid conditions, which reflect the impact of strong oscillations of climate rather than pulses of orogenic activity or any ecosystem response to the end-Permian extinction.

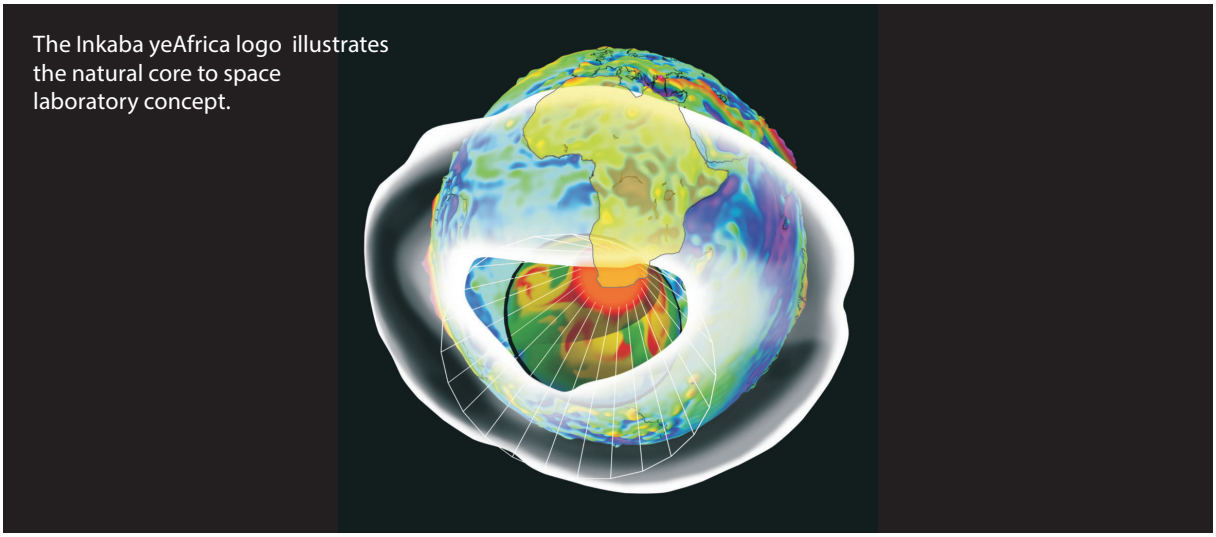
Future activities
Fieldwork for this project was concluded during the past year. The focus will be on completing geological and palaeontological analyses in the laboratory and publishing papers in peer-reviewed journals.

0935
INKABA yeAFRICA: THE AGULHAS–KAROO GEOSCIENCE TRANSECT

Project leader:	A.S. Lindeque, B.Sc.Hons.
Project team:	L.P. Chevallier, Ph.D., T. Ryberg, Ph.D. and M.H. Weber, Ph.D. (both GeoForschungZentrum Potsdam), M.J. de Wit, Ph.D. (University of Cape Town).
Primary objective:	*to generate a 100-km-long near-vertical seismic-reflection image of the crust and Mohorovicic discontinuity (Moho) across the southern Karoo Basin, with the aim of investigating the nature of the crust, the depth to the Moho, Cape Fold Belt tectonics, basin geometry and source of the Beattie Magnetic Anomaly (BMA).*
Duration:	2005/6 to 2008/9.
Budget:	2007/8: R20 000.

Motivation
This project continues the longstanding collaboration between the CGS and the GFZ which has been in existence since 2003, under the Inkaba yeAfrica German-South African research initiative. Inkaba yeAfrica fosters a CGS-GFZ partnership by observing earth systems in a core-to-space sector over southern Africa, and simultaneously building capacity by producing a new generation of young scientists. The CGS will benefit from this collaboration, as the project leader will obtain an M.Sc. degree in integrated studies of geology and geophysics. This qualification will bring expertise in onland near-vertical deep crustal seismic reflection imaging to the CGS.

Progress
After completing the data-acquisition phase along the profile from Prince Albert towards Fraserburg across the Beattie Magnetic Anomaly (BMA), the project leader received a one-year scholarship from the NRF and GFZ to process the data at the GFZ. This phase yielded excellent results and fruitful collaboration between the organisations. The seismic image shows good correlation with complementary wide-angle refraction data, magnetotelluric data and existing boreholes. The results were presented at several prestigious international conferences:
American Geophysical Conference, 8–18 December 2006 in San Francisco, USA;



The Inkaba yeAfrica logo illustrates the natural core to space laboratory concept.

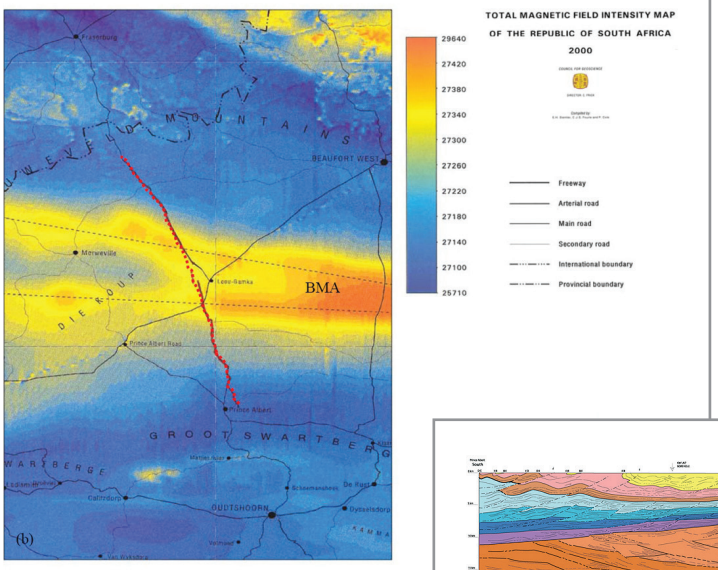
Deutsche Geophysikalische Gesellschaft Conference, 25–30 March 2007 in Aachen, Germany;
European Geophysical Union Conference, 15–20 April in Vienna, Austria;
South African Geophysical Association Conference, 22–26 October, Durban.

Talks were also given at the Department of Geological Sciences at UCT, the CGS's GeoIndaba and the 2007 annual Inkaba yeAfrica workshop. Three CGS reports were completed and initial results were published in a collection of three papers in the South African Journal of Geology, Inkaba yeAfrica Special Issue volume 110 (2/3), 2007.

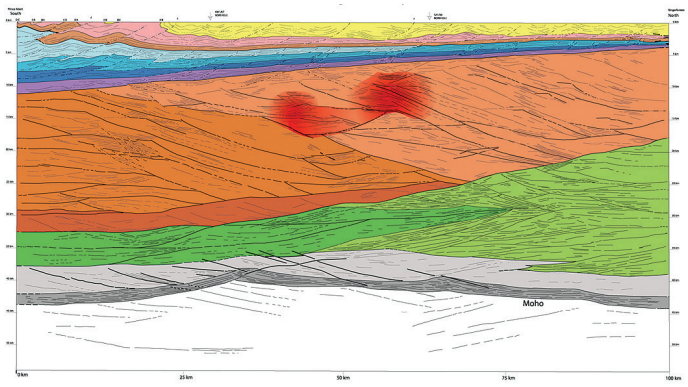
Conclusion
The first seismic image of the crust across the southern Karoo Basin and the derived tectonic model contribute new understanding of 1) the probable source of the BMA, 2) the Cape and Karoo Basin dynamics, 3) structure of the mid-crust and 4) the depth of the Moho.

Results encouraged further research and additional profiles are being proposed, parallel to the present line, to test the Beattie Magnetic Anomaly findings and a southward extension from Prince Albert to George, over the Cape Fold Belt and Kango Inlier, to image the crust below the mountain range. Reconnaissance for possible locations was carried out in November and December, and favourable locations for suggested lines were found.

Future activities
An M.Sc. thesis resulting from this research is due for submission in 2008 and may be published as a bulletin or memoir. Work to be carried out in 2008/9 will include raising funds, land-access permissions and preparations for data acquisition in the field.



Magnetic map showing the location of the Beattie Magnetic Anomaly (BMA).



Tectonic model based on the integration of seismic reflection data, wide-angle refraction data, magnetotelluric measurements, aero-magnetic data, receiver function analyses and existing boreholes.

SADC

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, B.N. Modie, Ph.D. (Botswana Department of Geological Survey), T. Segwabe, B.Sc. (Botswana Department of Geological Survey).
Primary objective: *to investigate and correlate the sedimentary rocks of the Karoo Basins of South Africa, Botswana and Namibia.*
Duration: 2006/7 to 2007/8.
Budget: R1 195 251.

Motivation
This is a collaborative project requiring participation of the geological surveys of South Africa, Botswana and Namibia. Research will focus on the rocks and tectonic evolution of the Kalahari–Karoo Basin which extends from southeast Namibia, through the central part of Botswana into the northwestern regions of South Africa. This project is a continuation of a statutory project ST 2006-0903 and supports the Department of Science and Technology's (DST) efforts to stimulate regional research collaboration in the SADC region. Namibia, Botswana and South Africa all face similar socio-economic challenges, and also share the presence of various related Karoo-age rock sequences. Rocks of the Karoo sequences contain virtually all the coal deposits in the SADC region, the primary source of electricity for South Africa and its neighbours. Few detailed studies have investigated the development of Karoo Basins outside the border of South Africa. Research into these rocks will not only improve our understanding of the distribution of mineral resources, especially coal, and the nature of aquifers, but also strengthen scientific ties between the participating countries and provide an opportunity to develop regional scientific capacity.

Progress
T. Segwabe, of the Botswana Department of Geological Survey (BDGS), is researching the mineral potential of the northern belt and southeast central subbasins of the Kalahari–Karoo Basin, with a specific focus on coal and coalbed methane. This investigation supports the current statutory duties and objectives of the BDGS. Progress in this research, which is also registered as a research project at Rhodes University, has been good.

During the year Segwabe reviewed stratigraphic principles and the redefinition of all the criteria used to establish the final stratigraphic division. Once a new set of criteria had been established, the borehole information collected by Segwabe during June and July 2007 was grouped and selected according to depth. Selected lithogical drillcore data were subjected to redescription and redefinition according to the new set of criteria. Stratigraphic subdivision was achieved to group level, while the rocks of the Ecca Group were further subdivided into formations, members and beds.

ArcView ® software was used to plot the selected boreholes and group them according to the pre-established subdivision. At a later stage these data will be used to construct three-dimensional models using Rockworks ® software. Facies analysis, which is based on lithological data, has started and is still in progress. In October Segwabe, E. Bordy of Rhodes University and J. Neveling (CGS) conducted a visit to several localities in Botswana in order to verify geological information and collect additional sedimentological data.

The Geological Survey of Namibia (GSN) was unable to assign a young geologist to this project during 2007 and 2008. The CGS had assigned a young geologist, J. Maseko, to work on this project to investigate the tectonic history of the southern portion of the Kalahari–Karoo Basin. Maseko had completed most of his literature research and visited the BDGS in Lobatse to collect additional data, but resigned in mid-2007. During September and October, J. Neveling used data derived from Maseko's work and other sources to develop initial correlation charts and to investigate aspects important to future basin analysis. A new scientist, V. Nxumalo, has been appointed during the course of October to participate in the project. Nxumalo will revive the study of the geology, correlation and tectonics of the Kalahari subbasin, which forms the western extremity of the Kalahari–Karoo Basin and extends into the Aranos Basin of Namibia.

A Memorandum of Understanding between the CGS and BDGS was drafted to be signed in 2007. To date, four progress reports have been submitted to the DST, and the required computer equipment has been purchased.

Conclusion
Although the start of the project has been slow, the most important personnel are now participating in the project. The early preparatory phases have been completed, two postgraduate research projects have already commenced and are progressing well.

Future activities
During the next year the focus will be on data collection and advancing the individual projects of two young scientists. This will be carried out in consultation and with their university supervisors.

CENTRAL MAPPING

0380
COMPILATION OF A 1:2 500 000-SCALE GEOLOGICAL MAP OF THE SADC COUNTRIES

Project leader: F.J. Hartzer, Ph.D.
Project team: P.J.A. Bosch, M.Sc., contributors from the SADC countries.
Primary objective: *to compile a geological map of the SADC countries, producing a common legend based on international stratigraphic correlations.*
Duration: 1999/2000 to 2008/9.

Motivation
Geological maps at scales of 1:1 000 000 or 1:2 000 000 exist for all the SADC countries, but there is a large variation in the quality and age of the data. Some of the maps date back to the 1960s, while others are very recent. In addition, the mapping philosophy and technical approach of the researchers vary from map to map.

This project was started with an international stratigraphic correlation, published in 1998. The compilation of a geological map, building on this correlation chart, is the next logical step, despite the immense complexities associated with it.

Progress
The data were compiled, digitised and coded for manipulation by GIS. In terms of quality control the legend has been checked by an external reviewer and proposed changes were implemented. Topographical data were created and added to the database for the production of the map. Currently the map creation is in its final stages.

Conclusion
Progress is according to plan, although unforseen events may have a negative impact on future progress.

Future activities
The map should be printed in mid-2008.

0602
1:50 000-SCALE GEOLOGICAL MAP AND EXPLANATION 2627BC WESTONARIA

Project leader: F. Gabbrielli, Ph.D.
Project team: M.R. Johnson, Ph.D.
Primary objective: *to revise the geological map and explanation for the 1:50 000-scale sheet 2627BC Westonaria.*
Duration: 2007/8.
Budget: R75 000.

Motivation
The map area, most of which falls within Gauteng, is located about 40 km southwest of Johannesburg and is undergoing rapid urban and industrial development. An improved knowledge of the geology of the region will be a valuable aid to all interested parties including soil scientists, urban planners, and companies intending to prospect and establish mining ventures in the area.

Progress
The original geological mapping of the map area was completed in 1993. Geological maps and reports of the area were compiled by various authors in draft form in 2000. During the course of the present project maps and reports of previous workers were collated and studied. The revised geological map and explanation have been accepted for publication.

Conclusion
Mining and farming are the main economic activities. The largest mines are gold mines and include the Driefontein, East Driefontein, Leeudoorn, Kloof, Libanon, Venterspost, Elsburg and Western Areas mines, and the Cooke Section of Randfontein Estates.

In the northwest the area is underlain by Archaean rocks correlated with the Hospital Hill and Government Subgroups of the West Rand Group, Witwatersrand Supergroup. Late Archaean and Proterozoic rocks of the Transvaal Supergroup occupy the greater part of the area. The Transvaal Supergroup is represented by the Black Reef Formation, and the Chuniespoort

and Pretoria Groups. Rocks of the Phanerozoic Karoo Supergroup are not exposed, but they have been intersected in boreholes drilled in the northern part of the area.

Diabase sills correlating with intrusives of Bushveld Complex age intrude the Timeball Hill and Silverton Formations. Syenite dykes, regarded as part of the of Pilanesberg dyke swarm, also occur in the area. They divide the dolomite into groundwater compartments which can be dewatered to make the gold mines workable and avoid the possibility of uncontrollable inflow of water.

Future activities
The map and explanation will be published during the next financial year.

Conglomerate of the Rooihoogte Formation (Pretoria Group) exposed in a sinkhole to the south of Western Areas Gold Mine.

Folding in shale of the Black Reef Formation on Knopjeslaagte 385 JR, southwest Centurion.

0603
GEOLOGICAL MAP AND EXPLANATION OF THE 1:50 000-SCALE SHEET 2528CC CENTURION

Project leader:	F. Gabbrielli, Ph.D.
Project team:	M.R. Johnson, Ph.D.
Primary objective:	*to revise the geological map and explanation of the 1:50 000-scale sheet 2528CC Centurion.*
Duration:	2007/8.
Budget:	R75 000.

Motivation
An updated knowledge of the geology of the area will serve as a basis for mineral exploration, engineering-geology investigations and groundwater studies. It will also be a valuable aid in a variety of other fields such as town and regional planning, as well as soil, agriculture and environmental studies.

Progress
A 1:50 000-scale geological map of the area was published by the Geological Survey of South Africa in 1973. This map needed to be updated and was also out of print. Various workers remapped the area during the period 1998–2002. A new map was compiled and edited and is now ready for digitising, and an explanation is ready for publication.

Conclusion
Archaean granite, gneiss and amphibolite of the Basement Complex occupy a large portion of the southwestern part of the map area. Late Archaean and Proterozoic rocks of the Transvaal Supergroup are exposed in the eastern and northern parts of the area. The supergroup comprises, from the base upwards, the Black Reef Formation and the Chuniespoort and Pretoria Groups. Phanerozoic rocks of the Karoo Supergroup are exposed in the southeastern part of the map area. Syenite dykes and sills of Pilanesberg age intruded the lower parts of the Chuniespoort Group. Mining in the area consists mainly of the exploitation of deposits of sand and quarrying rock for aggregate.

Future activities
The project team will continue to liaise with the Spatial Data Management (SDM) and the Information and Collections Management (ICM) units in order to follow through with the publication of the map and its explanation.

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

Project leader:	F. Gabbrielli, Ph.D.
Project team:	M.R. Johnson, Ph.D.
Primary objective:	*to revise the geological maps of the 1:50 000-scale Sheets 2627BD Lenasia and 2628AC Alberton, and to produce an explanation.*
Duration:	2007/8 to 2008/9.
Budget:	R125 000.

Motivation
The area forms part of the Gauteng Province and has been identified as a major growth area in South Africa. Field mapping of the study area was carried out in 1993. The compilation of maps and reports has been going on episodically since 1994. The project aims at studying maps and reports of previous workers in order to compile updated maps and a combined explanation.

Progress
The project started in January 2007, but was postponed to give priority to the Westonaria and Centurion projects. The explanation is now approximately 80% complete.

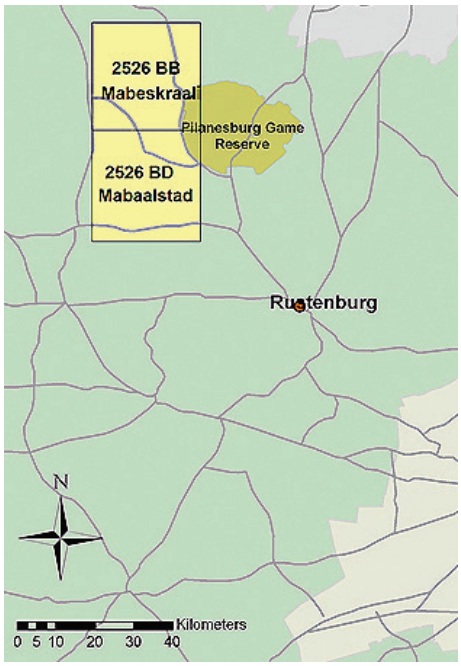
Conclusion
Most of the area is flat or slightly undulating. The main topographic features are represented by the Klipriviersberg and Suikerbosrant hills in the north-central and southeastern parts of the area respectively. Archaeozoic rocks of the Turffontein Subgroup of the Central Rand Group (Witwatersrand Supergroup) crop out along the northern slopes of the Klipriviersberg hills. The Klipriviersberg Group of the Ventersdorp Supergroup is well exposed along the Klipriviersberg and Suikerbosrant hills, while the Transvaal Supergroup occupies a large portion of the southern part of the map area. Rocks of the Dwyka and Ecca Groups (Karoo Supergroup) are mainly exposed on Sheet 2628AC Alberton. The intrusive rocks comprise diabase, syenite and dolerite.

Future activities
The two maps and their explanation will be completed early in the 2008/9 financial year.

0901
1:50 000-SCALE MAPPING OF THE AREA COVERED BY 1:50 000-SCALE SHEETS 2526BB MABESKRAAL AND 2526BD MABAALSTAD

Project leader:	R. Shelembe, M.Sc.
Project team:	S. Molefe (student), L. Molonyama (student).
Primary objective:	*to produce an accurate 1:50 000-scale geological base map of the Mabeskraal and Mabaalstad areas in the North West Province.*
Duration:	2006/7 to 2007/8.
Budget:	Mabeskraal: R508 143; Mabaalstad: R284 917.

Motivation
Projects such as this one in the Mabeskraal area are motivated by the need to encourage rural development and the alleviation of poverty, as well as the need for innovation and skills development. The CGS is instrumental in exploration and target generation for commodities such as those found in this area. The Mabeskraal mapping project has been extended to the south (Mabaalstad) so as to make a larger contribution to the understanding of the Bushveld Complex and its country rocks, and thereby also producing an up-to-date geological map of the area.

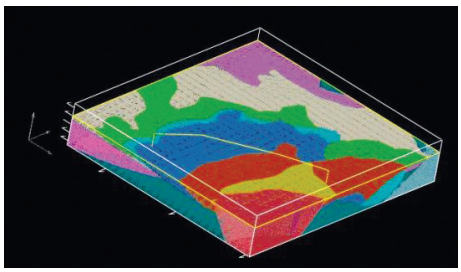


This project will include an assessment of mineral potential, development and application of an exploration model, and possible regional 3D modelling of the various Bushveld-related commodities using the Mabeskraal geological map and various data resources available such as satellite imagery, regional geochemistry, PGE analyses and geophysics.

Progress
Fieldwork for the Mabeskraal part of the mapping project has been completed, and a preliminary map has been produced and edited, while a report is currently being edited. For the Mabaalstad area, the fieldwork has been completed. A preliminary map and a field report are currently being edited.

Conclusion
The Mabeskraal-Mabaalstad project is one of the basic mapping projects that has the potential of contributing to geoscientific knowledge.

Future activities
During the coming year the mapping area will be extended to cover 1:50 000-scale sheet 2526BC Madikwe.



3D regional modelling of the Mabeskraal area.

0994
INTEGRATION OF 3D MODELLING INTO REGIONAL MAPPING

Project leader:	R. Shelembe, M.Sc.
Project team:	D. Sebake, M.Sc., B. Ingram, M.Sc., M. Roos, H.Nat.Dip.Cart, Dip.GIS, S. Ngesi, B.Sc.Hons.
Primary objective:	*to evaluate the 3D Geomodeller® software developed by the Bureau de Recherches Géologiques et Minières (BRGM) in collaboration with Intrepid Geophysics, using the 1:50 000-scale geological map 2526BB Mabeskraal.*
Duration:	2007/8.
Budget:	R213 862.

Motivation
The CGS is developing increasingly sophisticated technological applications in the earth sciences. A new product will consist of a series of digital 3D maps of various parts of South Africa. An inherent objective is to stimulate and broaden scientific knowledge using virtual reality. This will be a tool used to 'view' and understand how geological entities vary spatially.

For this project, which involves the development of a regional 3D model of the area covered by 1:50 000-scale sheet 2526BB Mabeskraal, these developments will be achieved by training scientists in the use of software that will carry out 3D modelling. The project will involve scientists from various disciplines in the CGS, and this will ultimately create knowledge of 3D map production within the organisation.

In terms of an agreement between the CGS and BRGM, the CGS will be issued with a research license for the 3D Geomodeller® software, and training would be provided for this collaborative project between the CGS, BRGM and Interpid.

Progress
The training of five CGS geoscientists has been completed. A 3D model for bedrock underlying the Mabeskraal 1:50 000-scale map area has been completed, and a report embodying a recommendation on the evaluation has been compiled.

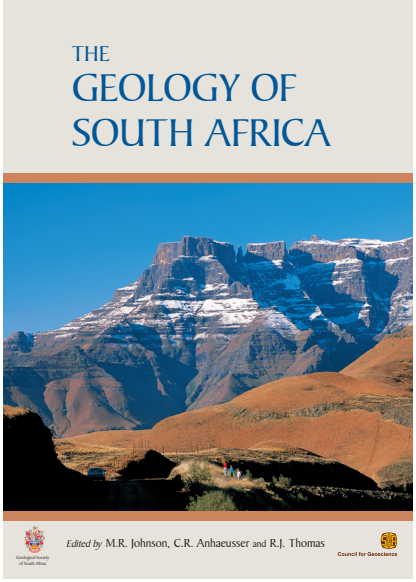
Conclusion
A contribution has been made in the integration of 3D modelling into regional mapping, a step which is essential for the expansion of geoscientific knowledge.

Future activities
Future activities include the formulation of a CGS strategy for the further use of 3D geological modelling. This will be done in collaboration with geological surveys of other countries.

South African Committee for Stratigraphy (SACS)

0055
TEXTBOOK OF SOUTH AFRICAN GEOLOGY

Project leader: M.R. Johnson, Ph.D.
Project team: C.R. Anhaeusser, Ph.D. (University of the Witwatersrand), R.J. Thomas, Ph.D. (British Geological Survey).
Primary objective: *to provide a comprehensive reference work on the geology of South Africa for both students and practising geologists.*
Duration: 1995 to 2007/8.



Motivation
The need for a new textbook on the geology of South Africa arose in the 1990s, as the previous book covering this topic had been published in 1982 and had become outdated. The Geological Society of South Africa (GSSA) entered into an agreement with the CGS to co-publish the textbook, in terms of which the CGS was responsible for redrafting the figures, compiling the index, preparing the layout and organising the printing, as well as sharing the editorial function.

Progress
Two thousand copies of the book were printed and released at the Geoforum of the Geological Society of South Africa in July 2007.

Future activities
Should a reprinting become necessary in the near future, the opportunity will be taken to allow minor updating and revision by the authors while retaining the present layout and pagination.

0449
SACS PUBLICATIONS

Project leader: M.R. Johnson, Ph.D.
Project team: A. van Heerden, B.A.(Bib.)
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 fieldwork, and provide basic data for use in reports and publications.

Progress
SACS Catalogue Volume 9 was printed. This volume contains descriptions of
Elandsfontyn Formation,
Hlagothi Complex,
Lambert's Bay Breccia-Basalt,
Langebaan Formation,
Nkwalini Olivine Melilitite Suite,
Prospect Hill Formation,
Robertson-Heidelberg Melilitite Suite,
Sandveld Group,
Varswater Formation,
Velddrif Formation,
Vredenburg Batholith Units,
Wellington Pluton Units and
Witteberg Group.

SACS Catalogue Volume 13, containing descriptions of the Buffelskloof Formation, Goraap Suite, Hangsfontein Granite, Kuboos Batholith Units, Matok Granite, Orange River Group, Stellenbosch Batholith Units, Vioolsdrif Suite, Waterberg Group and Wolkberg Group, has been edited and most of the figures have been redrafted.

SACS Lithostratigraphic Series No. 49, Lithostratigraphy of the Langkrans Formation, Wolkberg Group, was printed.

SACS Lithostratigraphic Series No. 50, Lithostratigraphy of the Msikaba Formation, is in the press.

SACS Lithostratigraphic Series No. 51, Lithostratigraphy of the T'hammaberg Formation, Bushmanland Group, has been edited and the figures have been redrafted.

Future activities
This project is ongoing.

0473
SACS DATABASE (A MODULE OF GEODE)

Project leader: M.R. Johnson, Ph.D.
Project team: S. Tucker, Dip.S.B.M.
Primary objective: *to store information on stratigraphic units in order to create a national data source and to standardise usage on maps, reports and publications.*
Duration: Ongoing.
Budget: See GEODE under Spatial Datal Management Unit.

Motivation
It is necessary that rock unit names be standardised on geological maps, reports and publications of the CGS and, as far as possible, by the rest of the geological community. The SACS database also supplies information to the public on the source of rock-unit names, and on obsolete and proposed names, and links are created to other modules of Geode in order to access related records by lithostratigraphic or informal unit names.

Progress
During the past year 57 lithostratigraphic units were added to the database and one was deleted. In total, 1 502 names are now contained in the database.

Unit Status:	Approved	Historical	Informal	Not applicable	Not yet approved
Litho Rank:					
Undecided					1
Batholith			8		
Bed	4	1			1
Complex	29	2			4
Formation	325	52		1	136
Group	49	10			12
Member	90	17	2		20
None	121	31	7	5	118
Pluton			6		

Unit Status:	Approved	Historical	Informal	Not applicable	Not yet approved
Reef			61		
Subgroup	35	4			8
Subsuite					12
Seam			243		
Supergroup	9	2			
Suite	33	3		1	21
Zone			18		
Totals	**695**	**122**	**345**	**7**	**333**

Future activities
This project will continue indefinitely, as the SACS database is used as a source of information for other modules of GEODE, as well as other databases.

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.P. 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., P.M.W. Botha, B.Sc.Hons, 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 of SACS and its task groups, as well as refereeing and editing manuscripts submitted to SACS for publication.*
Duration: Ongoing.

Motivation
As a member of the ISSC (International Subcommission for Stratigraphic Classification), SACS makes an input and receives feedback concerning stratigraphic terminology at an international level. The CGS provides 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.

Progress
The task groups for the Karoo Supergroup (sedimentary rocks), Alkaline Complexes, Gariep-Cape Rocks, Soutpansberg and Waterberg Groups, Biostratigraphy and Swazian Rocks and Pre-Bushveld Intrusives held meetings during the course of the year.

ISSC Newsletters/Circulars received were studied and responded to where appropriate.

Legends of all 1:250 000- and 1:50 000-scale maps currently being drafted 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 were noted and brought to the attention of the cartographers.

Future activities
This project will continue indefinitely.

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 provide a map showing the distribution of rocks of the 70 major lithostratigraphic units of South Africa.*
Duration: 2003/4 to 2007/8.

Motivation
It is envisaged that a simplified, 1:2 000 000-scale lithostratigraphic map will form an essential part of the CGS's publications on the geology of South Africa and serve as a basic tool in geological education, complementing the published 1:1 000 000-scale geological map. At one quarter of the size, and much less expensive to purchase, this map should prove particularly attractive not only to students, but also to those who either cannot afford or who lack space for the 1:1 000 000-scale map.

Progress
Delays in releasing the map provided the opportunity to undertake further checks and to improve the legend. This mainly involved adjusting the colour scheme adopted. It has now been decided to print the map rather than make it available as a print-on-demand product.

Future activies
The map will be printed and released during the next financial year.

EASTERN CAPE UNIT

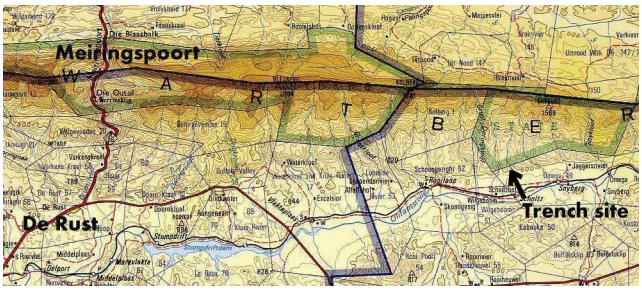
0950
LATE QUATERNARY REACTIVATION OF THE KANGO FAULT — PALAEOSEISMIC TRENCH RESULTS

Project leader: M.L. Goedhart, M.Sc.
Project team: C. Dondo, M.Sc., P.W.K. Booth, Ph.D., R.W. Shone, Ph.D. (Nelson Mandela Metropolitan University).
Primary objective: *to investigate the neotectonic reactivation of the Kango fault by detailed logging of a vertical exposure allowing offsets to be directly measured and dated.*
Duration: 2007/8.

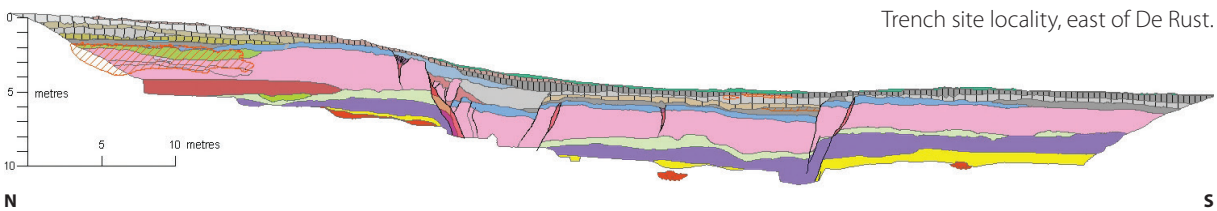
Motivation
South Africa is seen as a stable intraplate region where earthquakes are relatively infrequent to rare, but this perception is based on a relatively short period of the Earth's history (~350 years) that includes only the historical and instrumentally recorded seismic events. In contrast, recurrence of large, damaging, surface-rupturing earthquakes in intraplate regions may be in the order of 100 000 to 150 000 years, so the existing seismic record used for the regional hazard assessment may miss large, significant events. To correct this imbalance, the CGS embarked on a review of the country's seismic hazards to include, for the first time, palaeoseismic data – data from prehistoric earthquakes. Determining the location, timing and magnitude of earthquakes which occurred before mankind started recording individual seismic events is not easy, but can be achieved by stringent geological investigation along major zones of crustal weakness, targeting sites of past surface rupture.

Progress
The excavation across the ruptured head of the alluvial fan 18 km east of De Rust exposed a 32-m-wide graben in the central portion of the trench, with relatively undisturbed footwall and hanging-wall sediments. Twenty-one lithological units, six soil horizons and nineteen fault strands were mapped, correlated and interpreted within the local geological setting.

Fracturing occurred in the footwall, the main fault zone and as antithetic faults at the southern end of the grabens. In all cases, the upper ends of the faults terminated in the same horizon, indicating a single event, i.e. the Most Recent Event, or MRE. Retrodeformation of the trench log indicated that the displacement measured at the trench site is close to the average scarp height measured along strike of the Kango fault, indicating a palaeo-earthquake of magnitude between 7.18 and 7.43 M_L. This rupture has been dated at the start of the Holocene, indicating that this segment of the Kango fault can be considered 'active'. The discovery of a regional disconformity at the base of the trench also enabled the minimum recurrence interval for the Kango fault to be determined. A spin-off from the investigation is the ability to date and correlate this disconformity with past sea-level changes, enabling a better understanding of the effect of climate change on local erosion and sedimentation in the Little Karoo, some 100 km away from the coast. These results were presented to the South African Quaternary science community, and to the international Quaternary science community at Cairns, Australia, in a session devoted to new developments in neotectonics and palaeoseismicity. In both cases, the trench results were well received, and comments and suggestions were documented for incorporation into the final manuscript.



Trench site locality, east of De Rust.



Detailed trench log, showing graben development in Holocene sediments overlying the Kango fault, east of De Rust. This major listric fault extends some 10 km down into the earth's crust.

Conclusion
This palaeoseismic investigation has provided valuable data for the seismic hazard assessment of a region. For the first time, the regional probabilistic seismic hazard assessment is being augmented by very specific prehistoric, deterministic, palaeoseismic data. The two methods are complementary as they jointly provide a better picture of earthquake threat that neither method is able to present alone. Together with known isostatic uplift in the southeastern Cape region, slow crustal instability is expected to generate further large, damaging, surface-rupturing earthquakes along this fault system. This has direct impact for development plans in the region.

Future activities
Additional palaeoseismic investigations are underway in the Eastern Cape to better define the seismic hazard of this seemingly stable area. Results are being incorporated into the hazard assessment of a number of new developments in the greater Port Elizabeth region.

0950

OPTICALLY STIMULATED LUMINESCENCE (OSL) DATING OF TRENCH SAMPLES IN THE INVESTIGATION OF THE LATE QUATERNARY REACTIVATION OF THE KANGO FAULT

Project leader: M.L. Goedhart, M.Sc.
Project team: Z. Jacobs, Ph.D., C. Dondo, M.Sc., P.W.K. Booth, Ph.D., 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: 2007/8.

Motivation
The Optically Stimulated Luminescence (OSL) dating procedures used to determine the date of the Most Recent Event (MRE) for the palaeoseismic trench at De Rust, as well as the recurrence and slip rate for the Kango fault, are time consuming and complex, but the results have a direct bearing on the seismic hazard assessment of the region. As the laboratory techniques employed are well documented, but the local application relatively unusual and requiring rare interpretive skills, a publication indicating the methodological and analytical procedures adopted, and experimental results obtained, would support the reliability of the ages used in the hazard assessment.

Progress
OSL dating has been applied to 12 of the 52 sediment samples collected from the footwall, hanging wall and main fault zone in the palaeoseismic trench near De Rust. These samples showed two broad age groups, with samples near the base of the trench yielding Upper to Middle Pleistocene ages, while the overlying samples were all early to mid-Holocene in age. The OSL ages were used to determine the age of the MRE and to estimate the recurrence interval and slip rate for the Kango fault. These were found to be typical for intraplate stable continental regions and Atlantic-type rifted margins. This supports the current understanding of seismicity in the region and therefore the seismotectonic model used.

Procedures applied were audited and approved by specialists in the UK. The methodologies used were also presented in Cairns, Australia, to obtain international peer review and acceptance of the results. Comments were noted and are being included in the manuscript.

Preparing to measure the in situ background gamma radiation of an OSL sample, taken 6 m below surface in the palaeoseismic trench at De Rust. Samples must be protected from sunlight, as the technique measures the time that has elapsed since the sand grains' last exposure to sunlight, thereby providing the date of their burial by the overlying sediments. Where these horizons were last ruptured, the date can be related to the age of the earthquake.

Conclusion
OSL dating is an extremely valuable tool in determining the age of Quaternary sediments, particularly where no fossil material or radiogenic isotopes are readily available. The techniques applied to the samples in this study may well become standard for similar future palaeoseismic investigations.

Future activities
Three additional OSL samples are still being analysed at Wollongon University, Australia. Their results will be included in the final assessment of the earthquake responsible for the surface rupture along this segment of the Kango fault.

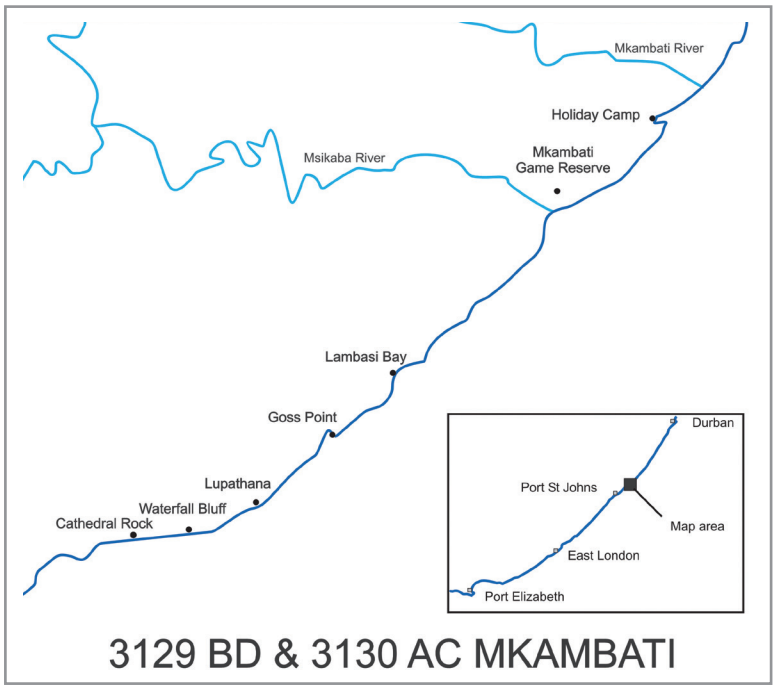
0980

GEOLOGICAL MAPPING OF 1:50 000-SCALE MAP 3129BD & 3130AC MKAMBATI, AND PART OF SHEET 3129BB KANYAYO

Project leader: J.S.V. Reddering, Ph.D.
Project team: V.R. Mitha, M.Sc., D. Kilian, B.Sc.Hons, D.E. Black, B.Sc.Hons.
Primary objective: *to revise the existing geological map and compile a map explanation for this map close to the northern border of the Eastern Cape Province.*
Duration: 2007/8.
Budget: R106 500.

Motivation
Areas along the Eastern Cape coastline falling within the Spatial Development Initiative (SDI) have been identified as priority areas for initiatives to improve the economy in rural and established metropolitan areas. During previous mapping programmes the geological maps along the coastline and hinterland in the area from Port Elizabeth to East London, as well as a large area surrounding Port St Johns, have already been revised and are in the process of being published. The northern border area adjoining KwaZulu-Natal is rural tribal land and a large conservation area. Improved geoscientific data for this area will support regional spatial planning and can be used by local, provincial and national government land-use planning agencies, investors and entrepreneurs.

Progress
Following preliminary data collation and aerial photo interpretation, a thorough literature review and field mapping, the geology of the 1:50 000-scale map 3129BD & 3130AC Mkambati has been revised. Mapping in this inaccessible area has been challenging because of the rugged terrain and poor access. A comprehensive database of all site localities described during the fieldwork links each observation point to a detailed description of the outcrop, rock type, stratigraphic classification and structural data, as well as samples taken for further analysis and photographs. The ArcGIS system was used for further analysis and map compilation. Mapping expeditions have revised the lithological contacts between the Mbotyi Formation and Dwyka Group. Mapping has revealed many dolerite intrusions previously not indicated on larger-scale maps. The map explanation has been compiled.



Conclusion
The improved map will complement the mapping that has been completed to the west, and will link up with the revision of the Port Edward sheet on the Eastern Cape–KwaZulu-Natal border to the north. The identification of dolerite sills has revealed rocks that could provide valuable construction materials in this area.

Future activities
Completion of the Mkambati map and explanation has extended the revised geological map coverage to cover almost the entire Eastern Cape coastline. The updated geoscientific information can be used to improve infrastructure within the coastal SDI.

0981
GEOTOURISM BROCHURE FOR THE ADDO ELEPHANT NATIONAL PARK (AENP)

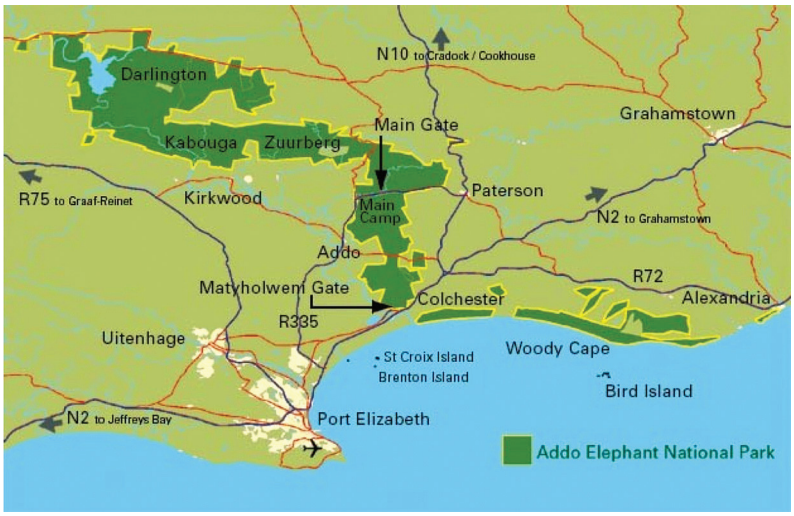
Project leader: D.E. Black, B.Sc.Hons.
Project team: D. Kilian, B.Sc.Hons, V.R. Mitha, B.Sc.Hons.
Primary objective: *to produce a fold-out brochure of the Addo Elephant National Park (AENP) thereby promoting an appreciation of the relatively unknown earth-science heritage of the area, and document the geological history preserved in the rocks and landforms within the park boundaries.*
Duration: 2007/8.
Budget: R36 600.

Motivation
The CGS would like to expand its range of popular geoscience publications with a fold-out brochure focusing on the geology of the AENP in the Sundays River region that is consistent with and fully integrated into the SAN Parks vision for the conservation area.

There have been concerted efforts worldwide to popularise earth science and to promote the recognition of geological heritage. This project involves the production of an educational brochure which will enhance the available tourism information services provided in the park. In addition, by enhancing the scope of ecotourism the brochure may provide the potential for income generation, therefore developing a holistic approach focusing on conservation and the socio-economic wellbeing of previously disadvantaged communities.

Progress
The data gathering, compilation of geological descriptions at a popular geoscience level, and preparation of preliminary graphics have been completed.

Future activities
The final artwork and publication will be undertaken by the ICM Unit. The brochure will be promoted and distributed, and revisions will be made based on feedback from AENP and the public.

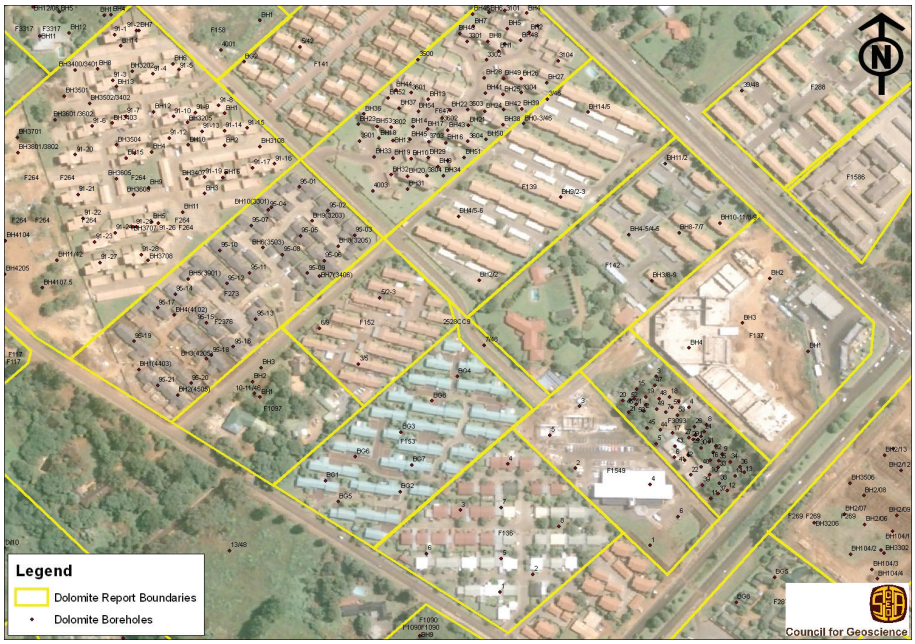


Boundaries of the extended Addo Elephant National Park.

ENGINEERING GEOLOGY

0061
ENGEODE (A MODULE OF GEODE)

Project leader: L. Croukamp, M.Sc.
Project team: A.C. Oosthuizen, B.Sc.Hons (Eng.Geol.).
Primary objective: *to make engineering-geology data available to the public in various digital formats.*
Duration: Ongoing.
Budget: R150 000.



GIS image showing dolomite report boundaries and dolomite borehole localities.

A sinkhole which occurred during 2007 in southern Pretoria.

Motivation
Access to information through GEODE provides the foundation for reinvigorating research into dolomite and other geotechnical issues. A process of centralising and digitising all information was undertaken with the aim of developing products that could assist in exploitation of areas underlain by dolomite. As there is a growing demand from developers, consultants and the general public for this information, this process has to make information easily available. The project is an ongoing process which ensures that all data are captured and easily available to the public.

The CGS is responsible for gathering all dolomite-related information and preparing it so that it can be used to guide safe development. The most important geotechnical data stored are the soil profile descriptions, sample data and the dolomite profile logs. A record is kept of each document, and ENGEODE is a database of reports, maps and files, soil profile descriptions together with associated sample data, and also dolomite borehole logs together with their associated sample descriptions.

Over the last year, a total of 3 300 dolomite report boundaries were captured on GIS, 7 500 boreholes were plotted, gravity maps were digitised and sinkhole data from various sources were gathered.

Although the CGS does not comment on the geotechnical conditions of the land, a number of geotechnical reports are still received and incorporated in the ENGEODE database. The total number of reports now incorporated into the indexing system is 3 250.

The importance of this dolomite databank is growing, as more consultants working in the industry require GIS data from the CGS. The CGS has been involved in a number of data-acquisition projects to date, and, once this databank is fully functional, it will be a very useful tool for the industry. A definitive sinkhole record for South Africa will be produced during the next year.

The ENGEODE database plays an important role during the creation of the 1:50 000 geotechnical map series of the CGS and investigations are underway to generate more and innovative products from the database. The data in ENGEODE will be accessible through the planned Web portal of the CGS, once developed. This will allow a broader field of users to utilise the information stored in the database.

0062
DOLOMITE DATABANK

Project leader: G.J. Heath, B.Sc.Hons (Eng.Geol.).
Project team: A.C. Oosthuizen, B.Sc.Hons (Eng.Geol.), L.G. Heath, R. May, V. Peer.
Primary objectives: *to maintain the Dolomite Databank and continually improve the accessibility of the data, making hard-copy data available to the public.*
Duration: Ongoing.
Budget: R130 900.

Motivation
The dolomite databank has been in existence for more than 40 years. Information in reports submitted to this databank is regularly used by consultants in the industry. It is the Engineering Geology Unit's responsibility to ensure the efficiency of the database system, allowing easy access to the public. A large number of dolomite-stability reports are submitted to the Engineering Geology Unit every year for storage and capture.

A procedure for centralising and capturing information was developed with the aim of producing products that could assist in the exploitation of ground underlain by dolomite. There is a growing demand from developers, consultants and the general public for this type of information.

Progress
The index list compiled during 2006/7 was verified, and a quality-control system was implemented to ensure that all the reports indicated on the index list are stored in the database. Capture of report boundaries, dolomite boreholes and gravity maps commenced during 2007/8. Information regarding the occurrence of sinkholes was obtained from various sources.

The following data were captured during 2007/8:

3 300 dolomite report boundaries were captured in ArcGIS
7 500 dolomite boreholes listed in the dolomite stability reports were captured in ArcGIS
Gravity maps of the Venterspost, Bank, Oberholtzer and Zuurbekom Groundwater Compartments on the Far West Rand were digitised
1 100 dolomite-related instability positions were captured for the Tshwane area; 1 200 for the Far West Rand, and 160 in the Ekurhuleni Metropolitan Municipal area.

Conclusion
Having the data available on a GIS has increased the functionality of the databank. The importance of this dolomite databank is growing, as more consultants working in the industry require some GIS data from the CGS. The CGS has been involved in a number of data-acquisition projects to date, and once this databank is fully functional, it will be a very useful tool for the industry.

Future activities
Data capture is an ongoing process, and will remain part of this unit's responsibilities in the years to come. The capturing of the dolomite boreholes will continue in 2008/9 and a definitive sinkhole database for South Africa will be produced.

0851
1:50 000-SCALE GEOTECHNICAL MAP 2627AD CARLETONVILLE

Project leader: C. Forbes, B.Sc.Hons (Eng.Geol.).
Primary objective: *to prepare a comprehensive 1:50 000-scale regional engineering-geological map that delineates multiple geotechnical constraints on development.*
Duration: 2004/5 to 2007/8.

Motivation
The final map product is ideally intended for use by local authorities, district municipalities and provincial planners, civil engineers, as well as private-sector land developers and members of the public. It must be taken into consideration that, however potentially useful, systematic 1:50 000-scale geotechnical mapping is a costly exercise requiring extensive state subsidies unless carried out on a commercial basis.

The selection of the Carletonville sheet in 2003 was influenced by a number of factors including:

• ongoing dolomite-related subsidence problems within the urbanised areas of Carletonville and its satellite townships of Oberholtzer, Bank and notably Khutsong. This had, for example, influenced the Merafong City Council to initiate detailed and extensive geotechnical investigations of alternative areas for the relocation of Khutsong in 2003/4 at an estimated cost of R700m.

• the extensive local growth driven by gold-mining activities reflected in a high demand for both residential and industrial sites in the existing urban centres of Carletonville and Fochville, and along a connecting north-south corridor.

• expected urbanisation and development impetus along the northeast–southwest-aligned N12 highway corridor from Johannesburg which passes north of Fochville.

A regional geotechnical map of this area thus fills in the undeveloped farmland gaps and provides a holistic overview of all engineering geological problems present. It in no way provides an alternative to the NHBRC processes, whereby site geotechnical classification is required prior to development, but can guide the planning of such activities and assist in preliminary pre-purchase site appraisals.

Progress
The final map explanatory report is approximately 95% complete, while the GIS processing of the 13 standard geotechnical-parameter maps and allocation of polygon numbers remains to be done. Material will then be ready for further cartographic processing and an explanation will be published.

Conclusion
The 1:50 000-scale sheet 2627AD Carletonville is located in the southwest of Gauteng Province. The geotechnical factor and problem soil maps produced show that, in addition to dolomite which covers 62% of the sheet area mainly in the north, hard-rock outcrop constitutes the most severe constraint to economic land utilisation. Twenty-eight per cent of the area will require blasting, while a further 34% will experience moderate to slight excavatability problems. Soft to medium density and gravel-horizon-free aeolian and colluvial soils of >1 500-mm thickness occupy only limited areas of the mapped sheet, while less than 5% have no excavatability problems. Soil activity has been shown to be primarily low to medium in severity, affecting 69% of the soil-covered areas (72% of the sheet area). Only limited areas of medium- to highly-expansive soils are present (3–4% of soil area), occurring as restricted alluvial deposits. Drainage courses subject to periodic flooding are confined to 2% of the sheet area, and, while potentially unstable steep slopes affect only 0.5% of the sheet area, terracing and additional developmental costs associated with urban housing construction would still be required over 35–40% of the sheet area (GFSH-2 2002 code). The latter areas unfortunately occur mostly over the southern non-dolomitic parts, including the Gatsrand. Natural construction materials are limited to *in situ* road materials, marginal residual material for brick-making, and limited and environmentally sensitive colluvial deposits for plaster sand, but vast resources of mine-dump rock, mostly suitable for crusher stock, are present.

Soil activity has been shown to be primarily low to medium in severity (NHBRC Class H-H1), affecting 69% of the soil-covered areas (i.e. 72% of the map). Only limited areas of medium to highly expansive soils are present (3–4% of soil area), occurring as restricted alluvial deposits. Collapsible soil profiles occur on both aeolian and colluvial deposits, with the most severe conditions experienced on thicker colluvium along the Gatsrand (5–10% C_{p200}). Aeolian and mixed-origin materials have a higher natural moisture content, softer consistency and propensity to exhibit immediate consolidation

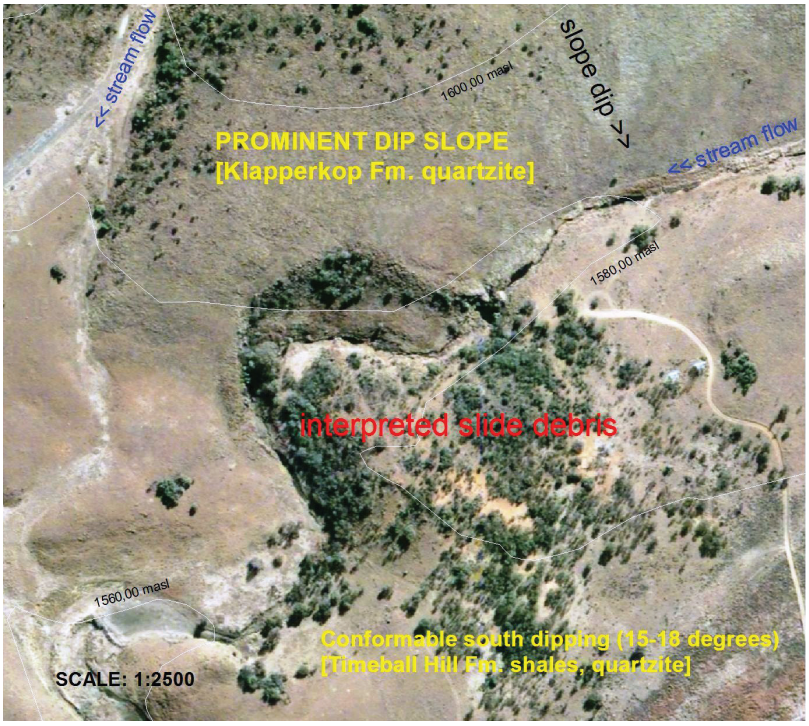
settlement (1-5% C_{p200}). Soil erodibility assessed from the perspective of slope gradient, soil type, dispersivity and image analysis, has *inter alia* identified <10 hectares of active donga erosion.

Drainage courses subject to periodic flooding are confined to 2% of the map area, while seasonal or periodic flooding from sheet runoff can also be expected in the numerous closed depressions and near-flat areas identified. Potentially unstable steep slopes affect only 0.5% of the map area, but terracing and additional developmental costs associated with urban housing construction would still be required over 35–40% of the map area (GFSH-2 2002 code). The latter areas fall mostly into the southern non-dolomitic parts, including the Gatsrand.

Natural construction materials are limited to sites for road materials, marginal residual andesite material for brick-making near Fochville, and limited and environmentally sensitive colluvial deposits for plaster sand along the Gatsrand. The large resources of mine-waste rock available are suitable for crusher stock, subject to checking for shale contamination and alkali aggregate reactivity.

The mapping exercise has, by virtue of the detailed examination of high-resolution colour Quick Bird imagery and inclusion of the Khutsong data, added about 95 sinkholes and 134 doline subsidence features to the hundreds already captured by the Carletonville-based Gold Fields dolomite unit, to the Carletonville sheet. This information has now been archived.

Future activities
Various thematic maps (such as potential expansiveness, collapse, inundation) may be published separately, while development of derivative map products (such as development potential for housing, landslide susceptibility, karst-subsidence susceptibility) can now be motivated.



Probable palaeolandslide, due east of West Driefontein Gold Mine, on the southern slope of the Gatsrand (Quick Bird 160-930, 2004).

0959
LIMPOPO LANDSLIDES INVENTORY AND SUSCEPTIBILITY MAPPING

Project leader: S.G. Chiliza, B.Sc.Hons.
Project team: S. Richardson, B.Sc.Hons.
Primary objective: *to produce a map displaying landslide distribution and susceptibility in the Limpopo Province.*
Duration: 2007/8 to 2008/9.
Budget: R69 000.

Motivation
Landslides are one of the most prominent catastrophic processes that cause loss of life, damage to natural resources — vegetation, land and soil — and infrastructure, such as dams and roads. Geohazard identification and mapping have been identified as core functions of the CGS. They entail hazard identification and description, problem research, information dissemination, as well as public awareness. The existence of complete and digitally archived 1:250 000-scale geological maps, but not of geohazards, highlights a gap which can be filled by the geohazards mapping programme.

Progress
Aerial photographs were used to determine the spatial and temporal distribution of ancient and recent landslides.

In February 2008 a field trip was undertaken to the Tzaneen and Makhado areas of the Limpopo Province. A light aircraft was employed for an aerial inspection of selected target areas identified from a detailed slope class map. Three mountain escarpments were selected for inspection:

i the north–south-trending Drakensberg Escarpment, 30 km southeast of Polokwane;
ii the northern Soutpansberg Mountains, which lie parallel to the Limpopo River and are bisected by the N1 highway; and
iii the Waterberg Mountain Range in the vicinity of Thabazimbi.

Aerial inspections proved invaluable, as these allowed for quick identification of a number of suspected palaeolandslides and rockfall areas, permitting access to normally inaccessible areas.

To date, about 200 landslides have been identified in the Limpopo Province, 98% of which were confirmed during aircraft flyover surveys and ground field checking.

Conclusion
The Limpopo project will produce a landslide inventory map, displaying landslide occurrences and distribution in the Limpopo Province, which will be complemented by a landslide susceptibility map. The latter product has the potential to mitigate development problems and thus reduce costs within or adjacent to hazardous areas. The information provided will promote safer living environments, impacting positively on quality of life.

Future activities
The February field trip focused primarily on the Drakensberg escarpment and Soutpansberg Mountains, and a similar exercise will be carried out in the Thabazimbi area during the coming year.

The landslide inventory, which involves field work and aerial photograph interpretation, will continue onto the second year of the project. This will be followed by susceptibility mapping, which is GIS-based modelling, during the latter part of 2008/9.

Recent active landslide along the R523 to Thohoyandou.

Lake Fundudzi, a freshwater body formed when a landslide blocked the course of the eastward-flowing Mutale River.

The Engineering Geoscience Unit also anticipates undertaking further research into Lake Fundudzi, which was formed by a landslide.

5628
BULLETIN ON CLOSURE OF UNSAFE MINE OPENINGS

Project leader: G. Heath, B.Sc.Hons (Eng.Geol.).
Project team: D. Molapo (student).
Primary objective: *to produce a CGS bulletin that documents work done in identifying unsafe abandoned mines workings in the Witwatersrand mining areas.*
Duration: 2005/6 to 2008/9.
Budget: 2007/8: R6 000.

Motivation
At the request of the DME, the CGS is identifying all unsafe, abandoned mine openings in the Witwatersrand mining areas with the objective of sealing those that are dangerous. While the DME has funded the task of locating dangerous mine openings in the Witwatersrand area, and their closure, it is important as part of the mining record to publish the results of this project as a bulletin.

Progress
To date 700 mine openings have been located, and 108 of the most dangerous have been sealed using subsurface concrete plugs.

The project has also been submitted to the University of the Witwatersrand as an M.Sc. thesis in mining engineering.

Conclusion
A record of the dangerous mine openings of the Witwatersrand mining basins will be published as a CGS Bulletin.

Future activities
The production of the bulletin is dependent on the completion of the project, which should be in mid-2008.

Dangerous mine opening situated in an informal settlement.

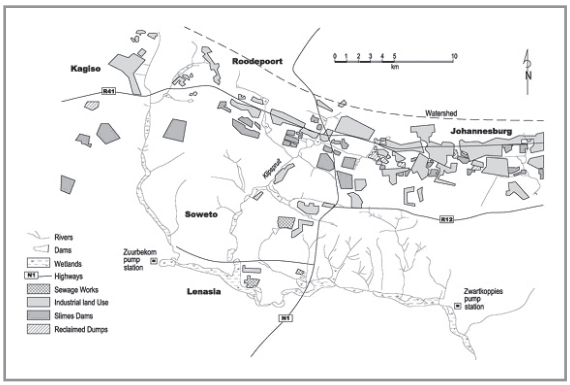
0890

HEAVY-METAL ACCUMULATION IN THE PEAT OF THE KLIP RIVER WETLANDS, SOUTH OF JOHANNESBURG

Project leader: J.S. Venter, B.Sc.Hons.
Project team: T.S. McCarthy, Ph.D. (University of the Witwatersrand), N. van Wyk, B.Sc.Hons, M. Kwata, B.Sc., P. Monare, M. Roos, H.Nat.Dip.Cart., Dip.GIS, M. Kotoane, Nat.Dip., D. van Tonder, B.Sc. Hons, J. Glass, M.Sc.
Primary objective: *to compile an inventory of heavy metals sequestered in the peat of the wetland.*
Duration: 2005/6 to 2007/8.
Budget: Total: R515 800; 2007/8: R25 500.

Motivation

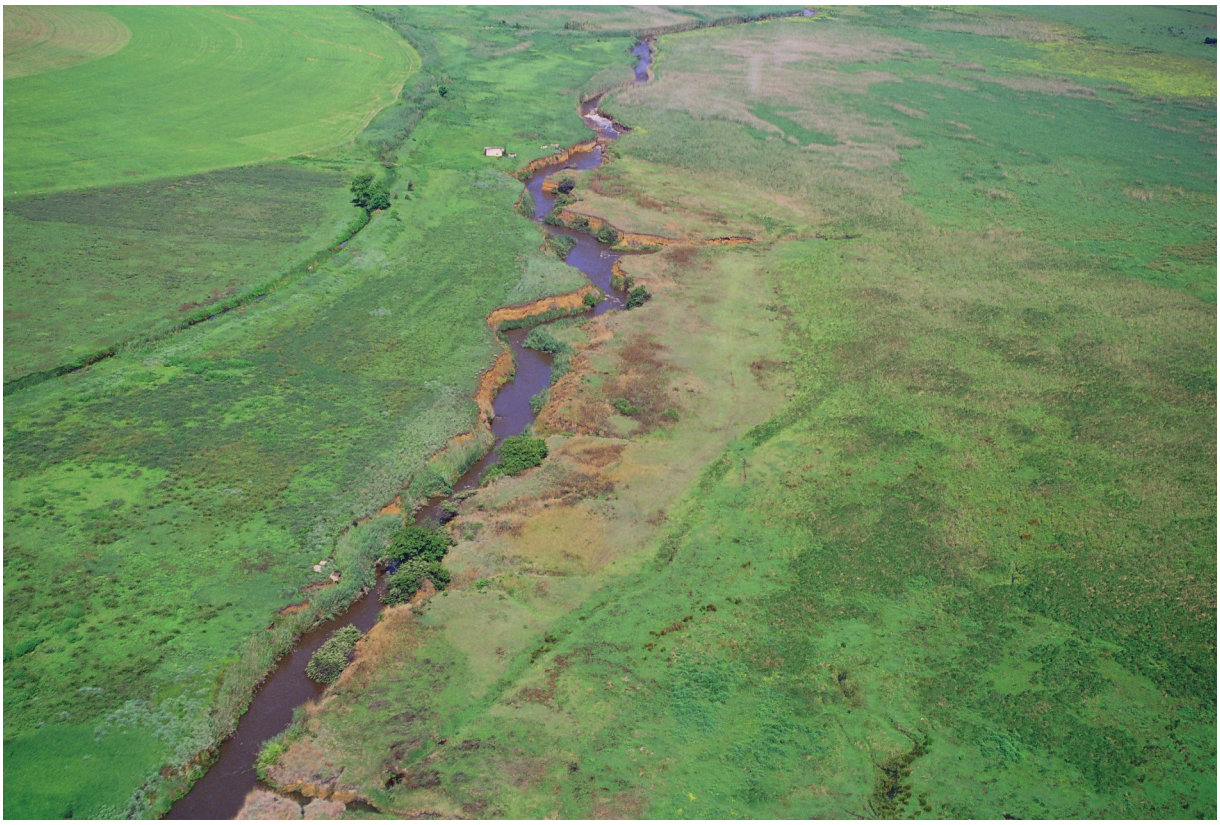
The project was undertaken in order to compile an inventory of heavy metals sequestered in peat in the Klip River wetlands, and to determine whether a signature indicative of pollutants caused by human activity in Johannesburg can be found in the peat. This wetland has always been economically important for Johannesburg, firstly as a water source and now as natural treatment of waste water for the western and central parts of the Witwatersrand. Furthermore, this project is definitely providing a service to the community, as people depend directly on this wetland for their livelihood. This study has focused the attention of the media and the authorities on the urgent need to rehabilitate and protect this wetland.



Progress

The project is in the final stage and the research findings are being documented.

Environmental degradation in the Klip River Wetlands.



Conclusion
Extensive capacity has been built by this project at the Council for Geoscience, and very good working relationships have been established between the CGS and the University of the Witwatersrand. Further contacts established include the Working for Wetlands Programme under the auspices of SANBI.

Future activities
Other projects stemming from the Klip River project will continue wetland research at the CGS. This project is now being documented and is being submitted as an M.Sc. thesis to the University of the Witwatersrand.

0941
A GROUNDWATER-MONITORING PROTOCOL FOR LIGHT NON-AQUEOUS-PHASE LIQUIDS (LNAPL) AT FUEL SERVICE STATIONS

Project leader: S. Esterhuyse, M.Sc.
Project team: B. Usher, Ph.D., L. Maré, M.Sc., M. Hauger (consultant).
Primary objective: *to test the effectiveness of geophysical and other techniques for the detection of oil pollution in a clayey environment.*
Duration: 2007/8 to 2009/10.
Budget: R90 073.

Motivation
A previous study was carried out during 2006/7 to investigate best practices for monitoring LNAPL storage and establish a pollution-monitoring protocol. Although this protocol is based on international best practice, it is still necessary to test pollutant plume survey techniques, borehole installation and sampling procedures in strata and related clayey soil that is encountered in South Africa.

Progress
Testing was performed in two phases, firstly in a laboratory tank and then in a controlled field test. Micro-scale geophysical data from the laboratory-scale model were used for the plume tracking and monitoring in the field-scale experiment. Once laboratory testing was complete, the controlled release field-scale test site was developed to test the efficiency of monitoring borehole installations, the materials used, sampling procedures and other methods of plume tracking as recommended by international best practices.

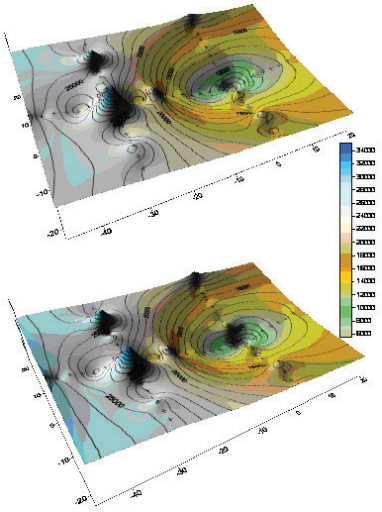
Research revealed that small-scale resistivity does reflect the presence of water and oil in clayey soil.

A tank was filled with a clayey soil obtained from Donkerhoek. Oil and water were inserted into the soil through simulated boreholes, which were surveyed for micro-scale resistivity. The presence of water and oil in the tank could be positively identified, as shown in the second figure. The depression in the 3D surface reflects the presence of water (to the right of the figure) and the elevation in the 3D surface (to the left of the figure) reflects the presence of oil. Electrode effects can also be observed.

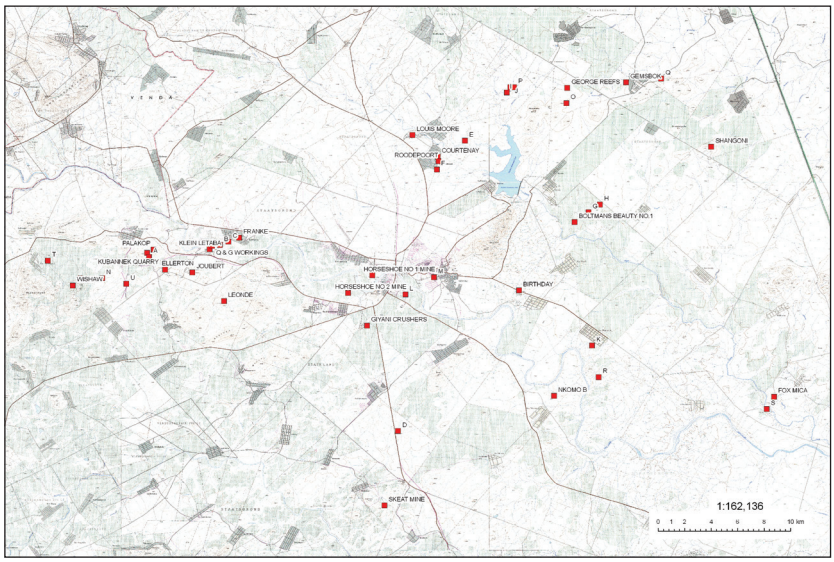
Vertical profiling, planned for 2008/9, should filter out much of the noise picked up during the horizontal profiling as shown in the second figure.

Conclusion
The laboratory experiment showed promising results in terms of detecting oil pollution in clayey soil. A horizontal survey using the Wenner resistivity setup was used, but noise was detected owing to electrode effects. A positive signal could, however, still be detected from the water and the oil. Vertical profiling should filter out much of the noise picked up during the horizontal profile used to generate the 3D surface. A vertical survey is now proposed which could possibly eliminate some of the noise in the survey. Testing the laboratory tank while tilting it, to check for induced flow and plume movement, is also proposed. When the experiments using clay have been completed, the same procedure can be used with sand, in order to determine the difference between the signals from oil and water.

The soil used in the experiment was sourced from Donkerhoek, and should be a reliable example of what can be expected at other sites.



3-D surfaces showing low resistivity in the water borehole (to the right of the figure) and high resistivity in the oil borehole (to the left).



0966
TOWARDS THE MANAGEMENT OF TAILINGS DAMS IN THE GIYANI GREENSTONE BELT

Project leader: N. Ndivhuho, B.Sc.Hons.
Project team: H. Coetzee, M.Sc., M. Kwata, B.Sc.
Primary objective: *to develop a management strategy for tailings materials at abandoned mines in the Giyani area.*
Duration: 2007/8 to 2008/9.
Budget: R52 300.

Motivation
The 70-km-long Giyani Greenstone Belt is situated in the northeast of Limpopo Province. A northeasterly trending greenstone succession up to 17 km wide forms the Nsama portion. The extreme eastern portion of the Greenstone Belt falls within the Kruger National Park.

Progress
Of the mines in the study area, 90% have been visited and assessed from an environmental point of view. Samples were collected from tailings dams and submitted for analysis by XRF in order to determine the trace-element contents. It was found that most of the mine dumps are unrehabilitated and could be a source of dust pollution to local communities. The dumps are also strongly affected by erosion and could cause water pollution during the wet season. Although this project focuses on tailings material, dangerous unsealed shafts were identified that need immediate attention.

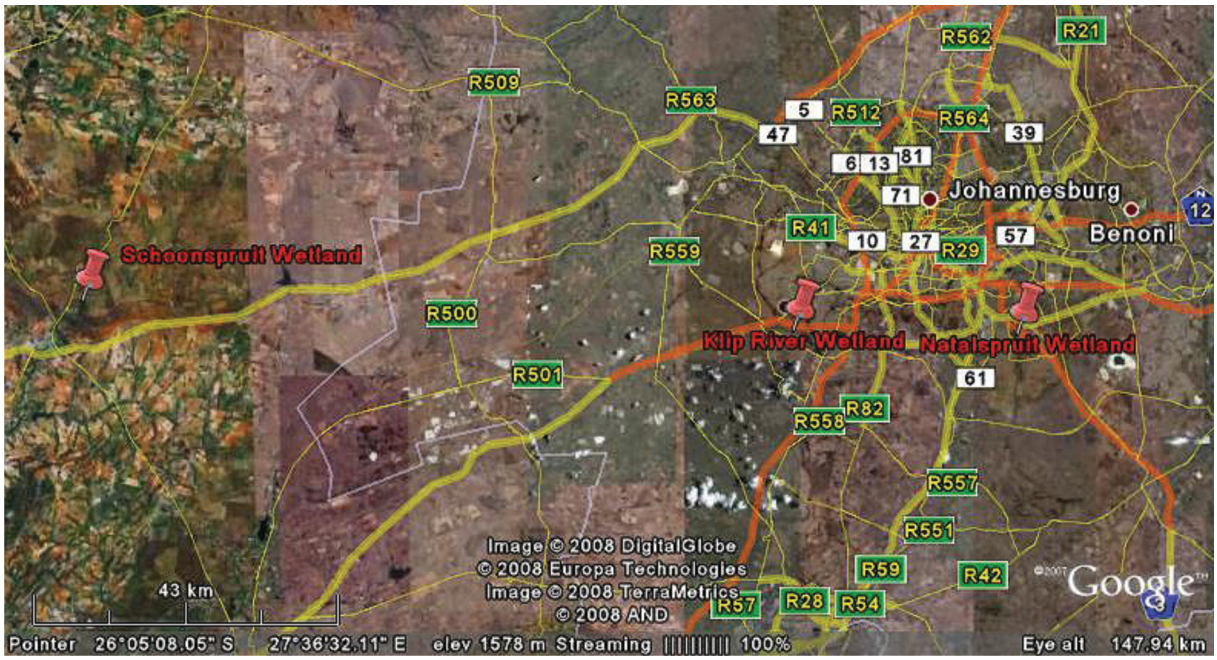
Future activities

Future activities will include soil and water sampling, mapping abandoned tailings dams, and interpretation of results. A report and map will be produced. Water samples will be collected to determine the impacts of tailings dams on water for domestic use, irrigation and livestock feeding. Tailings-dam samples are still to be collected and submitted for leach testing.

0967
GEOCHEMICAL FUNCTIONING OF WETLANDS

Project leader: J.S. Venter, B.Sc.Hons.
Project team: M. Kwata, B.Sc., P. Monare, N. van Wyk, B.Sc.Hons, J. Glass, M.Sc., D. van Tonder, B.Sc.Hons, T. Motlakeng, Nat.Dip., P. Wade, Ph.D.
Primary objective: *to gain a better understanding of the geochemical processes that take place within wetlands.*
Duration: 2006/7 to 2008/9.
Budget: R67 500.

Motivation
This project is a follow-up of the Klip River project, and affords the researchers an opportunity to further examine the workings of wetlands. It is important to understand exactly how they wetlands act as water purification filters so that they can be protected and used as passive water treatment plants.



Progress

Three wetlands were chosen for this project, namely the previously studied Klip River wetland, the neighbouring Natalspruit wetland, and the relatively unimpacted Schoonspruit wetland near Ventersdorp.

Water samples were collected and analysed as part of the Ecotoxicology Project. The researchers on these projects worked closely together as they studied the same wetlands, and the information gathered is used by both projects.

Water quality in the Natalspruit as received from the Ecotox project is as follows:

Samples (ppb)	Li	Na	Mg	K	Ca	Cr	Fe	Mn	Ni	Zn	Pb	U	F	Cl	NO_2	Br	NO_3	PO_4	SO_4
Natalspruit 1	21	52 891	16 534	13 529	66 786	86	559	51	76	636	53	7	1	49	0	0	1	2	142
Natalspruit 2	16	55 133	15 815	13 626	67 252	94	434	44	71	< 300	< 30	5	0	47	0	0	1	1	141

pH and Eh measured in the field immediately after sampling are:

Natalspruit 01	pH	Eh (mV)	EC (µS/cm)
0,2m	6,65	373	
0,4	6,73	328	
0,6		262	
0,8		-144	

Natalspruit 02	pH	Eh (mV)	EC (µS/cm)
0,2m	7,35	226	554
0,4	7,66	57	533
0,5	7,10	Dry	Dry

The samples collected were submitted to the laboratory for analysis.

Conclusion

pH, Eh and EC measurements of the peat, as well as the water entering the system, will hopefully shed light on the different processes within peat wetlands systems.

Future activities

Data collected from the Klip River project will also be used for this project. More extensive sampling will be conducted in the Natalspruit and the Schoonspruit. This information will be combined with the information already gained from the Klip River, as well as a literature study.

Sampling peat in the Klip River wetlands.

0971
URBAN LEAD AND PGE: A MEDICAL-GEOLOGY PERSPECTIVE

Project leader: D. M. van Tonder, M.Sc.
Project team: J. Venter, B.Sc.Hons, L. Croukamp, M.Sc., J. Glass, M.Sc., M. Kwata, B.Sc., F. Ngcobo, B.Sc. Hons.
Primary objectives: *to (i) isolate transport-related lead, PGE and other trace-element pollutants from pollutants from other anthropogenic sources by sampling dust from selected parkades in Johannesburg, Pretoria, Durban and Cape Town; (ii) compare the data with available data from other major cities, and (iii) develop a dust-sampling protocol for the CGS.*
Duration: 2007/8 to 2008/9.

Motivation
The link between geological sciences and human health, termed medical geology, is gaining interest as we understand more completely the coupled biogeochemical systems. An example of a medical-geology problem largely considered solved is that of lead poisoning. Heavy metals in the atmosphere are concerning as they can cause respiratory diseases, asthma, chronic obstructive pulmonary disease, cardiovascular disease, reductions in IQ, increased blood pressure, behavioural and developmental effects, and premature death and lung cancer. Leaded petrol is considered to be one of the main sources of lead poisoning, and, according to the World Health Organisation, in 2002 approximately 75% of petrol-propelled vehicles in South Africa were still using leaded petrol.

Progress
Dust sampling from selected parkades in Durban, Cape Town, Pretoria and Johannesburg has been completed. Roadside soils have been sampled in selected areas at high-traffic intersections in these major cities. Soil samples along major highways in Durban, Cape Town and Johannesburg have been collected. A sampling protocol in line with EPA standards is being developed.

Introduction and background chapters for the report for Cape Town, Durban, Pretoria and Johannesburg are being compiled. Dust wipe samples collected have been analysed using a Niton hand-held XRF employed for dust characterisation, and samples have been prepared for submission for ICP-MS and SEM analyses.

Future activities
A final report, a document elucidating the dust-sampling protocol, and a publication will be produced in the course of the coming year.

0988
CONTINUOUS MONITORING OF NATURAL ATTENUATION PROCESSES IN THE WESTERN BASIN OF THE WITWATERSRAND GOLDFIELD

Project leader: N. van Wyk, B.Sc.Hons.
Project team: J. Venter, B.Sc.Hons, H. Coetzee, M.Sc.
Primary objective: *to study the hydrogeochemistry of water courses bearing acid mine drainage in terms of load, and the timing and duration of peak concentrations of the most deleterious contaminants.*
Duration: 2007/8.
Budget: R49 000.

Motivation
Load, and duration of peak concentrations in terms of hydrogeochemistry in this water course were unknown. This innovative project has shed light on the rate of reaction of the Western basin to physical and chemical influences in the mine void.

Progress
The continuous monitoring systems installed have collected telemetric data for more than a year at 15 minute intervals, and the data have been stored. A number of problems, which included hardware malfunction, unforeseen dynamism of the system and variations in calibration methods, led to errors in the records. However, data quality protocols in terms of data tolerances have been achieved. Verification protocols and procedures in terms of data collection have been studied. A site-specific calibration method has been developed based on the instrumentation manufacturer's and supplier's methods. Using information from the data collected, certain predictions can be made, such as seasonal and diurnal cycles, and tidal and lunar influences.

Conclusion
Verification should be employed for another cycle to ensure that the protocols, in terms of tolerances, have been met.

Future activities
Another year should be employed for data collection, as the mines will start pumping in order to lower the water level in the mined-out areas to reach the environmentally critical level. In terms of load and timing in hydrogeochemistry the data could prove valuable to set limits on the proposed water-treatment plants.

0993
FEASIBILITY OF THE USE OF DERELICT AND ABANDONED MINE LANDS FOR THE DEVELOPMENT OF RENEWABLE-ENERGY PROJECTS

Project leader: H. Coetzee, M.Sc.
Primary objective: *to link the problems of land degradation and the energy crisis by proposing that abandoned and derelict mining sites could be used for the generation of renewable energy, many renewable technologies requiring large areas of land to be successfully implemented on a large scale.*
Duration: 2007/8.

Motivation
Large areas of land in South Africa have been degraded to some degree by mining. In many cases, the land may never be fit for unrestricted development, resulting from physical or chemical hazards. This is a particular problem in the Witwatersrand, where large areas within cities have been rendered unfit for housing development. Historically, little thought has been given to the post-mining land use in these areas, and available funding for land rehabilitation from government and the private sector, including mining companies, is inadequate for the task at hand. Furthermore there are real concerns regarding soil contamination by heavy metals and radionuclides, which may be present at levels which would limit the potential of this land for food production. At the same time, South Africa faces a number of crises in the energy sector, caused, among other reasons, by a lack of investment in new electrical-generating capacity, air pollution due to the large-scale consumption of coal, and high liquid-fuel prices due to dwindling resources and geopolitical factors.

This project combines the CGS's expertise and experience in the identification, location and management of mining environmental legacies with the search for an integrated solution for two national problems, namely mining legacies and the current energy shortage.

Progress
A number of technologies have been identified which are applicable for use on derelict mine sites, with wind and solar energy being the most promising.

Large areas of South Africa have potential for the generation of solar energy, in particular the arid western part. The wind-energy potential of South Africa is more limited. Within these areas, potential sites have been identified in the Namaqualand Copper District, the West Coast Diamond Fields and the Witwatersrand. A number of stakeholders have been identified in the renewable energy sector, the mining sector and communities affected by mine closure. Discussions with these stakeholders have indicated broad interest in the project, with the potential for future development in this regard.

An artist's impression of a large array of solar collectors, as could be developed on an abandoned mine site (Sandia National Laboratories, 2004).

Conclusion
Abandoned mine sites offer land suitable for the generation of renewable energy, which is a land use sustainable after mine closure.

Furthermore, the development of renewable energy plants could be utilised as a sustainable post-closure land use for currently operating mines, as well as the waste dumps proposed for the disposal of large volumes of material to be generated by the reprocessing of slimes from gold and uranium mines on the Witwatersrand.

Google Earth image of O'okiep, showing a large abandoned residue dump where solar-energy generation could be implemented.

GEOCHEMISTRY

0193

INTEGRATED GEOCHEMICAL MAPPING OF THE AREA COVERED BY THE 1:50 000-SCALE MAPS 2528CA PRETORIA, 2528CB SILVERTON, 2528CC CENTURION AND 2528CD RIETVLEIDAM

Project leader: S.W. Strauss, M.Sc.
Project team: J.H. Elsenbroek, B.Sc.Hons, D. van der Walt, B.Sc.Hons, M. Cloete, Ph.D., H. Maritz, B.Sc.Hons, W. Jordaan, M.Sc.
Primary objectives: *to set new standards for future geochemical mapping programmes in South Africa.*
Duration: 2007/8.

Motivation

The project will add value to the Regional Geochemical Mapping Programme by analysing additional elements to the 23 elements analysed by the Simultaneous X-ray Spectrometer. This assemblage of approximately 40 elements will be used for the interpretation and characterisation of geological mapping in the study area, identifying new exploration targets for mineral deposits and to study environmental pollution in the urban environment.

The programme is structured to improve the level of expertise of a broader group of scientists employed by the CGS. The programme should include:
Litho-geochemical mapping (the area covers a wide range of geological units from Archaean up to the Karoo Supergroup)
Metallogenic mapping, modelling and target generation (the area includes Pt, Pd, Cr, Au, Pb, Ti, V, Mn, Fe, diamonds and fluorspar deposits)
Environmental mapping: Pb (natural versus urban), As, Hg, Se, F in granites and alkaline rocks.

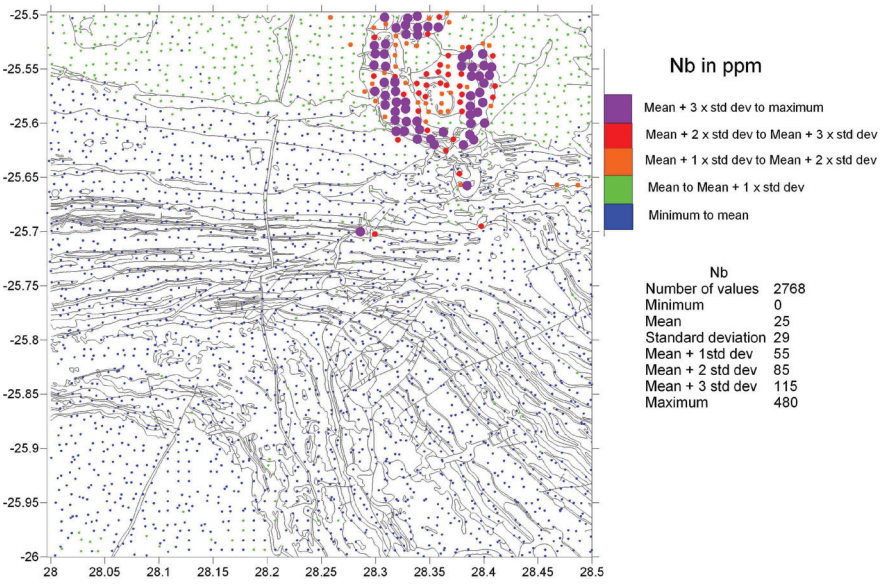
Progress

The soil sampling in the areas covered by the four 1:50 000-scale maps was carried out at a density of one sample per km^2. The northern half of the area covered by the 1:50 000-scale map 2527CB Silverton was sampled by helicopter-supported transport. The other sheets were sampled on foot with 4x4-vehicle support. The soil samples, each approximately 5 kg, were dry-sieved to extract the -75µ fraction, and were analysed by the following analytical techniques:

1. Simultaneous X-Ray Fluorescence (XRF) Spectrometry for SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, Ag, As, Ba, Ce, Co, Cr, Cu, Ga, Hf, La, Mo, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Zn and Zr
2. Sequential XRF Spectrometry for Si, Al, Ti, Fe, K, Mg, Mn, Na, P, Ca
3. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for Ag, As, Au, Ba, Be, Bi, Cd, Co, Cr, Cu, Hg, Li, Mo, Nb, Nd, Ni, Pb, Rb, Sb, Sn, Sr, Te, Th, U, V, W, Y, Zn and Zr
4. Dionex QIC Ion Chromatography for Br, Cl, F, NO_2, NO_3, PO_4, SO_4
5. DC Arc Emission Spectrography, at the Henan Laboratory, Peoples Republic of China for Pt, Pd, Au, Hg, Se and Bi.

Regional geochemical maps were compiled at a scale of 1:100 000. Geological and mineral economic data were compiled in order to interpret the geochemical data. Statistical measures were calculated for each geochemical element and these were used to display spatial anomalies in the data.

The compilation summarises the soil geochemistry dataset



A geochemical map of Nb distribution showing undersaturated complexes.

of the Tshwane area. A first screening of the data produced valuable information that could make contributions to mineral exploration (the Kleinfontein anomaly), as well as to the wellbeing of the inhabitants of the Tshwane metropolitan area. However, further work needs to be done on the data as more comprehensive models can be applied and tested to extract the full value of the research.

Conclusion
It is essential that the statutory Regional Geochemical Mapping Programme be continued as it serves one of the core functions of the geological mapping strategies at the CGS and also builds the infrastructure to support the small-scale mining and poverty-alleviation strategies of South Africa.

0892
FORMATION OF SMECTITE FROM CHLORITE IN ENGINEERING TIME

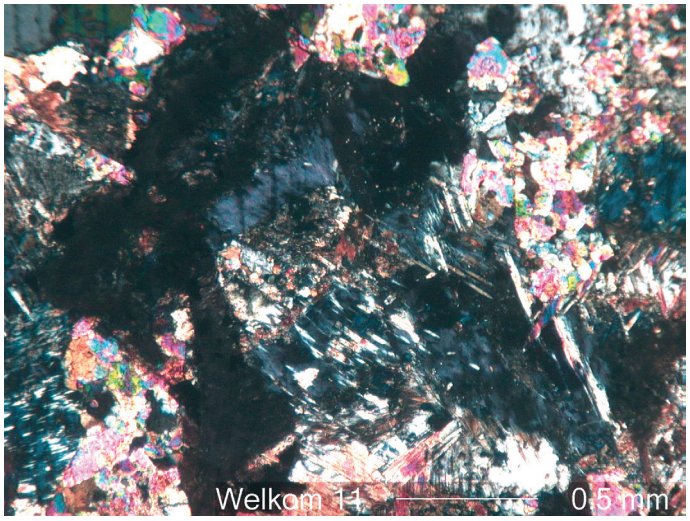
Project leader:	K. Enoch, B.Sc.Hons.
Project team:	M. Cloete, Ph.D., L. van Rooy, Ph.D. (University of Pretoria).
Primary objective:	*to determine whether chlorite weathers to smectite in the presence of pyrite in engineering time (20 years).*
Duration:	2006/7 to 2008/9.
Budget:	R14 500 per year (R43 500 in total).

Motivation
The gold-mining industry of the Witwatersrand provides an abundant source of hard aggregate in the form of quartzite from the infrastructural development of mines. The aggregate is mined at depth and dumped at the surface as waste material. It are then crushed and graded so that it can be used for road-construction purposes. The quartzites consist predominantly of quartz, mica, pyrophyllite, chloritoid, chlorite and minor pyrite. Witwatersrand quartzites normally contain 0–0.5% pyrite, but may have up to 3%. Even in small quantities sulphide minerals are deleterious. In the presence of oxygen and water, pyrite (FeS_2) weathers to ferric hydroxide ($Fe(OH)_3$), sulphate ions and acidity.

$$4FeS_2 + 15O_2 + 14H_2O \rightarrow 4Fe(OH)^3 + 8SO_4^{2-} + 15H^+$$

Chlorite $(Fe, Mg, Al)_6 (Si, Al)_4O_{10}(OH)_8$, a common mineral in Witwatersrand wastes, is considered to be a benign mineral in road construction. However, the presence of chlorite in road-building materials, together with pyrite-derived sulphuric acid, gives rise to smectite formation. Smectite is a clay mineral with an expanding lattice which is highly plastic and deleterious even in small amounts in road aggregates.

This research project will provide valuable information on methods of increasing the durability of roads, which could decrease maintenance costs where chlorite-bearing mineral aggregates are commonly used. Smectite formation will be tested on Witwatersrand mine-waste rock which is often used for road construction, and usually contains chlorite and pyrite. Accelerated weathering will be simulated in the laboratory to determine whether smectite, which is deleterious in construction materials, forms in engineering time.



Photomicrograph illustrating large, dark blue-coloured chlorite grains with epidote, quartz and plagioclase, from Sable Shaft Quarry, Welkom. Polarised light, crossed nicols.

Progress
A thorough literature study was done to assemble a list of possible reactions and associated thermo-constants which are required to investigate the reactions of chlorite. A model has been set up to determine the sequence of reactions in road-building material when associated with pyrite.

Conclusion
The sorted samples consisted of various rock types including conglomerates, quartzites, diabase and andesites. Some of these rock types contained significant amounts of chlorite. The mineral chlorite is prone to acid attack, which causes it to alter to smectite.

Future activities
Laboratory experiments are being conducted to simulate the conditions in which chlorite will alter into smectite.

0968

REGIONAL GEOCHEMICAL MAPPING OF THE GIYANI BLOCK COVERED BY THE 1:50 000-SCALE MAPS 2330BA TLANGELANE, 2330BB SHANGONI, 2330BC GIYANI AND 2330BD NSAMA, AND OF THE TZANEEN BLOCK COVERED BY THE 1:50 000-SCALE MAPS 2330CA DUIWELSKLOOF, 2330CB GA-MODJADJI, 2330CC TZANEEN AND 2330CD LETSITELE

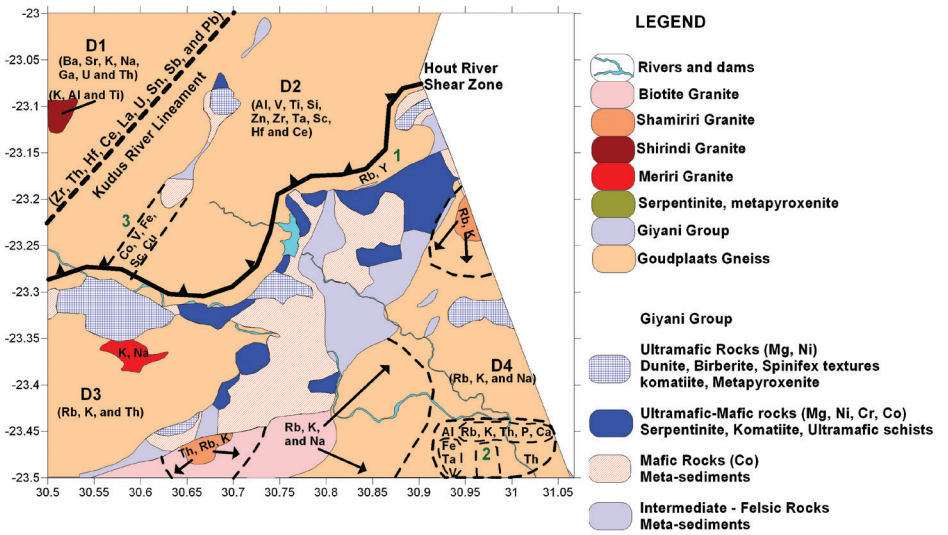
Project leader: M. Cloete, Ph.D.
Project team: S.W. Strauss, M.Sc., J.H. Elsenbroek, M.Sc., R. Netshitungulwana, B.Sc.Hons, E. Mulovhedzi, B.Sc.Hons, D. van der Walt, B.Sc.Hons, M. Bensid, B.Sc.Hons, T. Mdletshe, B.Sc.Hons. and H.C.C. Cloete, B.Sc.Hons.
Primary objective: *to continue the ongoing Regional Geochemical Mapping Programme as a core function of the CGS.*
Duration: 2007/8.
Budget: R5 000 000.

Motivation

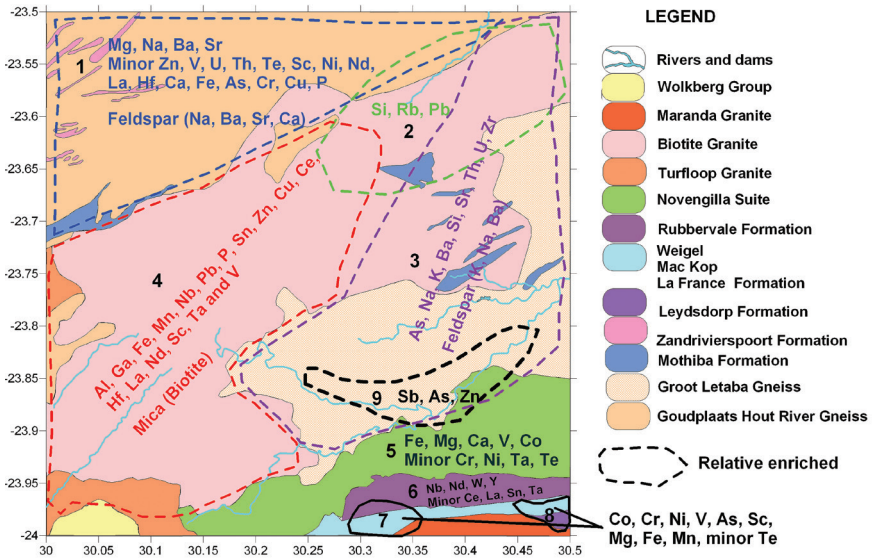
The regional geochemical mapping of these areas was funded by the National Treasury. The Regional Geochemistry Unit undertook the task of producing regional geochemical maps to complement the existing geological information, and to create a geochemical database. This information is essential in the identification of exploration targets for a wide range of commodities, to test exploration models and to initiate geological research.

Progress

Sampling was carried out at a sample density of one soil sample per km². The area was sampled on foot, with 4x4-vehicle support. The soil samples, having an approximate mass of 5 kg each, were dry-sieved to extract the -75µ fraction.



Synthesis of geology and geochemistry in the Giyani area.



Synthesis of geology and geochemistry in the Tzaneen area.

The samples were analysed by Simultaneous X-Ray Fluorescence (XRF) Spectrometry for SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, Ag, As, Ba, Ce, Co, Cr, Cu, Ga, Hf, La, Mo, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Zn and Zr.

The geochemical datasets allowed the investigation of single-element distribution patterns, as well as geochemical synthesis from a geological and exploration point of view.

The Giyani dataset consists of 2 725 samples and 98 100 data points. 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.

The metallogenic synthesis maps largely confirmed the known metallogenic provinces for gold and other minerals in the area. However, several 'new' metallogenic anomalies and trends have been identified that could be of importance from a mineral-exploration point of view.

The Tzaneen dataset contains 2 785 samples. Geochemical synthesis maps for the predominant geological units were created, showing their unique geochemical fingerprints. Provisional geochemical modelling also resulted in the identification of two 'new' geochemical exploration targets in the study area. Both these anomalies are regarded as prime targets for Au exploration in the greenstone belt.

The geochemical modelling also delineated an important artificial 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 caused by pesticides or fertilisers.

The comprehensive dataset has already proved to be a valuable national asset, and further value will be added by thorough interpretation of the geochemical data.

Conclusion
It is essential that the Regional Geochemical Mapping Programme continues, as it serves one of the core functions of the geological mapping strategies of the CGS and is part of the infrastructure which supports the small-scale mining and poverty-alleviation strategies of South Africa.

Future activities
The data will be examined for interesting geochemical anomalies which will be verified and followed-up.

0969

VERIFICATION OF THE REGIONAL Ni AND Cr ANOMALIES OF THE WITFONTEINRANT ON THE 1:250 000-SCALE MAP 2426 THABAZIMBI AND THE DISCOVERY OF THE WITFONTEINRANT MAFIC-ULTRAMAFIC DYKE

Project leader:	S.W. Strauss, M.Sc.
Project team:	J.H. Elsenbroek, M.Sc., R. Netshitungulwana, B.Sc.Hons, E. Mulovhedzi, B.Sc.Hons, D. van der Walt, B.Sc.Hons, S. Hlatshwyo, B.Sc.Hons, M. Maya, B.Sc.Hons, H.C.C. Cloete, B.Sc.Hons.
Primary objective:	*to verify the Witfonteinrant anomaly, an ultramafic body discovered by regional geochemical sampling, by analysis of additional soil samples taken during several field visits.*
Duration:	2007/8.

Motivation
The Witfonteinrant Ni-Cr anomalies were identified from the regional geochemical data matching the 1:250 000-scale sheet 2426 Thabazimbi. The Witfonteinrant Ni-Cr anomaly has an east–west extension of approximately 100 km. The anomaly is situated in the Malmani Dolomite Subgroup which forms the lower part of the Transvaal Supergroup.

Altered dolomite at the contact with the Witfonteinrant intrusion.

Progress
The existence of a mafic-ultramafic dyke — now called the Witfonteinrant ultramafic dyke — was established during a field visit during November 2007. The Witfonteinrant ultramafic dyke is exposed in a railway cutting immediately west of Middelwit.

Subsequently, three soil traverses (A, B and C) were sampled during the first week in March 2008 in order to establish the nature of the dyke, as

well as to investigate possible associated base-metal enrichment. Each traverse consisted of 40 soil samples taken over three kilometres, with sample spacing at 50 m for the kilometre centred directly over the inferred Witfonteinrant trend and 100 m for the flanking kilometres. The soil samples were taken at surface, and had an approximate mass of 5 kg each. They were sieved and the -75µ fraction was pressed into a powder briquette for analysis for SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, Ag, As, Ba, Ce, Co, Cr, Cu, Ga, Hf, La, Mo, Ni, Pb, Rb, Sb, Sc, Sn, Sr, Ta, Th, U, V, W, Y, Zn and Zr.

The Cr, Ni and Co trends, in particular, once again confirmed the anomaly and the existence of the dyke at all three locations. The width of the dyke appears to vary between approximately 500 m and 1 200 m, and to be better exposed to the east. Layering due to fractionation could have taken place but, apart from a double Cr peak at Traverse C, no real evidence was found to suggest it.

Some evidence suggests that sulphide enrichment could have taken place in the dyke at Traverse C. Anomalous sulphur, supported by anomalous arsenic (probably evidence of arsenopyrite or pyrite), zinc and nickel in the dyke at Traverse C, suggests that with favourable conditions, sulphide enrichment may have taken place during fractionation of the magma. The absence of these anomalies at the two other traverses (A and B) also suggests that conditions were not always favourable for sulphide enrichment to take place, but that in specific localities the potential existed. This implies that Ni-sulphides may be present in favourable 'hot spots' along the dyke and that the potential for Ni deposits along the Witfonteinrant ultramafic dyke probably does exist. The Uitkomst Complex model for nickel, platinum, palladium and base-metal mineralisation could therefore apply at certain 'hot spots' along the Witfonteinrant ultramafic dyke.

Future activities
Follow-up by drilling and auger to determine the full economic potential of the Witfonteinrant ultramafic body will be motivated and referred to the DME.

0970

VERIFICATION OF THE REGIONAL GEOCHEMICAL Ni AND Cr ANOMALIES IN THE AREA COVERED BY 1:250 000-SCALE SHEET 2920 KENHARDT: THE DISCOVERY OF THE BOOMRIVIER, DRIEBOOMLAAGTE AND LOOGKOLK COMPLEXES

Project leader:	J.H. Elsenbroek, M.Sc.
Project team:	S.W. Strauss, M.Sc.
Primary objective:	*to verify the Boomrivier, Drieboomlaagte and Loogkolk anomalies.*
Duration:	2007/8.

Motivation
Three regional nickel and chromium anomalies were identified and are referred to as the Boomrivier, Drieboomlaagte and Loogkolk anomalies. These anomalies are situated in an area previously mapped as Dwyka Group tillite, and it was necessary to verify these anomalies, investigate their source, and to verify the geological mapping of the area in question.

Progress
The regional nickel and chromium anomalies were found to be well-defined, to have a NW–SE trend and to cover an area of approximately 1 000 km^2. Three main Ni-Cr anomalies were delineated.

Three main rock groups were sampled in the study area. Olivine gabbros consisting of olivine, orthopyroxene, clinopyroxene, plagioclase, mica and opaque minerals have anomalous concentrations of Cr, Co and Ni. The second group of rocks mainly fall into the dolerite-gabbro range and consist of clinopyroxene, plagioclase, minor olivine and opaque minerals. The third group consists of andesite, fine-grained quartz diorite, shale and tuff. The three groups of rock types are easily distinguished from one another on the basis of their SiO_2–Fe_2O_3–MgO ternary plot, and cluster in three distinct areas.

The weathering profiles of the mafic and ultramafic rocks are characterised by the formation of calcrete nodules. It was therefore easy to distinguish between areas underlain by Dwyka tillite and those underlain by the mafic and ultramafic rocks.

The negative radiometric total-count anomalies reflect the non-radiometric mafic-ultramafic rocks well. Negative anomalies correspond with the Loogkolk, Boomrivier and Drieboomlaagte anomalies. They also indicate the dolerite sheets very well, and correlate with the dolerite outcrops shown on the geological map.

Two geological models are suggested. The first model suggests that three separate complexes are mostly covered by Karoo Supergroup sediments, in particular Dwyka tillite, and are exposed in an erosional window.

A second model suggests one large mafic to ultramafic complex underlying the Dwyka tillite, implying that the complex is only locally exposed in the three areas at Loogkolk, Boomrivier and Drieboomlaagte, the remainder being covered.

Future activities
Follow-up by drilling and auger to determine the full economic potential of the Boomrivier, Drieboomlaagte and Loogkolk complexes will be motivated and referred to the DME.

Exposure of the olivine gabbro on the farm Drieboomlaagte in a borrow pit.

GEOPHYSICS

Data Collection, Processing and Curation

0174
PHYSICAL PROPERTIES DATABASE: RESEARCH ON SELECTED PHYSICAL PROPERTIES

Project leader: L.P. Maré, M.Sc.
Project team: L.R. Tabane, D. Kruger, L. Loots, B.Sc.Hons, M. Groenewald, B.Sc.Hons, S. Tucker, Dip.S.B.M.
Primary objective: *to continue with sample collection and expansion of the GEODE database.*
Duration: Ongoing.
Budget: Total: R40 464; 2007/8: R11 910.

Motivation
The South African Geophysical Atlas, Volume IV, Physical Properties of South African Rocks, is a compilation of physical properties of South African rocks. The publication provides geoscientists with a quick reference to physical property information, as well as a comprehensive set of source references. This project supplies data to expand on the atlas.

Progress
During 2007/8, physical-property analyses, including bulk density, magnetic susceptibility, intensity of magnetisation, magnetic remanence, electrical resistivity, induced polarisation and seismic velocity were carried out on rocks from various South African stratigraphic units, including dolerite dykes from the Archaean, the Kraaipan greenstones and the Schiel Complex.

Core from a 1 200-m-deep borehole in the Weltevreden area was obtained from the National Core Library for physical property analysis, which included samples from the Klipriviersberg Group of the Ventersdorp Supergroup, the Black Reef Formation, and several formations from the Chuniespoort and Pretoria Groups of the Transvaal Supergroup. The data collected by the Physical Properties Laboratory have been verified and added to the GEODE database.

Palaeomagnetic data from several publications were collated and will be entered into the GEODE database. These data cover the Neoarchaean Ventersdorp and Pongola Supergroups, the Dwyka Group, mafic dykes from the eastern Bushveld Complex and post-Waterberg Group dolerites.

Conclusion
This ongoing project continues and will cover as many stratigraphic units as possible.

Future activities
During 2008/9 the facilities of the National Core Library will be explored more extensively to speed up the efforts to expand the database until it contains all the physical-property information of all the stratigraphic units known in South Africa.

0960
HIGH-RESOLUTION MAGNETIC- AND RADIOMETRIC-DATA ACQUISITION FOR THE RUSTENBURG–ZEERUST REGION

Project leader: D.G. Eberle, Ph.D.
Project team: J. Cole, M.Sc., M. Havenga, B.Sc.Hons, P.K. Nyabeze, M.Sc., R.L. Legotlo, Nat.Dip., A. Graham, Nat.Cert.(IT).
Primary objective: *to acquire geophysical data and create a mineral potential map.*
Duration: 2007/8.
Budget: R3 712 553.

Motivation
This project is part of a greater effort to map the entire country using airborne high-resolution–high-density total magnetic intensity and natural gamma-radiation data, in order to produce magnetic, digital terrain model, exposure rate (total count), potassium, thorium and uranium datasets. These datasets will form a basis for further geological mapping, mine-

ral, groundwater and hydrocarbon exploration, and environmental and land-use projects. They support other projects in the CGS, as well as vital sectors of the earth-science industry.

Progress
Data were acquired for the area covered by seventeen 1:50 000-scale map sheets in the Rustenburg–Zeerust area during the year and, to complete the data coverage, the parts of the areas covered by another ten sheets were investigated. Reports on the data have also been completed, and maps have been produced. The areas covered are 2427BC, 2427CD, 2427DA, 2525BB, 2525CC, 2526AA to 2526AD, 2526BA, 2526BC, 2527AB, 2527AD, and 2527CA to 2527CD. Sheets partially investigated are 2525BD, 2525DA, 2525DB, 2526BB, 2526BD, 2526CA, 2526CB, 2526CD, 2527AA and 2527AC.

Evaluation work including a geophysical ground survey commenced in the Dwarsberge–Witfonteinrant area, due north of the Rustenburg–Zeerust region, where Cr-Ni-Co-Cu anomalies were recently identified by the CGS. The report describing the outcome of this ground follow-up has been completed.

The data showed a set of magnetic bands correlating with units within the Chuniespoort and Pretoria Groups, heavily truncated and distorted by a massive NW–SE-trending dyke swarm which produced a region of considerable fractionation that may have been exploited by ascending fluids.

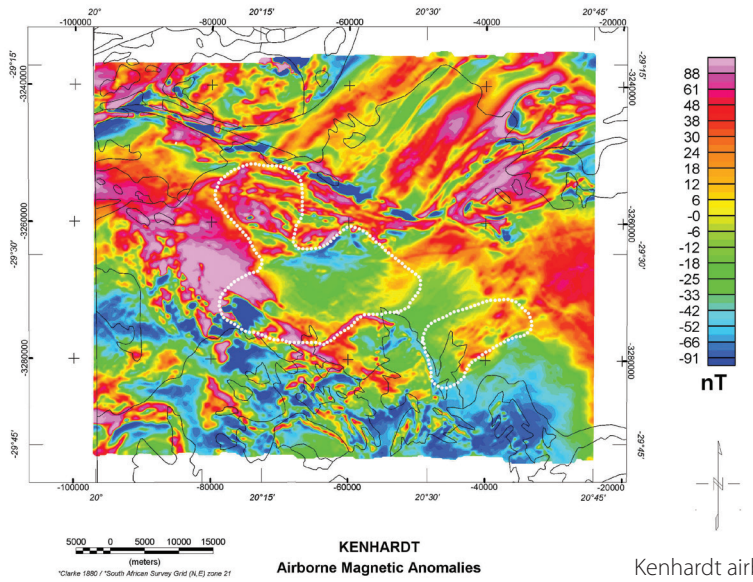
Conclusion
The data will be used in mineral-exploration and groundwater-targeting projects, as well as small-scale-mining projects. This programme has been found to constitute a critical part of the CGS statutory work.

Future activities
The remaining portions of the country that have not been geophysically mapped at this resolution will be covered, with priority given to selected areas. To facilitate the use of the data for commercial enterprises, SMEs or communal small-scale-mining organisations, the data will be evaluated to a point where an estimate of the mineral potential of each area can be supplied.

0961
HIGH-DENSITY MAGNETIC- AND RADIOMETRIC-DATA ACQUISITION OVER THE KENHARDT Cr-Ni-Cu ANOMALY

Project leader: D.G. Eberle, Ph.D.
Project team: J. Cole, M.Sc., M. Havenga, B.Sc.Hons, P.K. Nyabeze, M.Sc., R.L. Legotlo, Nat.Dip., A. Graham, Nat.Cert.(IT).
Primary objective: *to acquire geophysical coverages and create a mineral-potential map.*
Duration: 2007/8.
Budget: R805 636.

Motivation
This project is part of a programme to cover the whole country with airborne high-resolution total magnetic intensity and gamma-radiation data, producing magnetic, exposure rate (total count), potassium, thorium and uranium datasets. These datasets will form a basis for further geological mapping, as well as mineral-, groundwater- and hydrocarbon-exploration, and environmental and land-use projects. This project supports other CGS research projects, as well as vital sectors of the earth-science industry.



Kenhardt airborne magnetic data with areas of Cr-Ni-Co-Cu anomalies outlined with white dots.

Progress
In the Kenhardt–Pofadder region, areas covered by the five 1:50 000-scale map sheets 2920AD, 2920BC, 2920DA, 2920CA and 2920CB were flown. As sheet 2920AC had previously been flown, the area with occurrences of geochemical anomalies is completely covered. Reports on the data have been completed, and maps have been produced.

In order to add value to the airborne geophysical data and to derive new information, evaluation work including a ground survey was carried out. A report describing the outcome of this ground follow-up has been completed.

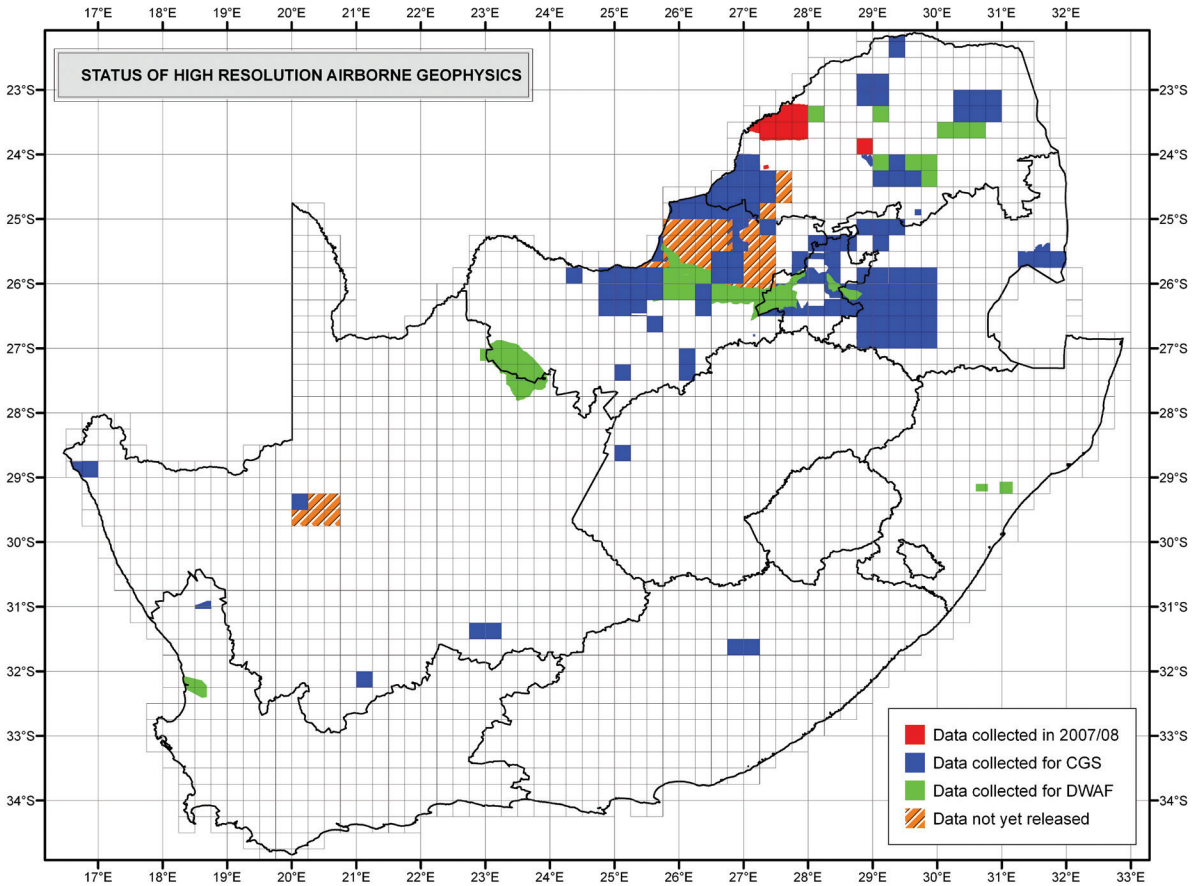
Conclusion
The assessment of the airborne and ground geophysical data has so far not identified the source of the Cr-Ni-Cu anomalies occurring in the area under consideration. It would appear that further ground-based geophysical research, in particular gravity data collection, is necessary to check on a shallow non-magnetic mafic intrusion that could be the source of the geochemical anomalies. A target area, 10 km in diameter, with promising magnetic, gravity and structural features was delineated.

All the data are accessible to stakeholders of the CGS for mineral-exploration, groundwater-targeting and small-scale-mining projects.

Future activities
The remaining parts of the country that have not been geophysically mapped at a high resolution will be investigated, with priority given to selected areas. To facilitate the use of the data for commercial enterprises, SMEs or communal small-scale-mining organisations the data will be evaluated after acquisition to such an extent that an estimate of the mineral potential of flown areas can be given.

0673
AIRBORNE HIGH-DENSITY GEOPHYSICAL SURVEYS

Project leader: D.G. Eberle, Ph.D.
Project team: J. Cole, M.Sc., P. Cole, M.Sc., M. Havenga, B.Sc.Hons, P.K. Nyabeze, M.Sc., A. Graham, Nat.Cert. (IT).
Primary objective: *to acquire high-resolution geophysical data.*
Duration: Ongoing.
Budget: Total: R8 445 072; 2007/8: R1 200 000.



Motivation
This project involves the acquistion of total magnetic field and natural gamma radiation intensities, and the production of magnetic, digital terrain model, exposure rate (total count), potassium, thorium and uranium datasets. These datasets are inexpensive to acquire, and contribute significantly to geological mapping, to mineral, groundwater and hydrocarbon exploration, and to environmental and land-use projects. They support other projects in the CGS as well as important sectors of the earth-science industry.

Progress
The whole of the area covered by 1:50 000-scale sheet 2328DD Limburg was surveyed as part of the statutory work for the year.

The areas covered by sheets 2327AD Stockpoort, 2327BC Limpopodraai and 2327BD Kromhoek, and parts of sheets 2327CA Hardekraaltjie, 2327CB Steenbokpan, 2327DA Ellisras and 2327DB Grootfontein were surveyed for the Coaltech project. As the project allowed full use of this dataset by the CGS, the data for these sheets were added to the statutory survey project.

Reports on the data have also been completed, and maps have been produced.

Conclusion
The airborne surveying and processing have been successful. The data will be used in mapping, exploration and groundwater-targeting projects, as well as small-scale-mining projects. This programme has proved itself to be a critical part of the CGS statutory work.

Future activities
The remaining parts of the country for which geophysical data at this resolution are not available will be covered in coming years, priority being given to areas of specific interest.

0679
UPKEEP AND DEVELOPMENT OF GEOPHYSICAL DATABASES: MAINTAIN AND EXPAND GEOPHYSICAL DATABASES, INCLUDING GIS COVERAGES

Project leader:	M. Havenga, B.Sc.Hons.
Project team:	P. Cole, M.Sc., J. Cole, M.Sc., H.L. Vilakazi, B.Sc., R.H. Stettler, Nat.H.Dip., A. Graham, Nat.Cert. (IT).
Primary objective:	*to maintain and expand geophysical databases, including GIS coverages.*
Duration:	Ongoing.
Budget:	R6 000.

Motivation
The Geophysics Unit has a large database which must be efficiently managed. This involves ensuring that the database is backed up and is made available to stakeholders so as to improve efficiency and productivity.

Progress
During 2007/8 the unit embarked on the task of capturing all geophysical publications and reports produced by the CGS, as most of the publications already in the database were produced after 1989. A student was instructed to scan all geophysical publications produced by the CGS. In total 700 publications and reports were identified and 643 of these have now been scanned. These reports and publications are in the process of being captured into the database.

A search was launched for all the deep seismic-reflection data recorded by the unit. The data were found to be in unweildy formats, and were converted to usable formats. ArcGIS 'shape' files were created to aid in locating data lines. Available reports related to the seismic surveys, such as observer notes and processing reports, were scanned to pdf-format files. This process was completed and the data captured into the database.

In addition to the reports, publications and seismic data, high-resolution statutory and commercial airborne data, re-levelled regional magnetic and gravity data, LANDSAT 7 data, raw geophysical data and scanned topographic maps were also added to the database.

Conclusion
The database has helped the unit perform certain tasks faster and much more efficiently, as it enables any employee to locate a dataset immediately from their computer. Searches for old 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
This is an ongoing project and new data will be added to the database as they are collected; the interface will be continuously updated to suit the needs of users.

Geophysical Interpretation

0987
PALAEOMAGNETIC STUDY OF THE PRECAMBRIAN MAFIC DYKES OF MPUMALANGA

Project leader: L.P. Maré, M.Sc.
Project team: L.R. Tabane, D. Kruger, F. Roelofse, B.Sc.Hons.
Primary objective: *to investigate the palaeomagnetism, geochemistry and petrography of NW-trending mafic dykes in Mpumalanga.*
Duration: Ongoing.
Budget: Total: R34 228; 2007/8: R5 088.

Motivation
The aim of this study is to determine the palaeomagnetic pole positions for the different dyke trends in the Mpumalanga Province. The successful calculation of these pole positions could provide essential information regarding the mantle evolution during the Proterozoic and the possible source of the dyke-swarm magma.

Progress
During the year 262 borehole cores from 24 dykes were sampled, bringing the total number of NW-trending dykes in this study to 28. The whole-rock compositional data demonstrate that the rocks are dominantly medium-potassic within-plate ocean-island basalts, with compositions typical of active continental margins. In this study the dykes were visually grouped into four general strike directions before the data were scrutinised. The palaeomagnetic results from the current study are in general poorly defined. These disappointing results can probably be ascribed to the extensive chemical alteration that was observed petrographically and that has destroyed, to varying extents, the primary magnetisation directions. This situation, however, correlates with findings of previous palaeomagnetic studies in the area.

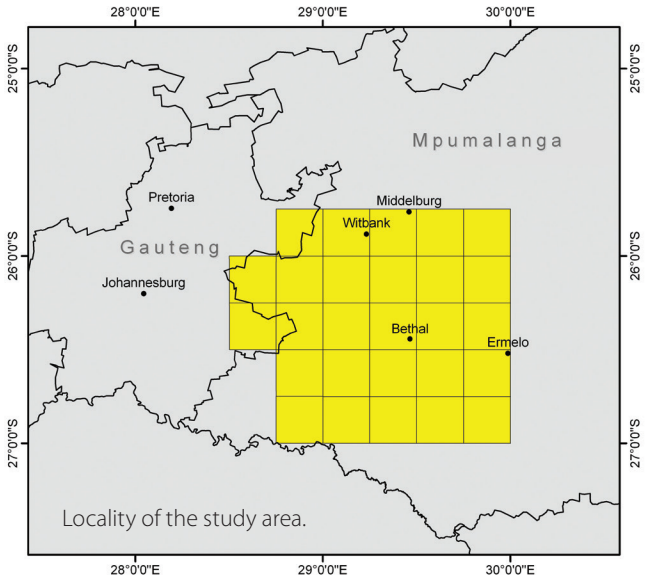
Conclusion
The extensive alteration and remagnetisation of the NW-trending dykes do not allow for the calculation of a reliable palaeopole for the northwest-trending dykes at this stage. There is, however, an indication from one of the groups that a primary pole direction might still be obtainable with an increased number of samples.

Future activities
During 2008/9 the younger NE-trending dykes in the same study area will be sampled and palaeomagnetically analysed. It is hoped that these dykes, which are more magnetic and are presumed to be younger than 2.05 Ga, will produce a primary magnetisation direction. Additional NW-trending dykes will also be sampled in an attempt to increase the accuracy of the calculated results from the current study.

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 produce a map of and report on the southeastern limb of the Bushveld Complex, including an interpretation of airborne magnetic and radiometric data, and to determine its geometry.*
Duration: 2006/07 to 2010/11.
Budget: 2007/8: R2 100.

Motivation
The Bushveld Complex is of immense economic importance to South Africa. Until now the western, eastern and northern lobes of the Complex have been extensively studied and mined. Most of the southeastern limb of the Complex is covered by Karoo Supergroup strata and, as a result, only limited work has been carried out in this area. Regional aeromagnetic and gravity data have been interpreted by the unit, but high-resolution airborne geophysical data that were collected in the Bethal area have still to be studied.



Progress

During the 1970s Buchanan studied borehole cores drilled into the gravity anomaly associated with this limb. He identified five petrographic zones, four of which he correlated with the Upper and Lower Zones of the complex. He interpreted the apparent absence of the Critical and Main Zones in the Bethal area as evidence that these rocks represent an injection centre separate from the main Bushveld basin. In 2005, Kruger suggested that the Upper Zone of the Bushveld Complex intruded from the southern lobe.

Magnetic modelling along one of the flight lines extracted from the high-resolution data, and focusing on an area well constrained by borehole information, showed the complexity involved in this process. Models were created to test different possibilities and gave some interesting results. It quickly became apparent that the data required a body with strong remanent magnetisation to be present in this area in order to fit the calculated field to the predominantly negative observed anomaly. For the mafic and ultramafic rocks of the Bushveld Complex, extensive palaeomagnetic work has shown the rocks of the Main Zone to be strongly remanently magnetised, with the magnetisation direction reversed with respect to the current magnetic field. The magnetisation direction for the Upper Zone in the western and eastern Bushveld Complex is normal, but in the northern Bushveld Complex it was reported to be remanently magnetised with a reversed magnetisation direction. Applying only the remanent magnetisation parameters from the different lobes to the igneous material did not give good results.

It must therefore be concluded that in order to obtain a good fit between the observed and calculated magnetic field in this area, magnetic bodies with normal magnetisation, as well as bodies with reversed magnetisation, must be included in the model. Various models were created to test this and these have important implications. If palaeomagnetic work on the borehole cores that constrain these models shows that the mafic rocks have only normal magnetisation directions, a second magnetic body must be present underneath the Bushveld rocks. A model was created including such a body, and good results were obtained when the magnetisation parameters of the Lower Witwatersrand shales were assigned to this body. On the other hand, it is possible that a geomagnetic reversal occurred during the emplacement of the Bushveld rocks.

Conclusion

Studying magnetic data collected over the Bushveld Complex is more complex than just examining the magnetic susceptibilities of the different units. Remanent magnetisation parameters are fundamentally important to the interpretation and modelling of magnetic data.

Future activities

The core from boreholes drilled in the Bethal area are stored in the National Core Library, and will be subjected to thorough physical-property analysis and palaeomagnetic investigation. This information will be used to create two-dimensional models along a number of profiles extracted along flight lines; these will then be used as a basis for three-dimensional modelling.

0938

3-D MODEL OF AN AREA AROUND VENETIA MINE USING GEOPHYSICS, GEOCHEMISTRY, GEOLOGY AND REMOTE SENSING

Project leader:	M. Havenga, B.Sc.Hons.
Primary objective:	*to determine the relationship between the various linear features seen in the magnetic data around the Venetia diamond mine and kimberlites, and to determine whether a relationship exists between these lineaments and the fairly large number of plug-like bodies occurring near Venetia.*
Duration:	2006/7 to 2008/9.
Budget:	Total: R29 433; 2007/8: R23 735.

Motivation

Much research has been carried out on the Venetia diamond mine. High-resolution aeromagnetic and radiometric data were collected over the map areas 2229AB and AD covering Venetia and extending north to the border. This presents

an ideal opportunity to interpret the airborne data with the aim to elucidating the structure of the larger area. A better understanding of the structure of the area will add to the knowledge base of the Limpopo Mobile Belt which could also aid the local community in finding groundwater, as this is an arid area.

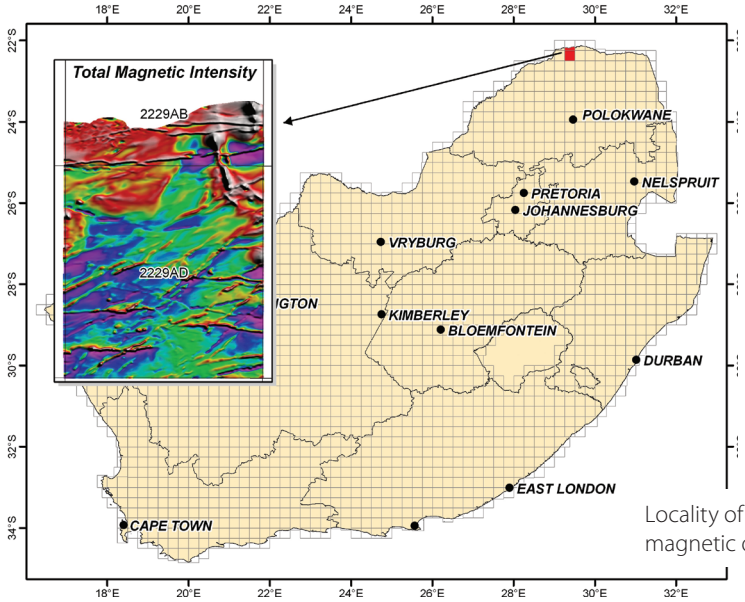
Progress

High-resolution aeromagnetic data collected over a portion of the Central Zone of the Limpopo Mobile Belt were interpreted, and revealed many linear anomalies. Many of the lineaments were interpreted to be dykes, but they could be magnetised faults. The anomalies are related to structural deformation and show many features that are not mapped.

In the Venetia area three lineament trends were identified, namely E–W, SW–NE and approximately WSW–ENE. Previous workers noted that many of the kimberlites in the area have a NW trend, but the three trend directions identified from the magnetic data also appear to influence the emplacement of the kimberlites. Most of the interpreted lineaments (possible dykes, magnetised faults and remanently magnetised dykes) follow the NE and E–W trends. These seem to be older than the faults inferred from the magnetic data, as they are all (or mostly) displaced by the inferred faults. A possible shear zone, visible in the magnetic data, is dotted with plug-like bodies and runs directly over the Venetia cluster of kimberlites. It follows a SSE trend and may be part of a shear zone noted on the farm Gotha, south of Venetia, by other authors.

Conclusion

The geological maping and geophysical data are not contradictory, but the geophysical data provides additional information on the structural and geological features of the Venetia area. This additional information can be used to elucidate the relationships between the dyke-like features, the faults, the plug-like bodies and the emplacement of the Venetia kimberlite cluster. There is also the possibility that the large shear zone running through Venetia may be an important role player in the emplacement of the kimberlite cluster.



Locality of the study area with the high-resolution airborne magnetic data collected over the area shown in the insert.

Future activities

A paper has been submitted for publication in a peer-reviewed journal, and another, written in collaboration with staff of the University of Johannesburg and the University of the Witwatersrand, is planned for 2008/9.

New Technologies

0939

THE THEORY, INSTRUMENTATION AND INTERPRETATION METHODS OF POLARISATION PROCESSES (MPP AND SEKM) AND THE INFLUENCE OF MEMBRANE-INDUCED POLARISATION (IP) ON OTHER ELECTROMAGNETIC METHODS

Project leader:	V. Hallbauer-Zadorozhnaya, Ph.D.
Project team:	L.P. Maré, M.Sc., O.W. Dingoko, B.Sc.Hons, L.R. Tabane, D. Kruger.
Primary objective:	*to develop the theory, instrumentation and interpretation of the IP method applied to surface measurements and physical modelling of rock.*
Duration:	2007/8 to 2010/11.
Budget:	Total: R48 867; 2007/8: R11 500.

Motivation
This project stems from a need to develop the theory, instrumentation and interpretation methods of polarisation processes (MPP and SEKM) and to study the influence of membrane IP on the other electromagnetic methods, namely resistivity, time domain, frequency domain and audio magnetotelluric.

Membrane polarisation occurs in all types of sediments containing pores of different sizes (with different transfer numbers). This project is intended to develop the theory of membrane polarisation occurring in rocks owing to applied electrical current during switch-on and switch-off time for different models of pore shape.

Progress
Algorithms for calculating the electrolyte distribution along pores at switch-on and switch-off times were proposed, and software was developed using the technical computing language Matlab®. It was shown that the resistivity of sediments depends on the type of applied current: low-frequency current caused blocked pores during a certain period of time, and the resistivity of sediments depends on the amount of open pores at a fixed time. If the current frequency is high, the resistivity of sediments can be calculated as electrical circuits containing resistors and capacitors.

During 2007/8 the work concentrated on developing algorithms for the calculation of the potential difference arising between the ends of rock sample/s during laboratory measurements. Programs for calculating the potential difference at switch-on and switch-off times were written in Matlab. Both programs contain several subroutines intended to calculate different mathematical problems.

The calculating programs are complete and qualitatively show the same phenomena as obtained by laboratory measurements, namely:
1. IP processes at switch-on and switch-off times are the same.
2. There is a linear dependence between applied electrical current and IP amplitude.
3. Two processes influence the measured resistivity.
4. There is an excess of concentration of ions at the contacts between pores.
5. There is a series of permanently decreasing number of non-blocked channels and consequently reducing paths for flowing electrical current.

At present the software programs are prepared for analysing and interpreting data measured in the laboratory.

Conclusion
A theoretical model of membrane polarisation at switch-on and switch-off times showed that the IP processes for the switch-on case can be described by the homogeneous diffusion equation with specified linear boundary conditions. In the switch-off case the process of concentration distribution can be described by the inhomogeneous diffusion equation with specified initial conditions and ions' exchange coefficients describing the boundary conditions. It was also shown that polarisation occurs in all types of rocks if the surface areas and transfer numbers are different for connected pores. The duration of the polarisation process depends mainly on pore radii of connected capillaries, transfer numbers, and the amplitude of the applied electrical current. The amplitude of potential difference depends on many parameters that are constant for solutions filling pore spaces. During the polarisation process some contacts between pores of different transfer numbers will be blocked and the electrical current will flow through the remaining channels. Excess or loss of concentration occurring at the boundary between pores of different size and transfer number influences the measured resistivity. The blockage of pore channels and excess/loss of ions both control the electrical resistivity of sediments. It is foreseen that this model will be used in the interpretation of induced polarisation data and laboratory measurements of petrophysical properties of sediments.

Future activities
IP — develop the theory for interlacing pores, improve the algorithm for the interpretation of physical modelling and field data, test this algorithm for laboratory measurements and for field data;
Study the influence of membrane polarisation on other electromagnetic methods: time domain, frequency domain, audio magnetotelluric, vertical electrical sounding;
SEKM — more testing in the field in different hydrogeological conditions;

0896
AIRBORNE TIME-DOMAIN ELECTROMAGNETIC SYSTEMS

Project leader:	D.G. Eberle, Ph.D.
Project team:	V. Hallbauer-Zadorozhnaya, Ph.D., P. Cole, M.Sc., P.K. Nyabeze, M.Sc.
Primary objective:	*to install and test equipment.*
Duration:	Ongoing.
Budget:	Total: R887 162; 2007/8: R10 600.

Motivation
The new airborne electromagnetic system (AEM) will be applied to geological mapping, mineral exploration, alluvial diamond exploration, groundwater investigations, and environmental and engineering projects. AEM exploration methods constitute a wide field, with advances being made continuously by international researchers.

The Geophysics Unit is in the process of implementing an AEM platform. To this extent a company in Russia (ELTA-GEO) was appointed to develop the equipment and install it on the aircraft. Once this will have been achieved, testing will ensue.

Progress
ELTA-GEO has completed much of the development of the equipment and are awaiting an opportunity to complete the installation. However, the aircraft has not been available for installation and testing during the past year.

Tenders for preparatory modifications of the aircraft, which have to comply with civil-aviation regulations, were published during the year and a sucessful tender was accepted.

Conclusion
The project is awaiting the availability of the Cessna Grand Caravan 208B which is scheduled for August/September 2008. Once it is available, the project will continue with the mounting of the AEM system.

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

0962
CONVERSION OF DOS PROGRAMS TO WINDOWS PROGRAMS

Project leader: O.W. Dingoko, B.Sc.Hons.
Primary objective: *to rewrite computer programs using object-oriented computer languages, so that they will run on Windows XP and Vista operating systems.*
Duration: 2007/8.
Budget: R2 100.

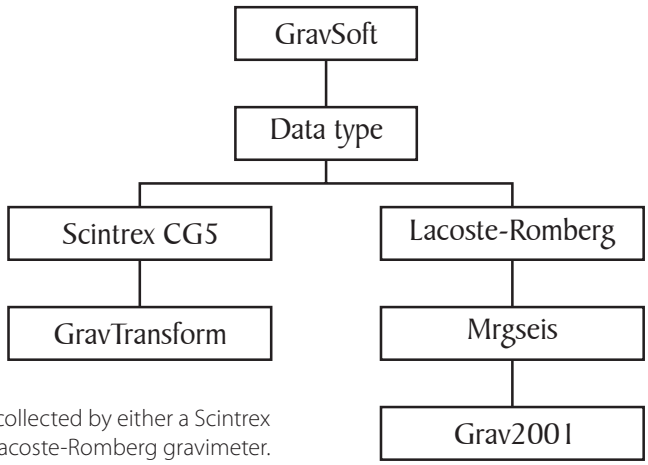
Motivation
Command-prompt-activated programs are not user-friendly. Some of these programs are not portable and this hinders cooperation between team workers. A major reason for this is incompatibility between modern operating systems. Programs that need to be redeveloped include gravity-processing programs, datums and projection programs, electromagnetic data-processing programs, as well as general processing software for efficient quality control on data.

Progress
The initial step of the project was identifying programs which needed to be upgraded. This required investigation of old data-processing software owned by the unit. It was found that these programs were written largely in FORTRAN.

The work done covered different fields of Geophysics, including gravity and electromagnetics, as well as fields such as map projections.

Ground-based gravity data had been processed using a spreadsheet program. The user entered data and then applied corrections to obtain the Bouguer anomaly values. A windows program would replace the spreadsheet. Having no manual data input, this program would be easy to use. The GravSoft program was designed for this purpose.

The Reproj program was developed to perform coordinate transformations in the field without the need for commercial software. This program was developed using computer codes from MADTRAN.



The GravSoft flow chart. This software processes data collected by either a Scintrex CG5 gravimeter or a Lacoste-Romberg gravimeter.

The SYSMIN program is used on airborne data and was designed for the following reasons:

- to break out of the unnecessary routine involved in processing airborne data
- to save time on QC processing and data formatting.

FORTAN programs for processing time-domain electromagnetic data were converted into windows applications. The Strauss program, originally written in FORTRAN, calculates the IP effect in time-domain electromagnetic data. The data is collected by a system consisting of a square transmitter loop and a circular receiver loop. The procedure uses a geological model with *n* polarising layers and the eddy currents induced in each layer are computed by assuming each layer is a conductive plane.

Conclusion
It has been observed that old command-prompt software is still being used. These programs, mainly written in FORTRAN, are used to process gravity data, electromagnetic data and airborne geophysical data. These were redeveloped using the Visual Basic.NET language, resulting in easy-to-use portable software with graphic user interfaces.

Education Thrust

0905
DEVELOPMENT AND TRAINING AT GEOPHYSICAL TEST SITE

Project leader:	R.H. Stettler, Nat.H.Dipl.
Project team:	L. Loots, B.Sc.Hons, P.K. Nyabeze, M.Sc.
Primary objective:	*to continue with the development of the test site and training.*
Duration:	Ongoing.
Budget:	Total: R168 350; 2007/8: R52 500.

Motivation
The purpose of this ongoing project is to develop an environmental test site, where instrument responses over known buried objects can be evaluated. Instruments can be tested and different instruments can be compared. The site will also be ideal for training young scientists, technicians and students.

Progress
A number of geophysical surveys were conducted over the test site with the main objective to further test the effectiveness of the site. The following surveys were conducted:

Frequency-domain electromagnetic surveys were conducted along 19 lines using a Geonics EM34-3. The line and station spacing was 1 m and the direction of the profiles was from south to north. The data were very noisy and hardly any distinction could be made between noise and the buried artifacts. The conclusion was that the EM34 is unsuited to the current design of the test site.

Six lines of frequency-domain electromagnetics using the Geonics EM31 instrument were completed, but again no real distinction could be made between noise and the artifacts with a line and station spacing of one metre. It was concluded that the EM31 is unsuited to the current design of the test site.

A Geonics magnetometer with gradiometer attachment was used to survey the area at a line and station spacing of one metre. Circular anomalies coinciding with the shallowly buried artifacts (1 m) showed up very well on the gradiometer map, but the deeper artifacts buried at two metres were not very well defined.

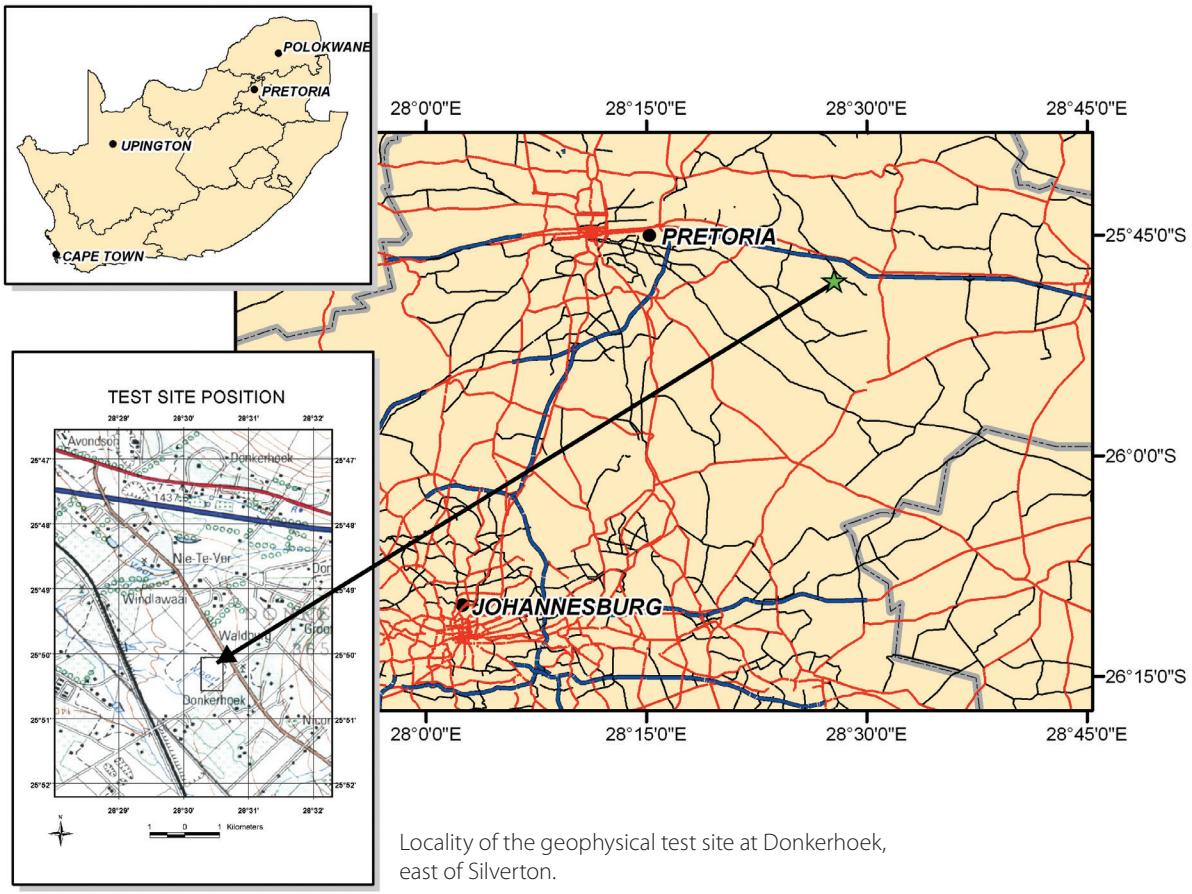
Four lines of resistivity surveying using an Abem Lund multichannel resistivity metre were carried out over the buried artifacts. Once again the results are inconclusive because of noise and effects of the clay.

A gravity survey over the site was started, but only two profiles were completed. Unfortunately they were done over an area containing no artifacts. More profiles will have to be done at a later stage to get a better indication of how successful the gravity method is.

Conclusion
Although the magnetic data had positive results over magnetic containers, most of the results of the methods proved inconclusive. There are a few explanations for this. The current design may be unsuited to the equipment in use by the CGS. In light of this, possible modifications may be made to enable greater success in the future. Alternatively, the size and depth of the objects may not be conducive to easy detection. Further testing and modelling will be required.

Future activities

In light of the negative results it was decided that an effective alternative would be to establish additional test sites, or a reference of possible test sites, that have known geological features, such as faults, dykes and sinkholes, in order to test instruments and provide the necessary training for students, young scientists and technicians. The viability of this possibility will be investigated.

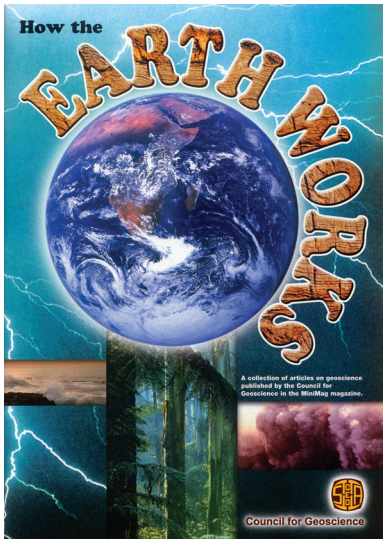


Locality of the geophysical test site at Donkerhoek, east of Silverton.

INFORMATION AND COLLECTIONS MANAGEMENT

Education and Information

The CGS houses large collections of reports and documents on the geology and mineral resources of South Africa as well as the African continent. These include unpublished reports sourced from mining companies, universities, government bodies and from programmes initiated by the CGS. Documents collected since 1895 are still available and are used regularly by the public. In addition, the Library holds valuable old publications including maps of South Africa and other African countries. These valuable collections are frequently accessed by mining and exploration companies, as well as the general public.



A series of articles for a popular children's magazine, MiniMag, has been running for a number of years and is continuing. These are series of a geoscientific nature, aiming to stimulate the interest of the readers, mainly primary school children, in the earth sciences. Staff of the ICM and other units contribute to this publication. A booklet, 'How the Earth Works' is compiled regularly from the CGS's contributions to MiniMag, and expands with each contribution. This volume is a very informative hand-out to children at CGS educational exhibitions, and is useful material for geography teachers in many schools.

0374
SOUTH AFRICAN GEOLOGICAL LITERATURE DATABASE (SAGEOLIT)

Project leader: R.R.M. Price, B.Sc.Hons.
Project team: M.M. Janse van Rensburg.
Primary objective: *to maintain and develop the SAGEOLIT database, ensuring access by the general public by means of the internet, and by SADC countries by means of CDs.*
Duration: Ongoing.

Motivation
SAGEOLIT was initiated in the 1980s as a main-frame-based database, and was migrated to GEODE to form part of the CGS's corporate modular database. It incorporates the Map Library database, and lists reports and plans of the CGS, as well as other unpublished reports and plans. Accuracy, consistancy and high standards of presentation are maintained.

One function of SAGEOLIT, i.e. allocation of internal report numbers, is carried out by the 'Interim Reports' table, which lists all report numbers allocated. Once a report has been received, the report details are transferred to SAGEOLIT. This ensures that numbers are not duplicated, and assists in assessment of report completion status. SAGEOLIT lists unpublished collections of the CGS, as well as others, such as the Goldfields of South Africa collection, the Soekor collection, and the STK collection.

Progress
Abstracts and maps are added continuously by a data-capture typist and a map librarian respectively, and plans are added whenever the possibility arises. Maps listed in the database are being scanned when needed, and the scanned TIFF images are stored on a central server. The scanned images are also stored on the map database, and over 4 000 scans have been recorded in SAGEOLIT. Internal reports are now required in digital format and are stored on a central server.

Non-confidential records from SAGEOLIT are downloaded to the Sabinet server monthly, allowing access by the Sabinet base. In terms of a new agreement with Sabinet, this information is supplied free of charge. These records are also added to an internet-accessible database regularly. The database can be accessed at http://196.33.85.17/geoinfo or www.geoscience.org.za l Information l Databases l Sageolit.

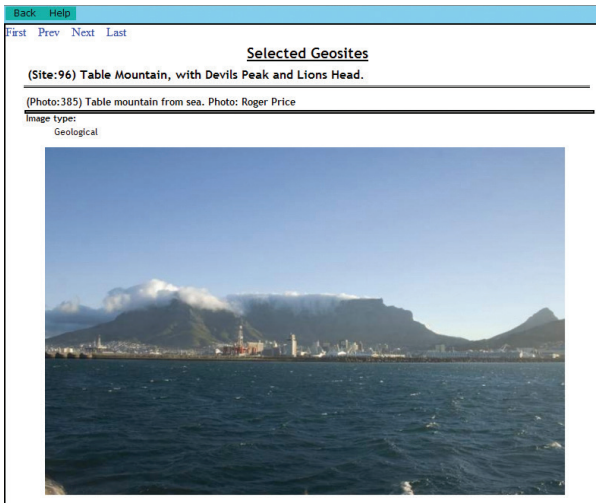
Links between SAGEOLIT records and the SACS database are stored in a SACS-links table, and similarly links between SAGEOLIT records and the cadastral database are stored in a Farms-links table. When manpower becomes available it will be possible to list aerial photographs in SAGEOLIT.

Future activities
This project is ongoing and activity will continue.

0912
GEOSITES

Project leader: D.J. Barnardo, M.Sc.
Project team: R.R.M. Price, B.Sc.Hons, A.J. Smit, B.Sc.Eng. (contract worker).
Primary objective: *to record sites of scientific and educational interest on an internet-based database, together with descriptions appropriate to readers of various interests and levels of education.*
Duration: Ongoing.
Budget: R20 000.

Motivation
The Geosites database aims to record geologically interesting sites in South Africa. Locality information is provided, making it easy for tourists to find the sites. The database is a collaborative project between the Conservation Committee of the GSSA and the CGS.



Progress
More than 90 such sites are currently captured into this database. However, other than the project team, only a few geologists have added records to the database. Sites chosen have been those visited by the project team in the course of duty or recreational activities, and information has been added according to availablity.

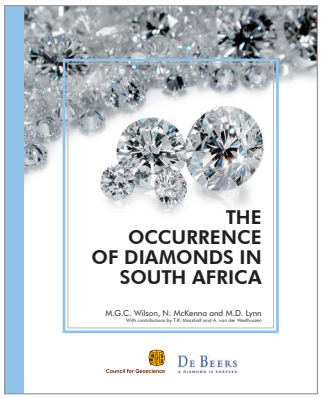
Conclusion
Activity on this project continues. The site can be seen at http://196.33.85.17/geoinfo or www.geoscience.org.za l Information l Databases l Geosites.

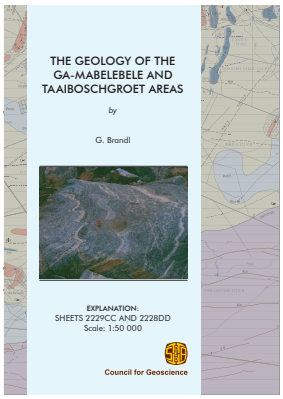
A page from the Geosites database.

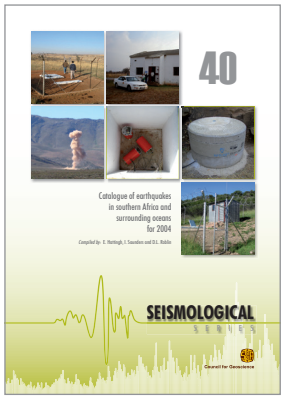
Publications

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:
Explanation of Metallogenic Sheet 2726 (1:250 000). The metallogeny of the Kroonstad region by Ward, J.H.W., Henry, G. and Oosterhuis, W.R.
Explanation of Sheet 2622 (1:250 000). The geology of the Morokweng area by Gabbrielli, F.
Explanation of Sheet 2818 (1:250 000). The geology of the Onseepkans area by Moen, H.F.G. and Toogood, D.J.
Explanation of Sheets 2229CC and 2228DD (Scale: 1:50 000). The geology of the Ga-Mabelebele and Taaiboschgroet areas by Brandl, G.
Explanation of Sheet 2626 (1:250 000). The Metallogeny of the West Rand area, by King, H.l., Pringle, I.C., Oosterhuis, W.R. and Ehlers, D.L.
Mineral Resources Series No. 1: The occurrence of diamonds in South Africa by Wilson, M.G.C., McKenna, N. and Lynn, M.D.
SACS: Catalogue of South African Lithostratigraphy Units, Volume 9 by Johnson, M.R.
SACS: Lithostratigraphy of the Langkrans Formation (Wolkberg Group). Lithostratigraphic Series No. 49 by Bosch, P.J.A.
Seismological Series 40: Catalogue of earthquakes in southern Africa and surrounding oceans for 2004 by Hattingh, E. Saunders, I. and Roblin, D.L.
The Geology of South Africa (Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. eds). Geological Society of South Africa, Johannesburg and Council for Geoscience, Pretoria, including the following chapters contributed wholly or partially by CGS staff:
Brandl, G., Cloete, M. and Anhaeusser, C.R., Archaean Greenstone Belts. pp. 9-56.
Eriksson, P.G., Altermann, W. and Hartzer, F.J. The Transvaal Supergroup and its precursors. pp. 237-260.
Johnson, M.R., Van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H. de V., Christie, A.D.M., Roberts, D.L. and Brandl, G. Sedimentary rocks of the Karoo Supergroup. pp. 461-499.







Partridge, T.C., Botha, G.A. and Haddon, I.G. Cenozoic deposits of the interior. pp. 585-604.
Roberts, D.L., Botha, G.A., Maud, R.R. and Pether, J. The coastal Cenozoic deposits. pp. 605-628.
Thamm, A.G. and Johnson, M.R. The Cape Supergroup. pp. 443-460.
Verwoerd, W.J. and De Beer, C.H. Cretaceous and Tertiary Igneous Events. pp. 573-583.
Annual Report of the Council for Geoscience for the year ended 31st March 2007.
Annual Technical Report of the Council for Geoscience for the year ended 31st March 2007.

The following CGS newsletters were published:

GEOClips Newsletter, 20, June 2007.
GEOClips Newsletter, 21, September 2007.
GEOClips Newsletter, 22, December 2007.
GEOClips Newsletter, 23, March 2008.

A list of maps released can be seen in the appendix.

Geoscience Museum

Project leader: A. Raath, Nat.Dip.
Project team: S. Mahwayi

The Geoscience Museum, situated in the Transvaal Museum Building in central Pretoria, has two large display halls. Over the past ten years older exhibitions, dating from the 1960s, have been replaced with new, more modern exhibitions.

With the limited resources and funds available, staff of the museum exhibit a selection of the 26 000 specimens in the best possible way. As the museum's artist is also responsible for much of the promotional material needed by the CGS and the Department of Minerals and Energy, as well as various educational activities, this is a slow process.

Exhibitions

Project leader: A. Raath, Nat.Dip.
Project team: M.K. Mohuba, A. Becker, H.Nat.Dip.

The O'okiep exhibition, which was officially opened during May of 2006, is nearing the end of its display period, currently planned as the end of June 2008. The entire research collection of Prof. Tom Clifford will, however, remain at the Geoscience Museum and will be available to interested scientists upon request.

South African Fossils Display

Project leader: A. Raath, Nat.Dip.
Project team: A. Becker, H.Nat.Dip., M.K. Mohuba, J. Neveling, Ph.D.

Preparation of the new fossil exhibition is progressing well, and an area has been stripped of its old showcases and prepared for the new exhibition. The initial scope of the project was changed somewhat after a visit to Dr Billy de Klerk at the Albany Museum, Grahamstown. Dr Billy de Klerk made his services available to the Museum during November 2007, and his comments and expert advice were extremely valuable. Due to unforeseen circumstances, the completion of the exhibition had to be moved to a later date.

Collections

Project leader: A. Raath, Nat.Dip.
Project team: M.K. Mohuba

During August 2006 a new database system had been installed, and M.K. Mohuba has transferred all the data from the old database to the new one. The new database has a field enabling images of each sample to be displayed. This will greatly enhance the functionality of the database and will assist with identifying specific samples for insurance purposes. There are numerous possibilities for use of the available data, especially in the educational activities of the Museum.

The selection of suitable samples for specific displays will also be made far easier, as it eliminates the need to physically trace possible samples in the mineral store in Silverton. However, the process of photographing all the specimens has proved to be very time-consuming, although a start has been made with specimens already on display.

It is proposed that in future all samples collected by geologists during field trips be donated to the Museum after completion of the project. This will ensure that the collection of rock samples will expand and will have the added benefit that samples will be available for viewing long after the completion of any given project.

The Systematic Mineralogy exhibition lacks specimens of nitrates, borates, tungstates and molybdates. Mineral dealers will be approached to source and possibly purchase some samples to enhance the display. No new mineral samples have been purchased to date, but possible replicas of fossils have been identified for purchase for the new Fossil Exhibition.

A donation of a variety of minerals was received from a member of the public. These minerals were unfortunately not properly catalogued, with only a few samples having known localities, and will therefore be used for educational purposes.

Collaboration with other institutions includes:

- Support for the MuseumPark and Tourism Forum initiatives.
- Attendance of the Tswaing Management Forum meetings.
- Collaboration with the Transvaal Museum.
- Collaboration with staff from the Geological Museum in Maputo, Mozambique.
- Input into the design and planning of exhibitions at the Tswaing Crater Museum.
- Investigation into possible collaborative projects with Gautrain Geolink Initiative.
- Advice on geological exhibitions to staff at the Kruger National Park, with the possibility of the project becoming part of a larger SANParks Project.
- Collaboration with staff of Freedom Park for the provision and information of suitable samples for a new Museum.

Visitor record for 2007/8:

	Adults	Children	Total
April 2007	1 496	2 026	3 522
May 2007	1 521	4 181	5 702
June 2007	1 105	1 371	2 476
July 2007	1 758	2 266	4 024
August 2007	1 928	4 657	6 585
September 2007	1 379	5 306	6 685
October 2007	1 082	1 916	2 998
November 2007	1 198	1 377	3 752
December 2007	1 879	1 688	3 567
January 2008	1 386	874	2 260
February 2008	858	810	1 668
March 2008	1 239	3 996	5 235
Totals	**16 829**	**30 468**	**47 297**

Visitor records are kept by the Transvaal Museum.

Maintenance

Project leader: A. Raath, Nat.Dip.
Project team: M.K. Mohuba, S. Mahwayi

All exhibitions in the Museum are routinely checked and upgraded when appropriate. The past year has seen a marked change in the appearance of the Museum offices. All the offices (except for the main storeroom) and two cloakrooms were refurbished. Wooden floors were sanded and re-sealed and all the offices and passages were re-painted. This project was time-consuming as the Museum staff had to move office a few times while the work was carried out.

Exhibitions and posters prepared by Museum artist:

15–17 May 2007: Bi-annual Council for Geoscience Open Day in Pretoria, for which 52 posters were created.
July : *AfricaArray* workshop
August: SUSTAIN
September: Australia
October: SAGA
November: Geosummit
2–5 March 2008: PDAC Trade Show and Expo, International Conference Centre, Toronto, Canada.

Education

Project leader: A. Raath, Nat.Dip.
Project team: S. Mahwayi

The previous education officer was transferred to the new Communications and Marketing Unit and another staff member is currently being trained as a museum guide. She will be responsible for guiding Grade R to Grade 3 children through the Museum, and for assisting with other educational programmes. The Museum is also receiving valuable input from the Transvaal Museum Education Department in this regard.

Upgrading of the current auditorium (Furnsteel Hall) to encompass an activity area has finally been completed not withstanding initial set-backs. Information leaflets regarding the various topics that can be presented, as well as the Holiday Programmes available at the Geoscience Museum, have been distributed to schools.

It is proposed that activities at the Geoscience Museum be marketed and advertised by the new Marketing Division. Discussions in that regard have already taken place.

General
Much time has been spent designing a website for the Geoscience Museum. A concept design with the required functionality was forwarded to the web designer for inclusion in the CGS web page. Unfortunately, this project has not been completed by the web designer and as yet, a Geoscience Museum website or link to such a website does not exist.

Delegates from the following international destinations officially visited the Geoscience Museum during the course of the year:

April: Ghana
July: Algeria
August: China
October: Poland.

Future activities
Work on the new South African fossils display for the Geoscience Museum is continuing. This will add considerably to the Museum exhibitions, which is aimed at informing and stimulating the public to take an interest in the geological diversity of the country.

Library and Information Centre (L&IC)

Chief librarian: L. van der Merwe, B.Inf.Hons.
Librarians: E. van Tonder, B.Inf., B.Sc., L. Breytenbach, Dipl.Lib., S. Makhafola, B.Tech., G. Makhubele, Dipl. Lib., Z. Nondudule, B.Inf.
Team: T. Swart, A. Msiza, M. Mokone, P. Chauke, M. Dikobe.

Introduction
The Library and Information Centre (L&IC) is South Africa's National Geological Library and is the most comprehensive Earth Science Library in Africa. The Library has over 17 000 books and 3 846 journal titles of which 337 are current subscription titles. Exchange agreements exist with 300 institutions both nationally and internationally, and a further 908 titles are received in this manner. The Library holds 2 601 journal titles which have been discontinued, and in some cases the Library is the sole source for these journals in the country. A collection of 15 000 other documents, including pamphlets (12 000), CDs (330) and videos, add to the variety of the collection.

The Map Division currently holds 16 500 sheet maps accommodated in hanging cabinets. A unique feature of this division is the database of maps published as part of books and journals. There are over 65 000 maps listed in the map database.

Functions
The functions of the L&IC of the CGS include the collection, maintenance and dissemination of information in various formats, to employees of the CGS and external clients, and the maintenance of the CGS collections of reports, plans, unpublished geological maps and borehole logs.

The Book Shop sells the CGS's publications and copies of reports and unpublished maps, as well as publications of the Geological Society of South Africa. The bookshop also distributes the annual reports of the CGS. The exchange lists of both the CGS and the Geological Society of South Africa are maintained, and copy services and base materials such as orthophoto maps, topographic maps and aerial photographs are provided.

The following statistics are indicative of the high demands made on the services of the L&IC:

Visitors	5 808
Enquiries received	4 617
Unpublished reports received from staff and other sources	846
Publications sold	1 994
Maps sold	2 492
Map sets sold	261
CD-ROMs sold	82
Publications donated	41
Publications of the Geological Society of South Africa sold	1 705
Aerial photographs issued	1 925
Orthophotos issued	24

Storage
During the year under review, the installation of high-density shelving for unpublished reports commenced. The Library facility is experiencing problems with regard to shelving capacity and old books are regularly weeded from the collection and transferred to the Library Extension, housed in the converted core shed directly behind the Library building. This project will be expanded to the old and unused journal series to alleviate the lack of shelving space.

Approval has been given for the upgrading of the entrance to the Bookshop and the public-reading facility so that it has a more modern appearance and so that browsing of publications by clients will be more accessible. The work will be carried out in the coming year.

Literature searches and information retrieval
There is an ever-growing demand for literature searches on a wide variety of topics using the various databases at the disposal of the L&IC staff. Literature searches are conducted on a daily basis and bibliographic reference lists supplied in printed or electronic format. The number of requests to supply bibliographic reference lists by e-mail is on the increase.

Current contents service
The current contents service continues to attract new external clients. This service arranges for pages of journal issues to be distributed in printed or electronic format. During 2007/8, 3 502 contents pages were supplied to clients as far away as

Uruguay. Contents pages supplied to CGS staff in Pretoria and to the regional offices amounted to 743 and 3 672 respectively. Requests for copies of articles by external institutions totalled 361, and 770 articles were supplied to the regional offices.

Online Library catalogue and databases
The extensive Library catalogue can be accessed via a sophisticated computer-based search facility on the CGS website, as well as a catalogue of published material, and catalogues of unpublished CGS, STK and Goldfields reports and other material.

E-journals
Access to full-text electronic journals or e-journals has also been made possible through the Library's subscription agent, a facility for the exclusive use of staff of the CGS.

During the year the Library subscribed to Elsevier ScienceDirect. The full-text access is restricted to the 31 titles to which the Library subscribes. Full-text backfiles were purchased back to 1995. The major advantage of ScienceDirect is that the regional offices have direct access via the internet. They can access, search and print their own articles with the allocation of a username and password. This also makes it possible for geologists in the field and from home, who may have internet access, to undertake literature searches.

Map services
The demand for maps and copies of maps from African countries in the Map Library collection continues. During 2007/8, 3 929 photocopies of maps were made.

The process of delivering the map in the format requested by the client has been refined and delivery time can now be within 24 hours. The delivery of scanned versions of maps by CD or DVD is the most popular amongst clients.

Loans and interlibrary loans
The Library remains an active member of Sabinet (the South African Bibliographic and Information Network) and is therefore also an active member of the interlibrary loan scheme. During 2007/8, the Library received 197 requests from other libraries, of which 124 were successfully completed with the provision of either loans or photocopies. Of these 110 were completed with the provision of photocopies of articles and 14 were book loans.

Collection development
Collection development is a continuous and labour-intensive process. It involves the receipt, accessioning and cataloguing of the publications. Collection development involves mainly purchasing (books, journals), exchanging (journals and CDs) and receiving donations (books and theses).

During 2007/8 the Library received 2 400 issues of journals, 114 new book publications, 32 CD-ROMs and 60 new pamphlets. Two hundred and sixteen maps were added to the map database and 846 internal reports were received.

National Core Library

Manager: L.D. Motloi, B.A.Hons.
Team: R.R.M. Price, B.Sc.Hons, L.R. Lekalala, J. Mosaka, S. Malokela, P. Mojela, I. Matjeke, I. Madibane.
Primary objective: *to archive borehole core and chip samples for research purposes.*
Duration: Ongoing.

Motivation
The National Core Library is a repository for borehole core and chip samples which have been collected during exploration and mining activities over the past 70 years. The Core Library houses in excess of 1 000 km of borehole core, representing most of the stratigraphic sequences in South Africa, and this collection is open to researchers and exploration companies, universities and the public.

The National Core Library at Donkerhoek.

Progress
The core is listed in a Paradox®-based database which is in the process of being migrated to a new system which will enable access through the internet.

The following boreholes were added to the Core Library during the year:

Borehole name	Depth from	Depth to	Comments
GH6/8	0.00	490.56	ISCOR
PC04	0.00	305.42	ONVERWACHT 509 JR, BRONKHORSTSPRUIT
KE 032-07-016	8.90	96.83	OGIES
GH6/7	0.00	499.75	BUSHY PARK, HAY

Thirty-six boreholes were examined for research purposes during the year:

Visitors to the facility included:

Dr Yasushi Watanabe and Mr Masaomi Kurihara from Japan, 10/08/2007.
Prof. Jens Gutzmer from University of Johannesburg, 7/08/2007.
Alan Jay Kaufman from the University of Munster, Germany, and University of Maryland, USA, 28/09/2007.
A party of about 20 government officials from the People's Republic of China, during January 2008.

Future activities
The database will be migrated to an internet-accessible system during the coming year. This will allow access to the database from the National Core Library.

Curation of the Fossil Collections

Project leader: J. Neveling, Ph.D.
Project team: L. Karny, Ph.D.
Primary objective: *to manage the fossil collections, protecting them from damage and providing an accessible repository of both fossil material and data.*
Duration: Ongoing.

Motivation
Specimen curation includes many activities, including the preparation, cleaning, storage, repair and protection of individual fossil specimens. Database management includes maintaining accurate locality and related information for each specimen. This contributes greatly to a fossil's usefulness, and database management can be considered to be the most important function of fossil curation.

Progress
The systematic repair of damaged fossils continued during the year, with a special focus on scientifically important fossils and material that can be used for display purposes or scientific investigations. The reorganisation of the vertebrate fossil collection, initiated in 2004, continued. Progress in the reorganisation of the medium-sized fossils on the open shelves was adequate, and the focus has been shifted to the smaller fossils housed in dust-proof cupboards, which were relocated according to identity and collector. In this respect a concerted effort was made to update and correct the identification of fossils with limited or dubious classifications.

During 2003 it was decided to introduce a new standardised numbering system for the fossil collections, in accordance with best-practice principles implemented at other national and foreign institutions. Since then good progress has been made in allocating new numbers to Karoo vertebrate fossils and updating this information on the database. This process has not yet been completed, largely as a result of the size of the collection, which includes more than 7 600 fossils, but progress has been good. New numbers were issued to 900 smaller fossils.

The database is a module of GEODE, the CGS's Oracle®-based corporate database. The query system was extended to include farm registration districts, thus allowing more detailed enquiries on fossil distribution. Maps can be generated with Oracle to illustrate the distribution and density of fossil localities within a specific areas.

Progress has been possible as the CGS has skilled personnel capable of identifying Karoo vertebrate fossils. A large number of fossils still await preparation, and obtaining the services of additional preparators will greatly increase the potential and utilisation of this collection. An internal audit of the fossil collection indicates that there are more than 9 200 fossils that still require preparation.

The palynology collection is in excellent condition and requires very little additional maintenance at this stage. However, lack of specialised knowledge hampers the curation of collections such as the Cretaceous ammonite collection from KwaZulu-Natal and the macroplant fossil collection. Greater efforts should be made to involve knowledgeable persons in these fields to aid with the curation of the collections.

No new additions were made to the fossil collection during the past year, as the fieldwork conducted by the project leader focused on geological data or entailed research collaboration with external scientists, in which case fossil material has been loaned to partner institutions. Preparation of fossil material collected during previous field seasons is still ongoing and, after these fossils were identified and studied, they were added to the collection.

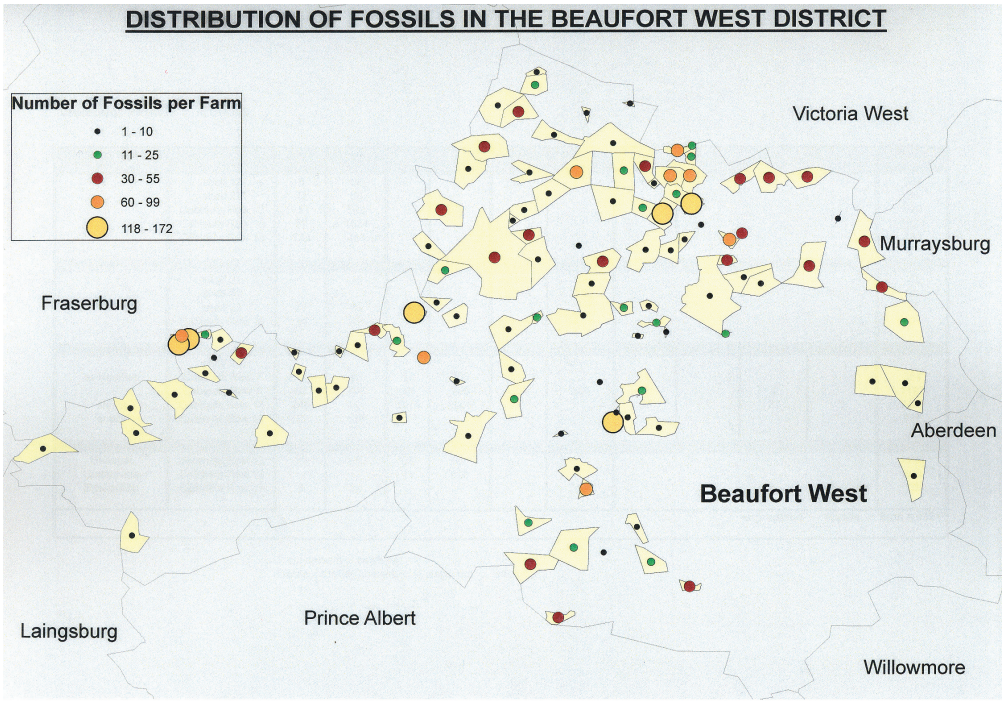
At present the bulk of the Plio–Pleistocene Basaansklip Fossil Collection is on loan to James Brink of the Florisbad Quaternary Research Unit (National Museum, Bloemfontein) who, with his colleague Lloyd Rossouw, is conducting research which will also aid in the curation of the collection and provide insight into the Plio–Pleistocene palaeo-environment. This collection is of great scientific relevance because of its size and taxonomic content (40 genera). All the Pleistocene fossils collected from the Gladysvale Cave are on long-term loan to the PURE Unit, Bernard Price Institute for Palaeontology (BPI Pal.) for display and study purposes.

A number of researchers have studied material from the collection, either at the CGS's premises or through a loan of important material. These include R. Govender, F. Abdala (BPI Pal.), J.A. van der Heever (University of Stellenbosch) and J. Botha (National Museum, Bloemfontein), who work on Karoo vertebrate material, L. Berger (PURE Unit, BPI Pal.), T. Crawford (Washington University, St Louis, Missouri), N. Dlamini (University of York, England) working on hominin fossils, R. Mutter of the British Museum of Natural History working on fish, and J. Brink and L. Rossouw (National Museum, Bloemfontein), working on Pleistocene fossils. L. Tsuji of the Humboldt University, Berlin, made contact early in 2008 to investigate the possibility of studying Pareiasaur material in April 2008. The continued use of the collections indicates their relevance to the scientific community.

Conclusion

Good progress has been made with the reorganisation of the main vertebrate fossil storage facility, the implementation of a standardised numbering system and updating of the database. A number of requests were received from researchers wanting to study the fossil material or use the database in large-scale research projects. This indicates that the fossil collection is considered to be a valuable and important scientific resource.

Representative specimens from the fossil collection have been used on numerous occasions to support marketing activities and platforms for public interaction.



KWAZULU–NATAL UNIT

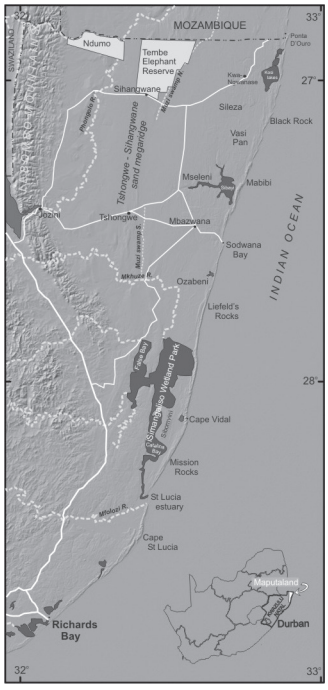
0069
REGOLITH GEOLOGY OF THE MAPUTALAND COASTAL PLAIN

Project leader: G.A. Botha, Ph.D.
Project team: N. Porat, Ph.D. (Geological Survey of Israel), R. Taylor, Ph.D. (eZemvelo-KZN Wildlife).
Primary objective: *to map the regolith geology of the Maputaland coastal plain, review the Cenozoic stratigraphy, differentiate and date the dune systems, characterise the weathering profiles, and define recent sea-level changes in Lake St Lucia and adjacent coastline.*
Duration: 2005/6 to 2007/8.
Budget: Total: R143 687; 2007/8: R112 600.

Motivation
This long-term research project has generated multidisciplinary collaboration with researchers from around the world who have interests in environmental change in the Maputaland coastal plain. The initial phases of the project elucidated the Cenozoic lithostratigraphy and geological evolution of the region. Subsequent phases of the project focused on the palaeoenvironmental 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, a World Heritage Site. The current focus is on publication of research findings in international scientific journals.

Progress
Progress was made with the preparation of manuscripts for submission to international journals. Specialist interpretations of changes in depositional environments and geomorphic processes were made towards publications by the interdisciplinary teams investigating the groundwater-dependent ecology of Lake St Lucia. A collaborative paper presented by researchers from the Norwegian University of Life Sciences, Ås, funded by the NUFU programme, was awarded a 'Best Oral Presentation' prize at the Groundwater Conference in Bloemfontein. A publication outlining the use of progressive soil-development characteristics of different ages of dunes as a relative dating technique was published in Quaternary International. A review paper on the luminescence dating of the range of lithostratigraphic units forming the Maputaland Group was accepted for publication by Quaternary Science Reviews.

Conclusion
This long-term research programme has integrated many mapping and analytical techniques to generate a vast dataset which supported the preparation of a range of specialist scientific publications. The regolith mapping and analytical techniques integrated during this project have formed the basis for collaborative research projects and generated interest from mining and exploration companies that has resulted in commercial projects in coastal-plain environments.



Locality map showing the Maputaland region.

View across the coastal barrier dune near Lake Bhangazi, south of Sodwana Bay over the Ozabeni wilderness area. The research project has clarified the age relationships between dune systems of Maputaland and contributed to the understanding of the geological history of the region.

Future activities
The research project has fulfilled the goals originally defined, but additional time has been budgeted during 2008/9 to publish an additional journal article on the raised shorelines around the iSimangaliso Wetland Park, and to integrate the latest research findings into the proposed memoir.

0767
STRUCTURAL MAPPING OF THE EASTERN BUSHVELD COMPLEX MARGIN

Project leader:	B.M. Clarke, B.Sc.Hons.
Project team:	Collaborating scientists: R. Uken, Ph.D. (University of KwaZulu-Natal), J. Reinhardt, Ph.D. (University of KwaZulu-Natal), T. Gerya, Ph.D. (ETH Zurich).
Primary objective:	*to investigate the structure of the Bushveld Complex contact aureole in the vicinity of Steelpoort and Burgersfort, Mpumalanga Province.*
Duration:	2003/4 to 2007/8.
Budget:	Total: R101 300; 2007/8: R49 000.

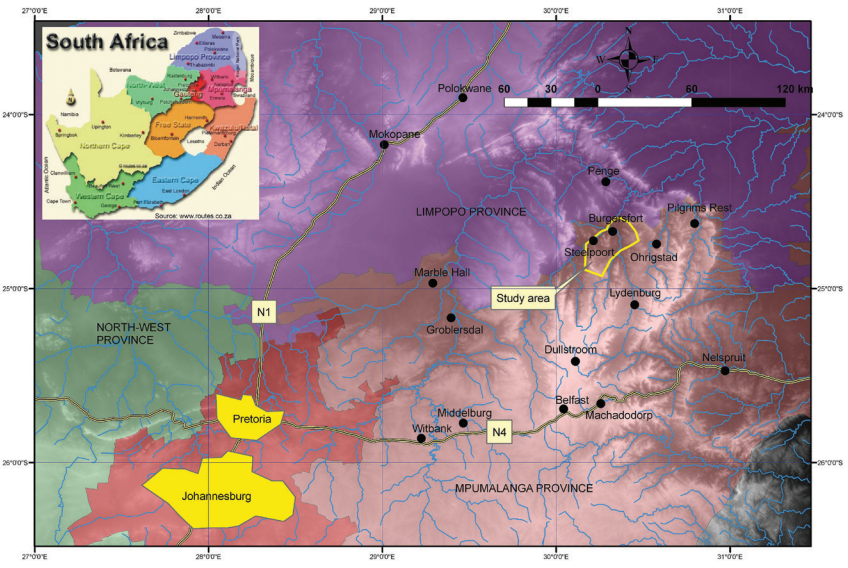
Motivation
Documentation and quantification of macro- and microfabrics within the metasedimentary aureole rocks, combined with metamorphic studies, will elucidate the thermomechanical evolution of the aureole and the igneous pile. Research is focused on domal aureole structures, which truncate and attenuate economically important horizons within the mafic-ultramafic Rustenburg Layered Suite (RLS) of the Bushveld Complex.

This project was initially conceived as an M.Sc.-degree opportunity for the project leader, combining structural mapping of unusual contact aureole structures with the interpretation of large-scale features in the Bushveld Complex. The project was upgraded to form the basis for a Ph.D., and is strongly weighted towards staff development and capacity building.

Deformation within the contact aureole has significant economic implication for the RLS, and potentially exciting exploration targets have been identified which could generate income for the CGS.

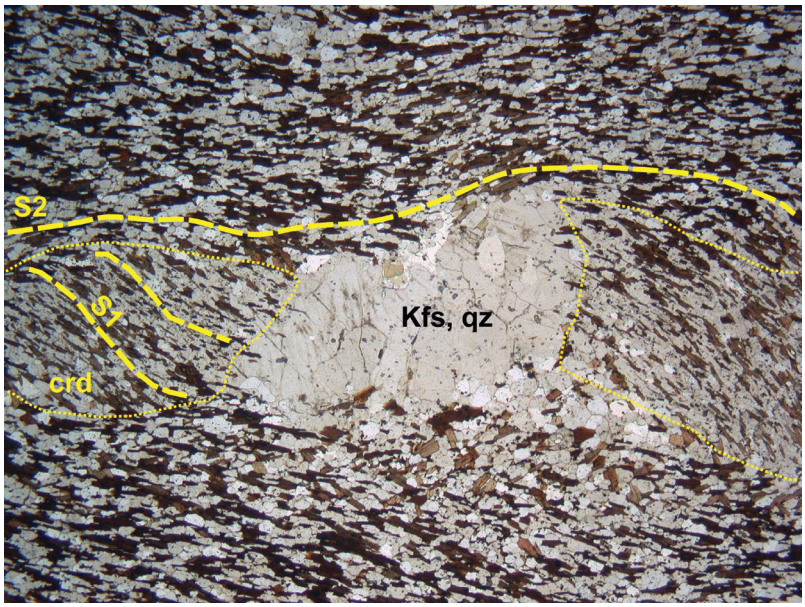
The project allows the CGS to develop core competencies in Bushveld Complex geology that have been lacking from the organisation for over a decade.

Progress
Mapping and data collection have been completed, and the project is at an advanced stage. Three key areas were investigated that record unique deformational and intrusion histories, and these are regarded as proxies for processes that operated throughout the Bushveld Complex. One paper has appeared in the South African Journal of Geology and three more have been submitted to international journals for publication. The key elements discussed in these papers include diapir development in the Bushveld Complex contact aureole and concomitant deformation of the layered suite, igneous emplacement mechanisms of conduit-like intrusions, and a large-scale synthesis, utilising both structural and compositional criteria, of the emplacement of the complex. The latter work was presented at the annual American Geophysical Union (AGU) Fall Meeting in San Francisco, USA, from 10–14 December 2007, in a session devoted to Physical and Chemical Processes in Large Layered intrusions.



Locality map of the study area.

The project leader also presented his results at the GeoIndaba of the CGS in April. The project is now nearing completion, four papers forming the basis for the Ph.D. thesis having been submitted to international journals. Corrections to these papers will be made, pending the outcome of reviews, and the thesis submitted for examination.



Fabric relations within one of the diapiric domes. An early subhorizontal fabric (S1), related to Bushveld Complex crustal loading, is preserved as inclusion trails within stretched cordierite porphyroblasts. S1 is continuous with the external axial-planar pervasive fabric S2, indicating that cordierite growth initially predated the development of S2, but continued into the early stages of S2 development. Prominent unstrained K-feldspar and quartz boudins occur between cordierite grains and are pockets of crystallised partial melt. These relationships indicate that the initial flat-lying fabric was steepened into parallelism with the axial planar fabric of the diapiric fold, and that this process occurred at or near the metamorphic peak, highlighting the high-grade nature of the diapiric event. Field of view ~1 cm.

Conclusion
Mapping results have added weight to the diapiric model of deformation proposed for domal aureole structures in the contact aureole, and the study has revealed significant syndiapiric deformation of the Bushveld Complex. In addition, previously unrecognised structural features from the floor rocks have allowed for the construction of a robust emplacement model for the Bushveld Complex that is entirely consistent with chemical and lithological variations in the complex.

Future activities
Journal article reviews will be received and changes implemented accordingly. The four component papers will be compiled to form the thesis that will be submitted for examination.

0816

REGIONAL GEOTECHNICAL MAPPING IN THE OSIZWENI AREA: AN APPRAISAL OF GEOTECHNICAL MAPPING TECHNIQUES IN THE CONTEXT OF NATIONAL AND PROVINCIAL LEGISLATION AND PLANNING POLICIES

Project leader:	C.A. Willard, B.Sc.Hons.
Project team:	G.A. Botha, Ph.D., N.P. Richards, Ph.D.
Primary objective:	*to appraise geotechnical mapping techniques in the context of national and provincial legislation and planning policies using the Osizweni area (1:50 000-scale sheet 2730CC) as an example.*
Duration:	2004/5 to 2008/9.
Budget:	2007/8: R51 900.

Motivation
Development of any area is governed by a broad spectrum of acts, regulations, planning policies and strategic-development framework initiatives on national, provincial and municipal levels. The Development Facilitation Act (Act 67 of 1995) lays down general principles governing land development. Its general principles state that development should 'ensure the safe utilisation of land by taking into consideration factors such as geological formations and hazardous undermined areas' and 'promote the sustained protection of the environment'.

The National Spatial Development Perspective (NSDP) provides national guidelines for land development into activity corridors and nodes around or linking main growth centres. Although the Spatial Growth and Development Framework (SG & DF) for KZN seeks to ensure that effective development takes place throughout the province, future economic growth is likely to reinforce the existing pattern, with the Durban Functional Region (DFR) remaining the dominant force. Consultation with provincial planning authorities highlighted the specific strategies for future economic activity focused on the hinterland towns of Ulundi, Ladysmith, Newcastle, Vryheid and Estcourt. These nodes represent most of the larger opportunities for interventions aimed at concentrated growth and development of an urban or industrial nature. Regional-geotechnical assessments and investigations will be necessary to assist in the decision-making process.

The 1:50 000-scale map sheet 2730CC Osizweni, covering about 670 km^2, includes the Newcastle–Madadeni–Osizweni area, which was identified as an expansion and development growth node, with Newcastle as the urban core. The planned

scope of development for the Amajuba District Municipality (ADM) makes the Osizweni sheet a useful case study against which the requirements for provincial- and municipal-level planning guidelines for geotechnical assessments can be investigated and assessed. The fieldwork, map compilation and map explanation for the geotechnical map have been completed during the period 2004–2007, and the product is nearing publication. Geotechnical mapping of this area provides a broad overview of the suitability of the land for proposed development, as hazardous geological or geomorphic conditions, that could impose environmental constraints or elevated cost implications on future infrastructure development, are delineated.

The geotechnical product based on the CGS's geotechnical factor legend will be compared and contrasted with the Development Potential Zonation (DPZ) approach developed in the KZN Unit. The DPZ map compilation provides a preliminary geotechnical assessment based on a desktop study using multiple data sources. The geotechnical appraisal assesses an area in terms of development potential based on bedrock geology, land-type data and digital terrain models.

This project will investigate the range of geotechnical assessments submitted for projects in the focus area. These will be compared with the various regional geotechnical mapping approaches employed by the CGS to define the maps and legend formats most appropriate to provincial and municipal development requirements and development-related legislation and policies. The project aims to contribute towards guidelines for the provision of geotechnical information for use by planners and developers.

In addition, the suitability of local materials for use as construction material can also be assessed. Residual sandy soils of the Vryheid Formation are widely excavated in the map sheet area for use in the informal housing sector. The suitability of these sands for use as general-purpose mortar sand or plaster sand can be investigated and assessed according to SABS standards.

Progress
Background data acquisition has been completed. This involved reviewing, contextualising and comparing geotechnical mapping methods and practices used in various countries around the world. An assessment of the development requirements as stipulated by national and provincial planning ordinances and legislation has also been finalised. An alternative geotechnical assessment of the area, based on the DPZ mapping approach, is near completion for the Osizweni area and demonstrates the different information that can be generated on the basis of published data and limited field investigations.

Conclusion
Geotechnical maps based on the CGS Geotechnical Factor legend and the DPZ map will be useful tools for assisting in decision-making, and will potentially be used as a basis for future growth and expansion.

Future activities
A regional geotechnical map of the 1:50 000-scale Osizweni sheet will be compiled using the CGS's Geotechnical Factor legend. The level of detail and information appropriate to different planning phases or site-investigation phases that can be derived from the geotechnical map and legend will be assessed in the context of planning and development requirements. Further fieldwork is proposed to carry out soil-profile descriptions and derive permeability data on excavated trial pits. This quantitative assessment will be integrated into the description of map polygons and geotechnical map.

The geotechnical factor map and the DPZ map will be compared with the ADM's spatial development framework (SDF) map to highlight areas where the planning guidelines could be enhanced through the level of geotechnical assessment provided.

Boulders and bedrock at shallow depths preclude certain areas in the Amajuba District Municipality from development as cemeteries, as excavation costs become elevated.

0850
MASS-MOVEMENT MAPPING AND LANDSLIDE INVENTORY

Project leader: G.A. Botha, Ph.D.
Project team: R.G. Singh, B.Sc.Hons.
Primary objective: *to map the distribution of mass-movement deposits, carry out a spatial analysis of the landslides and their causes, and to produce a landslide-susceptibility map differentiating the province into zones of varying degrees of slope instability.*
Duration: 2004/5 to 2007/8.
Budget: 2007/8: R61 550; total: R150 210.

Motivation
This innovative research project represents a holistic approach to regional mass movement and landslide-deposit mapping in KwaZulu-Natal. The project aims to map the distribution of various mass-movement deposits and progress to date has revealed that these Quaternary geomorphic features are more widespread than generally acknowledged. Spatial analysis of the landslide and a range of causal factors will produce a landslide-susceptibility map that differentiates the region into zones of varying degrees of slope instability.

A range of mass-movement types has resulted in the deposition of debris on hillslopes, and these often represent a significant hazard to strategic infrastructure and limitations to future development. The risk of mass movement excludes some large areas in urban nodes from formal development and many areas of informal housing are potentially at risk. A landslide-susceptibility map will highlight areas where landslides may form and ideally provide information for the realisation of potential devastation. The methodology adopted is based on international best practices which will improve scientific and GIS skills within the CGS. Singh has conducted a workshop to transfer knowledge to CGS researchers who are undertaking similar investigations in other regions.

Progress
During the regional landslide mapping and inventory project, numerous rockfalls and a range of landslide types were identified, mapped and classified across the diverse terrain morphological regions of the KwaZulu-Natal Province. Radiocarbon dating of organic material from ponds developed on back-tilted landslide surfaces has provided minimum ages for some ancient landslides and confirmed that these have occurred sporadically over the past 3 500 years. Comprehensive Geographic Information System (GIS) map layers and knowledge derived from field investigations have contributed to landslide susceptibility modelling of the relationships between a range of landslide causative factors using the Bivariate statistical method.

Conclusion
The modified landslide classification system and susceptibility modelling technique used in the KwaZulu-Natal study are based on international best practice and can be applied to other areas in the country where there is a risk of landslides. The susceptibility map will be marketed as a tool in future decisions regarding regional urban expansions and development.

Future activities
The project has been finalised and the research results compiled into a thesis to be submitted for an M.Sc. degree. A more detailed assessment of the Durban and Pietermaritzburg areas will be carried out using other landslide-susceptibility modelling techniques during 2008/9.

The Dilston landslide represents a massive slope failure in the Mkhomazi River valley near Richmond, KZN. The toe of the landslide deposited huge dolerite blocks in the river bed and may have temporarily dammed the river.

0980
GEOLOGICAL MAPPING OF 1:50 000-SCALE SHEET 3130AA & AB PORT EDWARD AND PART OF SHEET 3129BB KANYAYO

Project leader: G.A. Botha, Ph.D.
Project team: G. Grantham, Ph.D., W. Olivier, B.Sc.Hons (contractor).
Primary objective: *to revise the geological mapping of the area covered by 1:50 000-scale sheet 3130AA & AB Port Edward and part of Sheet 3129BB Kanyayo.*
Duration: 2007/8 to 2008/9.
Budget: 2007/8: R112 600.

Motivation
The revision of this geological map will update the lithostratigraphic subdivision of lithostratigraphic units at the southern limit of the Natal Metamorphic Province outcrop on the KwaZulu-Natal and Eastern Cape border. The area is also the southernmost extent of the Maputaland Group units and the mapping project presents an opportunity to evaluate the correlation with the Algoa Group rocks further south.

The map area adjoins the Mkambati sheet to the south, where the Eastern Cape Unit has carried out mapping. Several large infrastructure projects have been planned in the region and an updated geological map is necessary for use by provincial and municipal planners in this rural area which has high poverty levels and limited infrastructure and services.

Progress
The resignation of a key member of the mapping team resulted in G. Grantham from the Central Mapping Unit volunteering to check the granitoid basement rocks on the map, as he has considerable experience in this area. Significant improvements were made to the mapping of the distribution of the Berea Formation ('Berea Red sand'). Digital orthophoto base maps, produced by the KwaZulu-Natal Unit, enabled small lithological units and stratigraphic unit contacts to be mapped with greater precision. Deep weathering and thick vegetation cover on the coastal sand ridge limits outcrop, and the basal beach gravel unit, correlated with the Uloa Formation, served as a reliable marker for the basal unconformity. Extension of the mapping south of the Mtamvuna River was interrupted when members of the Amadiba community chased the mapping team from the area. Attempts are being made through the Mbizana Municipality to gain the support of the community for the mapping project.

Conclusion
The geological map has been improved in the areas covered. Additional detail has been added to the map and the distribution of some units is markedly different to that on the existing map.

Future activities
The continuation of mapping depends on the facilitation of access to the area and the support of the Amadiba community who are dissatisfied with mining projects proposed in their communal lands. The project will be completed during the 2008/9 programme.

View across the Mtamvuna River gorge near the river mouth. The rocks in the foreground underlie a raised-beach deposit that could date back to the Miocene–Pliocene (~12.5 to 2.6 my). An older Cretaceous beach gravel (~80 my) occurs at a similar elevation on the opposite side of the gorge.

LABORATORY

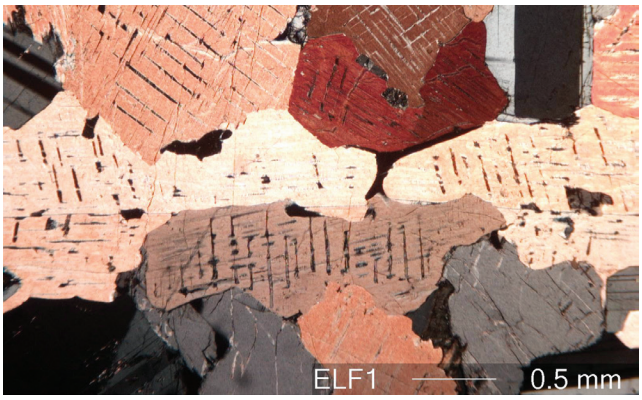
0208
ONGOING PETROGRAPHIC SERVICES

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

Motivation
The microscopic study of rocks and minerals, either optically or with more advanced techniques such as electron microscopy, 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 sections and polished stubs, is a fundamental necessity for geological research.

Progress
The production of the section was lower than the previous financial year at about 879 products delivered with a total value of about R116 000. This amount excludes work performed for external clients, which showed a significant increase over the previous financial year.

Conclusion
This service will continue to be provided indefinitely.



Photomicrograph of a rock containing clinopyroxene and plagioclase (polarised light, crossed nicols).

0407
CERAMICS LABORATORY

Project leader: M. Atanasova, M.Sc.
Project team: A.D. Mabela, N.Dip.(Ceramic Technol.), J. Friedland, B.Sc.Hons (Applied Mineral.), K.S. Khumalo, P.B. Mchunu.
Primary objective: *to i) identify raw materials for use in the ceramics industry, optimising their use by means of mix development; ii) assist the ceramics industry in process control; iii) assist the ceramics industry in solving technical, ceramic or production problems, and iv) assist small-scale entrepreneurs in setting up factories for ceramic products.*
Duration: Ongoing.

Motivation
The Ceramics Laboratory focuses on investigations involving clay, which occurs abundantly and plays a vital role in the economy. The main activities of the Ceramics Laboratory include evaluation of clays to determine suitability for possible uses, clay deposit site investigations, mix development and process control for manufacturers such as tile and brick plants. These activities involve analytical procedures such as physical evaluations, flexural-strength determinations and dilatometry. The Ceramics Section makes use of analytical services offered by other sections of the CGS, including mineral analyses by X-Ray Diffraction (XRD) and chemical analyses. Dilatometry involves the measurement of thermal expansion over a given temperature range which is important to the ceramics industry, especially for assessing the compatibility between glazes and clay bodies.

A full physical evaluation entails small-scale laboratory simulation of a manufacturing process to test the suitability of materials, or to test the manufacturing process. The steps of the physical evaluation are the same as those in the envisaged production process, but also include measurements of flexural strength, water absorption, shrinkage, and the identification of problems such as lamination, cracking, black coring or melting. The full physical investigation usually starts off with the shaping of laboratory-scale equivalents of a ceramic product (by dry-pressing, extrusion, slip-casting or hand-shaping) from finely ground damp clay. These clayey bodies are dried (with flexural-strength determination of the undried and dried sample) and subsequently fired at various temperatures to determine the optimum firing temperature. The fired samples are also tested for flexural strength.

The full physical investigation described above often shows that a given material is not suitable for ceramic production. In many cases, a naturally occurring clay is unsuitable for manufacturing, and mixing of different materials, such as the addition of quartz, feldspar or other clay materials is required. Mix development determines the proportions in which available materials can be combined to yield an optimum mix.

As available raw materials are first investigated individually, an investigation also includes mineralogical and chemical analyses as well as full physical investigations. Subsequently recipes are developed for mixtures with optimised properties which can be used for manufacturing ceramic products such as sanitary ware, bricks and tiles.

For a manufacturing plant it is vital that the compositions of the raw materials, as well as the process materials remain consistent over time. The Ceramics Laboratory offers process control to a variety of production plants, which involves sampling, mineralogical and chemical analysis, and analysis-trend determination.

Progress

The key focus area was in the brick and tile industry. Process control was performed for various companies. This entails providing chemical and mineralogical analyses of raw materials and mixes on a regular basis. Results were graphically represented to display trends or possible deviations from desired compositions. Occasionally advice was given for small production problems experienced in the production plant.

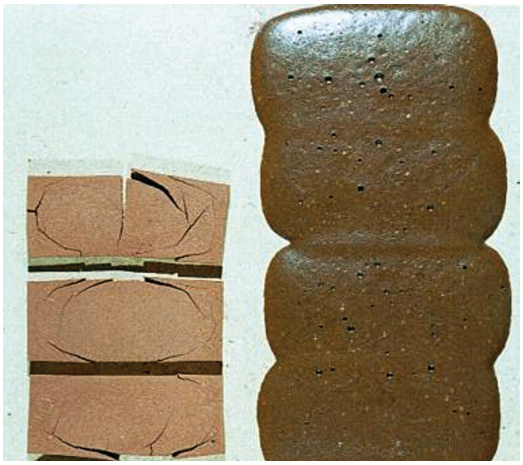
Mineralogical, chemical and full physical analyses were performed on a number of prospective clays and several of these investigations formed part of the Small-Scale Mining Project.

A LINSEIS L75 Platinum Series dilatometer fitted with an alumina-measuring system was obtained during June 2007, and started generating commercial income in October 2007 (approximately 70 samples were measured). Dilatometry analyses included determination of drying and firing shrinkage curves for raw-clay bodies. Further, thermal expansion patterns over a given temperature profile were determined for tile bodies, engobes and glazes.

A statutory investigation into approximately 80 clays from the Zebediela area was carried out for the Limpopo Unit. This entailed preparation of laboratory-scale tiles with characterisation of their physical properties, such as drying and firing shrinkage, green and fired strength, and water absorption. From the samples, about 60 could be pressed into tiles, the remaining having had either a low clay-mineral content or having shown lamination due to overly high clay-mineral content.

Future activities

Because of its age the Modulus of Rupture (MOR) measuring instrument is becoming unstable. A motivation was compiled to replace this with an Instron 30 kN Test System during the 2008/9 financial year. Requests for dilatometry are increasingly exceeding capacity, therefore the possible purchase of a second dilatometer is being considered.



Cracking and melting.

0332
CHEMISTRY SECTION

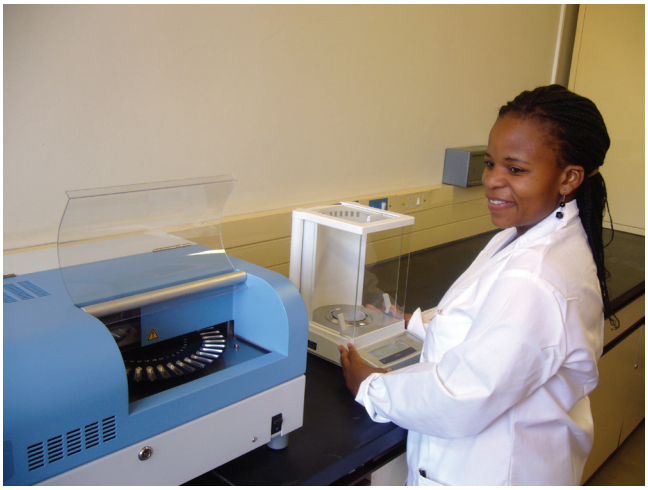
Project leader: L.J. Jordaan, M.Sc.
Project team: H. Maritz, B.Sc.Hons, M.T. Lehaha, B.Tech., L.M. Mokete, B.Tech., L.L. Sathekge, Nat.Dip., R.H. Sello, R.M. Papo, M. Vuma.
Primary objective: *to provide analytical services.*
Duration: Ongoing.

Motivation
The CGS requires chemical analyses of rocks, soils and water in order to interpret local and international resources, to verify geological mapping, to identify exploration targets and to quantify environmental hazards.

Progress
The Chemistry Laboratory analysed 13 196 samples during the reporting period, and 45 per cent of this work was performed for commercial clients. Three hundred and thirty-two jobs were completed at an average income of R7 495.47 per job. An average of 39.75 samples were analysed per job. The average income per sample was R188.58.

Conclusion
It is essential that the Chemistry Laboratory caters for the needs of all our clients both within and outside the CGS, which requires a stable and dedicated staff component, serviceable modern instruments and participation in both commercial and research projects.

Future activities
The Chemistry Laboratory started with an expansion programme to cater for the analyses of soil samples from the geochemical mapping programme. A new ICP-MS instrument and several sample-preparation laboratories will be in commission in 2008. A new mercury analyser was purchased to cater for the growing environmental market and will be in operation in 2008.



The new Milestone DMA-80 Direct Mercury Analyser.

0889
WHOLE-ROCK AND MINERAL GEOCHEMISTRY OF THE MAIN ZONE AND PLATREEF ON THE FARM MOORDKOPJE 813 LR, AS INTERSECTED BY BOREHOLE MO-1

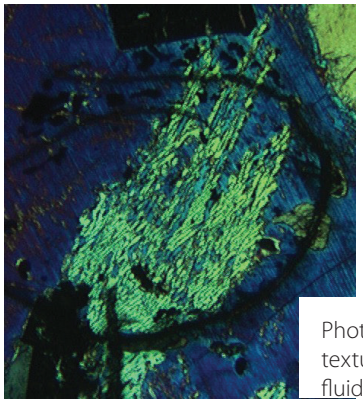
Project leader: F. Roelofse, B.Tech. (Qual.), B.Sc.Hons (Geol.), B.Sc.Hons (Metall.).
Project team: M. Cloete, Ph.D., L.D. Ashwal, Ph.D. (University of the Witwatersrand).
Primary objective: *to characterise the Main Zone and Platreef on the farm Moordkopje 813 LR in order to further knowledge on the magmatic evolution of the Northern Limb of the Bushveld Complex.*
Duration: 2007/8 to 2008/9.

Motivation
Despite numerous studies on the magmatic evolution of the Bushveld Complex, the evolution of the complex as a whole and, in particular, the Northern Limb of the complex remains poorly understood. In 2005 Ashwal *et al.* arguably made the most recent significant contribution to our understanding of the magmatic stratigraphy of the Northern Limb of the complex by constructing a huge dataset of near-continuous geophysical and geochemical measurements from a study of the almost 3-km-long Bellevue drillcore. This borehole core intersected the entire Upper Zone and almost half of the Main Zone. The aim of the present study is to characterise the remainder of the magmatic succession of the Northern Limb from the mid-Main Zone down to the Platreef.

Progress
The project was upgraded to a Ph.D. study at the beginning of the year, which necessitated additional work in the form of isotopic measurements on samples covering reversals in mineral compositions over the interval studied. Rb-Sr and Sm-Nd isotopes will be determined which will hopefully shed light on the origin of these reversals.

The current year saw preparation of the required mineral separates, as well as a visit to the University of KwaZulu-Natal where plagioclase compositions were determined on their electron microprobe during the upgrade of the CGS's instrument. The analysis of clinopyroxenes is still underway and should be completed early in the new year. A rare texture, known as symplectitic augite, was described in one of the samples being studied during the year, which resulted in a paper being accepted in the South African Journal of Geology entitled 'Symplectitic augite from the Platreef — textural evidence for fluid/rock interaction on the northern sector of the Northern Limb of the Bushveld Complex?'

Conclusion
The work is still in progress.



Photomicrograph showing symplectitic augite in the Platreef. The texture is thought to result from grain-boundary mobility caused by fluid-rock interaction. Width of field of view ~2 mm.

Future activities
Isotopic measurements and the determination of clinopyroxene compositions should be finalised early during the new financial year. Measurements will be conducted on mineral separates (orthopyroxene, clinopyroxene and plagioclase) and whole-rock samples at the University of Cape Town which will be visited for this purpose early during the 2008/09 year. The remainder of the year will be used for interpretation and reporting.

0893
TERRESTRIAL GLAUCONITE IN SOUTHERN AFRICA

Project leader:	T. Roelofse, B.Sc.Hons.
Project team:	M. Cloete, Ph.D., J.N. Dunlevey, Ph.D. (University of KwaZulu-Natal), F. Netterberg, Ph.D. (consultant).
Primary objective:	*to establish whether the green clayey material in some South African pans is glauconite and to verify the origin of this marine-environment indicator mineral.*
Duration:	2005/6 to 2007/8.
Budget:	2007/8: R14 000; total: R42 000.

Motivation
Knowledge of the conditions of formation of terrestrial glauconite could allow insight into the reconstruction of climatic conditions for the Quaternary development of the Kalahari Basin. In addition, the scientific capacity of the project leader will be enhanced and the project results will be presented as an M.Sc. dissertation.

Scientific collaboration with Dr Frank Netterberg, a national authority on environmental and geotechnical engineering, will establish strong research and commercial links for the CGS.

Skills in the use of infrared at the CGS are limited, and it is hoped that exposure to this technique will expand the expertise of CGS staff in the field of clay mineralogy in particular and infrared mapping in general.

Progress
The project is entering its final stages before completion, with only the results of some last Fourier Transform Infrared analyses still outstanding.

Conclusion
The sediment from selected pans in the Noenieput, Nossob and Twee Rivieren areas were shown to contain glauconite or Fe-rich celadonite in a fine-grained matrix having a variable grain size and chemistry which hosts poorly sorted grains of quartz, calcite, dolomite and feldspar in varying concentrations. Salts identified in some of the pans include halite and thenardite. In addition to glauconite and Fe-rich celadonite, some pans also contain what appears to be a Na-sepiolite in the matrix. Analcime, reaching concentrations up to 40% in some pans, forms part of the clayey matrix.

Thermoluminescence age measurements of samples taken at standard depths suggest different sedimentation rates for Koi pan and Brak pan. Koi pan sediments at a depth of about 124 cm below the surface were last exposed to sunlight 42.0+5.7/-4.8 thousand years ago, while samples from Brak pan, taken at the same depth, yielded an age of 141+∞/-39 ka. As the glauconite and Fe-rich celadonite are believed to form in the pan, these ages also represent the maximum ages of their formation.

Green pan sediment as seen in Koi pan (S27°25.972', E20°53.221'), Kalahari.

Future activities
During the coming year a report will be submitted, and an M.Sc. dissertation based on the research will be completed.

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 establish a database of water, sediment and fish chemistry for South African dams and drainage basins.*
Duration:	2007/8 to 2010/11.

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, water and fish. The chemical composition of a fish can therefore be traced backed to 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
The project has progressed well, in spite of challenges imposed by the weather, the lack of any suitable infrastructure and the difficulties in finding suitable analytical methods. The initial phases included setting up the project, and finding partners and stakeholders. This was followed by a literature study, and the establishment of suitable infrastructure and equipment. The initial phases of data collection concentrated on fish and water sampling until a suitable boat and sampling equipment were obtained. Sediment sampling is now done routinely together with the water and fish sampling.

Future activities
Most of the required infrastructure has been established and the project can progress with more fieldwork and chemical analyses being done.

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.
Project team: M. Cloete, Ph.D.
Primary objective: *to identify suitable industrial alkaline waste materials 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 2008/9.
Budget: R22 888 per annum; R45 776 in total.

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. Its participation in the international effort to lower emissions will most certainly become mandatory sometime after 2012. The total sequestrable CO_2 emissions in South Africa currently account for over 249-million tons.

A combination of several climate-change mitigation measures is required to effectively reduce atmospheric emissions of CO_2 from human activities. Theoretically, 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 industrial processes have been successfully developed as yet.

The overall objective of this project involves theoretical and experimental evaluation of a range of readily available alkaline wastes, and early development of promising technological approaches and processes that can effectively dispose of CO_2 by chemically binding it in an exothermic reaction with the wastes to form stable carbonates. Of particular interest is the establishment of the essentials for the development of a better understanding of the mechanisms, kinetics and process requirements of various possible leaching and/or carbonation reactions to identify potentially feasible reaction pathways and to permit engineering process development.

Progress

Twelve alkaline wastes with theoretically desirable characteristics for CO_2 sequestration were identified and acquired from four industrial sectors (paper recycling; steel making; coal-fired power generation, and platinum mining). Analysis of their bulk total composition confirmed their relative abundance in carbonatable elements (i.e. calcium, magnesium and iron), which are of particular interest for the reaction with CO_2.

Their total content of calcium and magnesium and their acid neutralising capacity were determined and used to estimate their theoretical maximum and minimum CO_2 specific sequestration capacity respectively. The results showed that the five steel slags and the platinum tailing samples tested have the combined potential to convert and store 1.3 to 2.9 million tons of CO_2 per annum. This represents 4.1 to 12.5% of the concentrated stream of 'clean' CO_2 (90–98%) generated by Sasol synfuel processes and directly released into the atmosphere annually.

Substantial effort was invested into the purchase of a suitable computer-controlled high-pressure, high-temperature reactor system (P_{max} 200 bar at T_{max} 350°C), which will be used for the development and testing of small-scale industrial dissolution and carbonation processes.

Future activities

Experiments on pH-stat titration and geochemical (solubility control) modelling of the pH-stat leaching curves will be performed to collect useful information on the leachability of calcium, magnesium, iron and silicon as a function of the potentially solubility-controlling mineral phases present in the wastes. Development and testing of accelerated mono- and multi-stage leaching and carbonation procedures will be carried out, with emphasis on the kinetic and mechanistic aspects of chemical reactions, and the structure, physicochemical and mechanical properties and stability of formed carbonated products.

The high-pressure, high-temperature reactor system (left), process controller (centre) and high-pressure liquid CO_2 pump (right).

5024
ONGOING RADIOGENIC ISOTOPE ANALYSIS

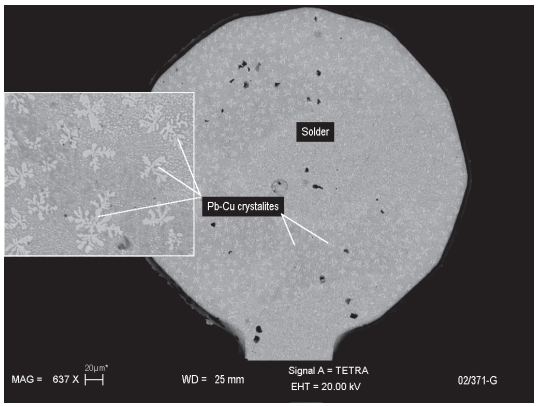
Project leader: M.C. Rademeyer, B.Sc.
Project team: E. Nkosi.
Primary objective: *to provide isotopic analysis as well as mineral separations to CGS staff and external clients.*
Duration: Ongoing.

Motivation
The Radiogenic Isotope Laboratory (Radlab) offers isotope analyses and mineral-separation services. Apart from isotope dating, isotope analyses can also be used to identify environmental contamination in water and rocks. The mineral-separation section of the Radlab includes rock crushing and heavy-liquid separation of zircons from whole rocks.

Progress
Numerous samples were analysed for various statutory projects. The Radlab is actively involved in a project involving fish (project 0955). Strontium-isotope ratio analyses were carried out on fish and water samples to find a correlation between the animal and plant life and the aquatic system in which they live. A total number of 112 samples were analysed for this project. Of these samples, 59 were water samples and 53 were fish samples from various dams. Rock crushing, zircon separation and heavy-liquid separation were carried out for various statutory projects.

Conclusion
The need for an isotope section within the CGS continues. Various other isotope laboratories, locally and internationally, have closed over the past years and this gives the CGS's isotope laboratory an opportunity to gain new clients.

Future activities
The Radlab will continue to be involved with the fish project. There has been some interest by the Medical Research Council in analysing blood and teeth samples. In order to do this, equipment and consumables will need to be purchased and workable methods will need to be developed. Upgrading of various components of the MAT 261 mass spectrometer will be needed in the foreseeable future. The Radlab is in the process of preparing the laboratory and equipment for the analysis of rare-earth elements (REE). This service will be offered in the near future.



Electron backscatter image of solder from an electronic circuit board. The insert is an enlargement and shows the dendritic Pb-Cu crystallites.

5032
ONGOING MINERALOGICAL ANALYSIS: SCANNING ELECTRON MICROSCOPY

Project leader: M. Atanasova, M.Sc.
Primary objective: *to provide SEM services to CGS staff and the general public.*
Duration: Ongoing.

Motivation
The Scanning Electron Microscope (SEM) uses X-rays to image and analyse rocks, minerals and industrial materials, and makes semiquantitative chemical analyses of microscopic particles possible. The INCA Oxford analytical software allows spot- and line-automated analyses, as well as sophisticated image analysis. SEM is widely utilised in applied mineralogy investigations and increasingly more in environmental studies, especially for characterisation of microscopic particulate matter. In conjunction with other analytical techniques, SEM is a strong tool for solving various industrial-scientific and application problems, as well as for enhancing the quality of scientific observations.

Progress
The total value of work is estimated at R153 350 of which R54 800 is the value of statutory work provided for CGS projects. These investigations have enhanced the quality of the scientific observations for numerous projects. Statutory projects include a comprehensive study on the terrestrial glauconite, investigations on heat-

SEM – Leica 440 Stereoscan with INCA (OXFORD) DS.

treated silcrete samples as part of a major archaeological project at Mossel Bay, and mineralogical investigations for various small statutory projects of the CGS.

The Laboratory operates a Leica 440 Stereoscan scanning-electron microscope (SEM) equipped with an INCA (OXFORD) energy dispersive system (EDS) which controls the analytical capacity of the instrument. This arrangement allows a wide range of analytical capability – secondary, backscattered and cathodoluminescence electron imaging, X-ray EDS microanalysis and X-ray element mapping.

Future activities
Because of its age of about 15 years the EDS detector is deteriorating rapidly and costs about R100 000 every second year to refurbish. With the addition of the cost of the increasing demand for liquid nitrogen needed to cool the detector, it is necessary to consider replacing it with a liquid-nitrogen-free detector of the same resolution.

5033
ELECTRON-MICROPROBE ANALYSES

Project leader: J.E. Walliser, B.Tech.
Project team: J.J. Maema.
Primary objective: *to provide electron-microprobe analyses of minerals to the CGS and its clients.*
Duration: Ongoing.

Motivation
The CGS requires chemical analyses of minerals in order to classify the various lithologies that are investigated during geological mapping projects. The analyses of mantle-derived indicator minerals by the electron microprobe are used in kimberlite exploration programmes and to determine the diamond-bearing potential of kimberlites.

Progress
The electron microprobe analysed 3 148 grains for commercial clients. Commercial work consisted mostly of diamond indicator minerals for exploration projects and for a research project. The total income for statutory work increased four times compared with the previous reporting period, and consisted of research projects, such as the Moordkopje and Halfway House Granite dome.

Conclusion
The JEOL 733 electron microprobe was upgraded with an advanced microbeam. The old computer DEC-system was removed and replaced with a windows-based operating Apogee WD system. Over the past three months the microprobe produced mineral analyses uninterruptedly and without experiencing any downtime. The ADDA2 imaging system, with Scandium software, was added.

Future activities
The imaging system will be implemented. Further internet-based training with manufacturing engineers is planned for trace-element analysis and imaging system. This last phase will represent the completion of the upgrade.

The JEOL 733 electron microprobe.

5036
ONGOING MINERALOGICAL ANALYSES: X-RAY DIFFRACTION

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

Motivation
Mineral analyses are required for a broad range of programmes and projects of the CGS. Mineralogical evaluation is an essential service for the description and compilation of geological maps, mineral exploration, identification of environmental hazards, risk assessment and economic evaluation of mineral resources.

The X-Ray Diffraction (XRD) facility at the CGS offers researchers quick, accurate analyses at competitive prices. It provides mineralogical evaluation and analytical results on the whole spectrum of geological materials, as well as synthetic products. Routine phase analyses are performed on whole-rock powder and oriented clay preparation in reflection mode, and minute quantities of material can be analysed in transmission mode using a capillary tube. Typical applications include qualitative phase identification and semiquantitative evaluation of XRD traces.

Progress

In total 2 666 samples were analysed during the year. Analytical work on 777 samples, at a cost of R302 655, was provided for various statutory projects of the CGS. These include:
Industrial Minerals Map of South Africa;
Mabeskraal Geological Map – 1: 50 000;
Klip River Wetlands: Heavy metal accumulation;
Geology of the Soutpansberg Graben;
New Smitsdorp – Geological Map 1: 50 000
and various method-development projects of the analytical sections of the laboratory.

Major projects and clients involve the industrial-minerals sector:

- brickmaking and ceramics applications
- ceramics industries
- environmental sector
- analyses of dusts, asbestos
- water purification systems
- animal nutrition.

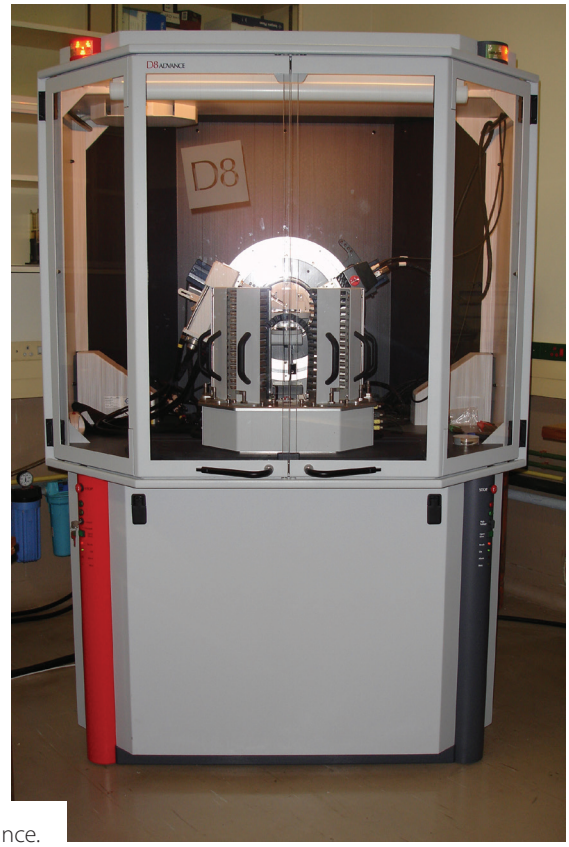
A significant part of the income generated is derived from small jobs in diverse market sectors, such as the construction industry, road-metal, clay, and brick- and tile-materials extraction, mining and mineral exploration, environmental applications, dimension stone, high-temperature engineering and the food industry.

Instrumentation

During 2007 the Laboratory at the CGS purchased a new X-ray diffraction system. The BRUKER D8 Advance is from the new revolutionary range in powder diffraction technology with modular design and versatile configuration. With its silicon strip detector, ultra-fast diffraction measurements are performed whilst 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. The advanced hardware technology, combined with Rietveld Refinement-based interpretation, presents new opportunities for more detailed and advanced research in the field of crystallography and applied mineralogy.

Future activities

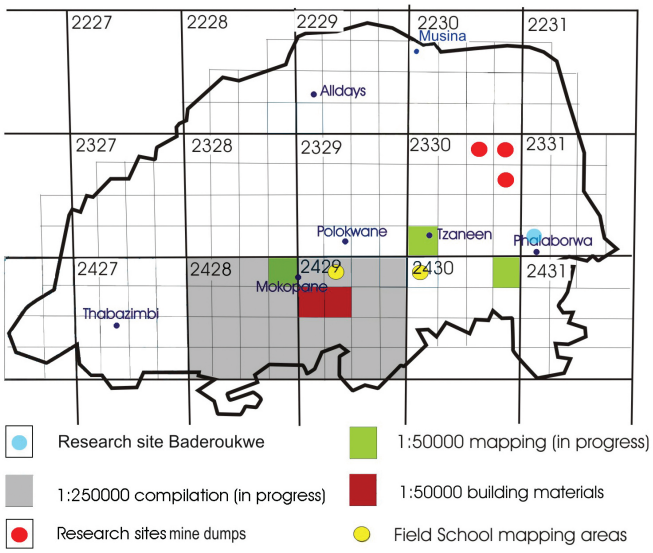
The new X-ray diffractometer will put the CGS in a position to implement for the first time the highly accurate Rietveld-based quantification techniques, and maintain competitivity by ensuring speed, capacity and accuracy in mineralogical services and research. It will also expand analytical applications into fields which were previously not possible, such as the analysis of thin films (for example industrial dust filters), and solids in suspension. The Rietveld Refinement method allows for the obtaining of additional information from diffraction data, such as the quantification of phases including amorphous content, identification of trace phases, determination of crystal structures, accurate determination of crystallite size and strain, peak profile fitting and indexing of crystal lattic. In adopting the latest developments in X-ray-diffraction technology, instrumentation and software, and mastering the wide range of additional applications available, new knowledge and skills will be acquired and developed which will align the CGS with leaders in advanced research in applied mineralogy and crystallography, and their application in mineral exploration, mineral processing and environmental sciences.



BRUKER D8 Advance.

LIMPOPO UNIT

The Limpopo Unit, centrally based in Polokwane, is responsible for the geological mapping of the province; details of the projects worked on this year are outlined below. In addition the unit is actively involved in providing geological input to assist prospectors in their applications for initial DME prospecting permits for a variety of minerals. Enquiries from the public generally involve either mineral identification or assement of the mineral or groundwater potential of farms or areas.



Locality map for Limpopo Unit projects, including the Field School, research sites and geological mapping.

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 techniques of practical field mapping.*
Duration: Ongoing.
Budget: R48 520.

Motivation
A number of years ago a need was identified to develop the practical mapping skills of inexperienced geologists who had recently joining the CGS. In view of the CGS's statutory mapping mandate and international mapping projects in progress, a field school was seen as a means of efficiently addressing this issue.

Progress
The project for this year was completed. The field school was held from 3 to 20 March and scientific staff who had recently joined the Central Mapping Unit were targeted. The field school focused on those geologists who would be required to utilise the skills provided. The school activities were spread throughout the Limpopo Province, which exhibits varied and reasonably exposed geology, suitable climate and is accessible.

On completion of the training, the participants were each required to produce a report and make a presentation to their colleagues on an assigned aspect of the fieldwork.

Conclusion
Although the mapping school is open to staff members from other units, inexperienced geologists who will be involved in mapping are now assigned to the Limpopo Unit for two years for the geological mapping programme which has a dominant training theme. The field school is in effect the introductory module to the training programme, and supplies a need that is in accordance with the training strategy of the CGS.

For the mapping exercises two study areas that are geologically well known, but differ strongly regarding rock types, metamorphic grade and tectonic style, were chosen. Basic map and aerial-photography interpretation skills were covered before field training commenced.

Participants making observations at the contact zone between the greenstone belt and intrusive granitoid gneisses near Polokwane.

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

Near Polokwane the area of interest comprised low-grade amphibolites of the Pietersburg greenstone belt which are in tectonic contact with grey gneisses. The latter consist of several varieties that are intimately mixed, although the sequence of intrusions can still be determined.

Future activities
The school will be repeated on an annual basis 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.

0975
1:50 000-SCALE GEOLOGICAL MAPS 2428BB TINMYN, 2330CC TZANEEN AND 2430BB MICA

Project leaders:	R.W. Belcher, Ph.D., N. Baglow, B.Sc.Hons.
Project team:	S. Buthelezi, B.Sc.Hons, G. Nene, B.Sc.Hons, M. Dau, B.Sc.Hons.
Primary objective:	*to investigate the geology of the map areas with particular emphasis on the structure, mineral potential and groundwater.*
Duration:	2007/8 to 2008/9.
Budget:	R302 542.

Motivation
Geological mapping is one of the core functions of the CGS. The 1:50 000-scale mapping programme forms a basis for the production of 1:250 000-scale maps and supplies information upon which other research hinges. The map areas selected were chosen for the variety of geology that they cover and suitability for use in the training of inexperienced mapping geologists under the expanded Field School programme (see report on Field School).

Progress
The area covered by sheet 2428BB Tinmyn is underlain by Lunsklip Granite and by the Black Reef Formation, Malmani Subgroup dolomites and banded-iron-formation of the Penge Formation. The Bushveld Complex intruded between these and the overlying Pretoria Group rocks, with the mafic suite (hosting the PPRus platinum mine) poorly exposed over flat terrain, and the granitic suite underlying the main range of hills. Rooiberg volcanics are well developed and are succeeded by sediments of the Waterberg Group into which numerous dolerite sills have intruded.

For the Tinmyn mapping, four students from the University of Pretoria were included as participants in the programme in order to undertake B.Sc.Hons mapping projects.

In the Tzaneen area basement rocks studied were dominantly the Goudplaats Gneiss (~3 200 Ma) intruded by the Duivelskloof Leucogranite at about 2 800 Ma. Representative lithologies were sampled for petrographic and geochemical analyses for both the Tinmyn and Tzaneen areas.

Preliminary work around Mica confirmed the existence of a number of granitoid bodies that intruded the Makhutswi Gneiss, which also hosts an abundance of mafic and ultramafic greenstone remnants. The pegmatites of the area are of economic significance.

Conclusion
The geology encountered in the course of mapping these areas exposed the young geologists to enough variety to significantly broaden their experience within a strongly supervised project environment, while at the same time contributing to the overall mapping programme.

Future activities
The portions of the map sheets covered this year under the auspices of the Field School training will be incorporated with mapping that is planned for 2008/9, and will contribute to the final production of maps with explanations.

Geologists on the extended Field School mapping programme investigating a granite outcrop in the Tzaneen area.

Well-exposed contact between jointed Rooiberg Group volcanics and Swaershoek Formation conglomerates of the Waterberg Group, from the Tinmyn area.

0989

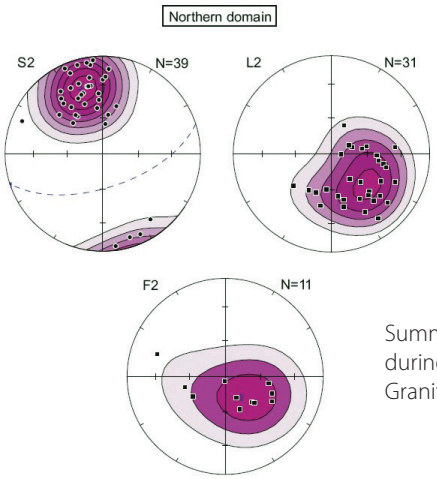
THE STRUCTURE, GEOCHEMISTRY AND EMPLACEMENT OF THE BADEROUKWE GRANITOID, MURCHISON SCHIST BELT

Project leader:	R. Belcher, Ph.D.
Project team:	K. Benn, Ph.D. (University of Ottawa).
Primary objective:	*to map the Baderoukwe granitoid and its environs, develop research skills and present the results in a scientific paper.*
Duration:	2007/8 to 2008/9.
Budget:	R21 975.

Motivation
Geological research forms part of the mandate of the CGS, and this project continues the mapping undertaken in the Murchison greenstone belt, which is adjacent to the project area and which was documented in Memoir 81 of the CGS. The project will in particular develop research skills within the unit and external collaboration will enhance the validity of the results.

Progress
The preliminary fieldwork and sampling was undertaken and the internal report completed.

Conclusion
Geologically the area can be subdivided into several groups based on the predominant lithology and on previous work; northern basement, schist belt, Baderoukwe pluton and southern basement. These units also correspond to the structural subdivisions; northern granitoid domain, schist belt itself, Baderoukwe pluton intruding central-eastern parts of the pluton, and the southern granitoid domain. Several deformation phases were identified across the area which were not necessarily present in all the domains.



Summary of structural data collected during the field period on the Baderoukwe Granitoid.

In the northern granitoid domain the earliest fabrics are S2 and the domain was assembled through the injection of sheets into the pre-folded amphibolites, and the foliations in the sheets are quite clearly magmatic. In some places the sheets have been isoclinally folded during the synemplacement shearing, locally resulting in isoclinal, rootless folds that have hinges parallel to the L2 extension (and mineral) lineation in the sheets.

Future activities
The project will continue during the 2008/9 financial year.

0898
ZEBEDIELA BUILDING MATERIALS

Project leader: N. Baglow, B.Sc.Hons.
Project team: O. Miyambu, BESMEG.
Primary objective: *to ascertain the general potential for clay and other building materials in the Zebediela area.*
Duration: 2005/6 to 2008/9.
Budget: R23 615.

Motivation
Regional geological mapping of the area in 2004 revealed that there are sporadic occurrences of clays, and this project aims to quantify these on the regional scale in order to obtain a better understanding 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.

Progress
Previously auger holes were drilled across the map area, with sites determined both by encouraging results from the reconnaissance programme of the previous year and the need for in-fill information. The samples were analysed by XRD to determine the various clays present and the results plotted to portray their distribution. Preliminary ceramic tests were carried out on the clays from the various sites.

Conclusion
Results of XRD analyses from drillhole samples confirmed the existence of smectite, palygorskite and other clays at various depths over a wide area. Preliminary ceramic tests have yielded some encouraging results.

Future activities
Further ceramic tests will be conducted on the most suitable clays. The map produced will be used as the basis for ground-truthing remote-sensing data over the same area. This could be a prelude to developing a methodology for looking for favourable clay-rich areas elsewhere.

0990
LIMPOPO TAILINGS

Project leader: O. Miyambu, BESMEG.
Project team: N. Baglow, B.Sc.Hons, H. Coetzee, M.Sc.
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 2008/9.
Budget: R19 187.

Motivation
The research is conducted in order to contribute towards the amount of available information on the impact of mining on environmental, social and economic issues. The research will contribute to sustainable development in mining, a project initiated by the Department of Minerals and Energy together with the CGS and, specifically, the Environmental Geoscience Unit.

Progress
The project team visited the Osprey Gold Mine and assessed the workings. The mine ranking system was applied to determine the extent of the impacts.

Conclusion
Shafts and adits had been left open and lacked adequate safety features, with the exception of wire fencing to prevent access, which is inadequate. The tailings dumps lacked vegetation cover at the time of the visit. Lack of plant cover increases the effect of dust blowing towards habitations during winter.

Some of the buildings had been broken into by members of the nearby community, and chemicals in the storerooms had been spilled. There are signs of erosion of the slimes dams by rainwater runoff, and the eroded materials will eventually flow into rivers. Community members reported cases of animals dying from drinking water.

Future activities
Follow-up research will be conducted during a future M.Sc. programme that will also suggest the best rehabilitation, mitigation and management strategies.

Osprey Gold Mine slimes dam showing erosion by rainfall.

0997
1:250 000-SCALE MAPPING OF SHEET 2428 MODIMOLLE

Project leader: N. Baglow, B.Sc.Hons.
Primary objective: *to compile a 1:250 000-scale geological map and write an accompanying explanation, with the aim of supporting local mineral development and groundwater issues.*
Duration: 2007/8 to 2010/11.
Budget: R22 548.

Motivation
The first edition of this map was published in 1978 as sheet 2428 Nylstroom, with a short explanation printed on the map. Mapping of critical 1:50 000-scale sheets has been ongoing since 1997, improving knowledge of these particular areas and lithologies. This new work, covering the dolomite terrain, will be included. The old map is still in demand and the lack of a detailed geological explanation has been a shortcoming.

The map sheet covers areas that have witnessed significant small- and large-scale mining activity, rapid urbanisation in Sekhukhuneland, and have serious groundwater needs.

Progress
The chapter outline has been completed, an inventory of existing information has been undertaken and a reference list has been compiled.

Conclusion
The general geological outline has been completed and aligned with the geology on adjacent map sheets.

Future activities
The preliminary map compilation incorporating available data will be undertaken during 2008/9.

MARINE GEOSCIENCE

0753

MARINE GEOPHYSICAL SURVEY OF THE PORT ELIZABETH HARBOUR, CONDUCTED ON BEHALF OF THE INSTITUTE FOR MARITIME TECHNOLOGY AND THE SA NAVY

Project leader: S. Coles, B.Sc.Hons.
Project team: H. Cawthra, B.Sc.Hons, B. Smith, B.Sc.Hons, K.Smith, B.Sc.Hons, W. Kupido, W. Kidwell.
Primary objective: *to provide detailed maps of sea-bed sediments on the approaches to a key strategic harbour.*
Duration: Ongoing.
Budget: R64 100.

Motivation

Detailed maps of sea-bed sediments in the approaches to key strategic harbours is a requirement of national importance to the Institute for Maritime Technology (IMT), and ports that will host events for the 2010 World Cup, namely Port Elizabeth, Durban and Cape Town, have been given priority.

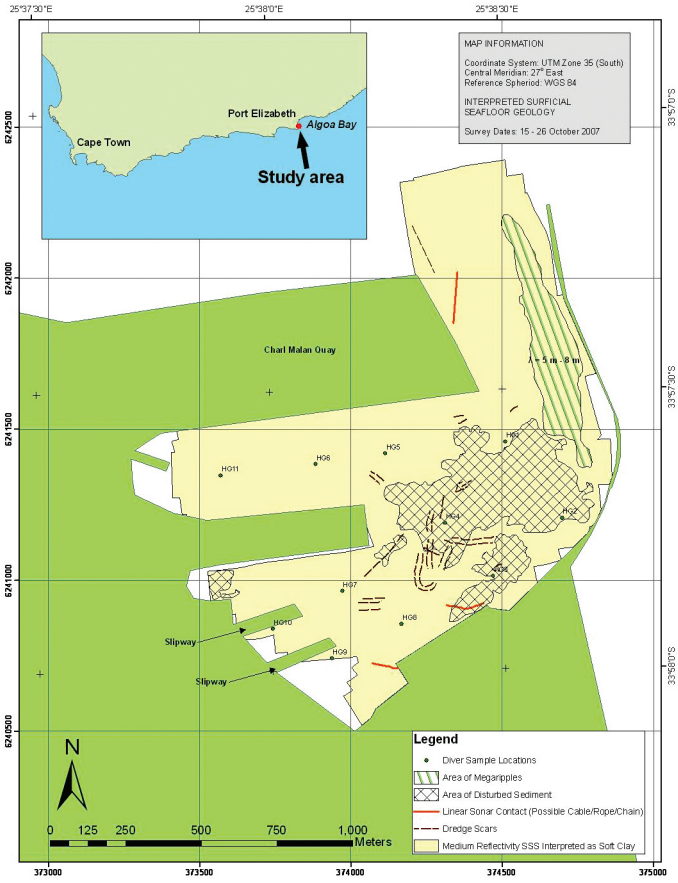
This statutory programme is of immense value to the Marine Geoscience Unit (MGU) as it provides an opportunity for unit members to become more skilled in marine-geophysical data acquisition, but learning outside of the pressures of a commercial environment where the daily costs or consequences of repeating work due to mistakes would be prohibitively expensive for the CGS.

Progress

The MGU conducted a geophysical survey as part of the 2007/8 annual strategic harbour approach survey programme of Port Elizabeth harbour, covering an area of 1.3 km^2. The survey was conducted from 15 to 26 October 2007 on behalf of IMT and the South African Navy, to provide detailed maps of sea-bed sediments on the approaches to a key strategic harbour. The final report was submitted to IMT on 20 February 2008.

Conclusion

The geophysical survey acquired detailed multibeam bathymetry and side-scan sonar data which were used to interpret the sediment type, sediment movement and the condition of the sea bed. The survey found that the water depths in the survey area ranged from less than 3 m in the west and east, to 17 m in the dredged channel in the centre of the survey area. The sea bed was dominated by soft to very soft clay or fine sand with megaripples. There was evidence of dredging in the deeper central channel, as well as dredge scars showing prior dredging activities. No sea-bed obstructions were identified, but several linear sonar contacts were found indicating either cables, pipes, ropes or chains. Unspecified sonar contacts seen throughout the survey area are most likely debris discarded from vessels in the harbour.



Future activities

This project is ongoing, with an annual survey on behalf of IMT and the Navy. During 2008/9 further surveys will take place in Port Elizabeth harbour; the survey will be extended further out to sea.

0963
INVESTIGATION INTO POTENTIAL GAS HYDRATE AND GAS ZONES OFF THE SOUTH AFRICAN COASTLINE

Project leader: B. Smith, B.Sc.Hons.
Primary objective: *to develop a deeper understanding of gas hydrates and their occurrence. Seismic data will be used to investigate whether gas hydrates or gas zones occur off the west coast of South Africa.*
Duration: 2007/8 to 2009/10.
Budget: R10 000.

Motivation
Gas hydrates represent a potential alternative energy source and in the present climate of energy shortages their localities should be investigated. Research in this area adds to the CGS's available information on this topic. Masters studies are strongly encouraged as these increase the capacity of the CGS by improving and expanding the qualifications of its staff.

Progress
Background research was done throughout the year on the present state of knowledge of gas hydrates, as well as attempting to acquire hard data to interpret. A research trip was undertaken, at the invitation of the Naval Research Laboratory in the United States, to observe data-gathering techniques, as well as to collaborate with those in the forefront of hydrate research.

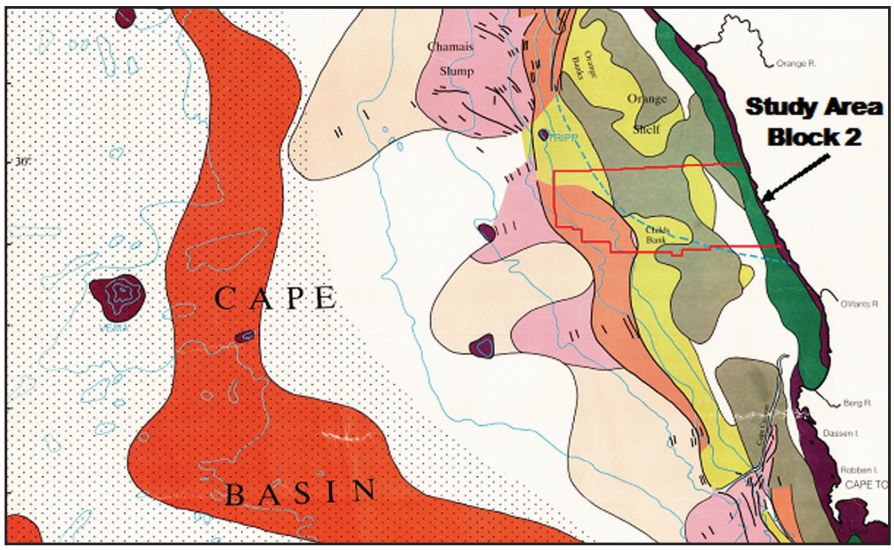
Throughout the year background data have been gathered and potential target areas identified. No results are forthcoming yet as the dataset still needs to be released by the relevant authorities.

Conclusion
Conclusion can only be reached after interpretation of the dataset and comparison with the known conditions; at this stage there are hypotheses that need data for verification.

Future activities
The project has a proposed budget of R68 000 during the coming year, greater than the current year owing to anticipated expenses for foreign travel, data acquisition, printing and archiving of reports, and communication with local and foreign universities.

A report on the background of gas hydrates and hydrate exploration, as well as the background of the dataset obtained, will be completed within the next year, as well as obtaining permission to use the data from the Petroleum Agency of South Africa (PetroSA). This will be 2D seismic data within blocks 1 and 2. Cooperation with the GeoforschungZentrum (GFZ) under the same project is also likely and will strengthen international bonds. The interpretation of the available dataset with The Kingdom Suite and Petrel software will be undertaken at the University of Cape Town, which holds the licence for the software. In cooperation with GFZ a data model is to be produced using their modelling software.

A report will be completed on the methods and techniques used to analyse the dataset, as well as a draft of the results and the conclusion gleaned from the model.



MINERALS DEVELOPMENT

0861
INDUSTRIAL-MINERALS MAP OF SOUTH AFRICA

Project leader: G.F.J. Horn, M.Sc.
Project team: L. Tongu, Ph.D., A. Keenan, M.Sc., R. Opperman, B.Sc.Hons, C.J. Vorster, M.Sc., W. Buitendag.
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 and other products.*
Duration: 2004/5 to 2010/11.

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-minerals mining companies are small- to medium-size enterprises with limited venture capital available. If the large value-added potential of industrial minerals, from crude-mined products through to beneficiated mineral products and 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 the understanding 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.

Progress
The Eastern Cape Province of South Africa is covered by eleven 1:250 000-scale maps: Aliwal North, Kokstad, Middelburg, Queenstown, Umtata, Beaufort West, Graaff-Reinet, King William's Town, Kei Mouth, Oudtshoorn, Port Elizabeth and Grahamstown.

Data on the mineral occurrences depicted on these sheets were extracted from SAMINDABA. This was followed up by desktop literature studies of reference materials pertaining to mineralisation in the Eastern Cape Province, and fieldwork planning, from April to June 2007. Operational meetings during which the mapping project was discussed and training given occurred whenever required. Unfortunately, resignations and reallocation of personnel to other projects during the previous year and the early part of 2007 left the industrial-minerals mapping project with only three of its original eight scientists. This problem resulted in the mapping team having no time to work on the main objectives of the project, such as provisional ore-deposit formation modelling, and therefore not attempting to identify new potential industrial-mineral deposits, a major objective of the original project motivation.

Only the Port Elizabeth, Kokstad and Umtata maps remain to be mapped. Focus will be on the Port Elizabeth map during January and February 2009, while the work on the Kokstad and Umtata sheets can only start after appropriate security arrangements have been made by the CGS. However, it is foreseen that all work on the Port Elizabeth map will be completed during the current financial year and that the North West Province would follow during the 2008/9 technical year. It is also foreseen that during 2008/9 work will commence in the Limpopo and Mpumalanga Provinces.

Those occurrences and deposits in which the ore bodies were still exposed, or that could otherwise be sampled without jeopardising sound scientific principles, were sampled. Because a set of basic analytical data per deposit could assist in future target selection, sample materials were prepared for basic petrographic, mineralogical and geochemical analytical studies.

The following table shows the statistics for the year 2007/8.

Year ended March 2008: industrial minerals mapping statistics.	
Eastern Cape Province: Twelve 1:250 000-scale sheets were covered during 2007–2008: Aliwal Noord, Kokstad, Middelburg, Queenstown, Umtata, Beaufort West, Graaff-Reinet, King William's Town, Kei Mouth, Oudtshoorn, Port Elizabeth, Grahamstown.	
Kilometres covered	25 608 km
Deposits and occurrences visited	437
Inaccessible deposits and occurrences	35
Deposits and occurrences not found at coordinates supplied by SAMINDABA	53
Number of localities sampled	167
Number of samples taken	170
Number of deposits and occurrences already on SAMINDABA	345
Number of new deposits and occurrences visited	92
Commodities investigated	Sand, aggregate, gravels (sabunga), calcrete, clay, gypsum, phosphate, zeolite, bauxite.
SAMINDABA database records completed	437

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 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.

0865
MINERAL RESOURCES FOR SUSTAINABLE DEVELOPMENT IN THE SOUTHERN AFRICAN CONTEXT

Project leader: A.Y. Billay, Ph.D., S. Frost-Killian, M.Sc.
Project team: L. Ngcofe, D. Eberle, Ph.D., J. Cole, M.Sc., P. Cole, M.Sc., S. Foya, Ph.D., R. Hansen, B.Sc.Hons, S. Strauss, M.Sc., D. van der Walt, B.Sc.Hons, D.L. Ehlers, B.Sc.Hons, G. Brandl, Ph.D., V. Mothetha, M. Brynard, Ph.D., S. Ngesi.
Primary objective: *to generate mineral-potential targets in known mineral provinces in South Africa.*
Duration: 2006/7 to 2010/11.
Budget: R39 585.

Motivation
Modern mineral-potential mapping by integrating geophysics, geochemistry, satellite images, mineral-occurrence or deposit data, structures and other geological information using GIS has proven to be successful in generating mineral-potential targets in known mineral provinces. This can help mineral-resource development and stimulate exploration

investment by reducing the risk involved in exploration 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 SADC region.

Progress
The project is currently subdivided into two sub-programmes:

Sub-programme 1: Predictive mineral-potential mapping (integration of geology, geophysics, geochemistry, remote sensing and satellite imagery using GIS) — the primary focus for 2008/9.

Sub-programme 1 involves the study of copper in the Musina and Alldays areas. The relevant datasets have been collected, processed and integrated. A technical report and a mineral potential map have been produced.

Sub-programme 2: Mineral resources for sustainable development in the southern African context and the associated Global Mineral Resource Assessment Programme (GMRAP), a cooperative programme between the USGS, CGS and other professionals throughout southern Africa.

As a participant of the GMRAP programme, the CGS took part in the first assessment of copper, potash, platinum and nickel for southern Africa in 2006. The GMRAP in its entirety is limited initially to eight commodities (Cu, Au, Pb, Ni, PGM, Zn, phosphates and potash). It will identify prospective future mineral-resource areas of the world by applying various statistical methods, existing information, known mineral deposits and occurrences, grade/tonnage models and well-defined deposit models, amongst others. The results will be presented on prospectivity maps, with a confidence rating for the possibility of finding new deposits. The draft 'first-pass' results of the first southern African assessment are expected to be processed in 2008/9, with the study due for completion in 2010. Work will be carried out on Sub-programme 2 during 2008/9, with predictive mineral-resources mapping in the SADC region and participation in GMRAP resuming in 2009/10.

Conclusion
For Subprogramme 1, the data integration method applied for the project area has outlined several potential areas that require follow-up fieldwork to verify the results and accuracy of the integration and data-interrogation techniques applied. A reviewed report will be available to the public and various interested exploration and mining companies in 2008/9.

For subprogramme 2, the project is of critical importance to the future development of the minerals industry, both in South Africa and in Africa as a whole. The CGS has large, relevant databases, as well as good cooperation with several geological institutions. The project represents a new and exciting research direction for the CGS and can contribute considerably towards the NEPAD and South African goals of sustainable development and poverty alleviation. Work on this programme will be intermittent during 2008/9, but will be resumed full time in 2009.

Future activities
The project will continue in the 2008/9 financial year, and the gold potential of Giyani or the Kraaipan greenstone belt will be examined.

0900
THE ACID NEUTRALISATION POTENTIAL OF DIFFERENT MINERALS AND ROCKS FROM THE ABANDONED COPPER MINES IN THE O'OKIEP COPPER DISTRICT, NAMAQUALAND

Project leader: R.N. Hansen, M.Sc.
Project team: M. Kotoane, P. Wade, Ph.D.
Primary objective: *to establish whether the rocks of the terrain surrounding the abandoned mines as well as the country rock now found on the mine waste dumps, have the capacity to neutralise acid-mine drainage, thereby facilitating the precipitation and immobilisation of the contaminants, and reducing the costs involved in the remediation of the contaminated areas.*
Duration: 2007/8.
Budget: R30 000.

Motivation
This project follows on work done to establish a geo-environmental model for the abandoned copper mines of the O'okiep Copper District, Namaqualand. A study has shown that a significant amount of acid mine drainage is causing contamination of local groundwater and ecosystems with a range of contaminants, including copper, cadmium, chromium, uranium and iron.

Namaqualand is semi-arid with an average rainfall of 150 mm per year. Owing to the low rainfall, the area is dependant on groundwater and the perennial Orange River for its water needs. However, the communities located around the

non-perennial Buffels River pump water from wells dug into the river bed during the dry season as water pumped from the Orange River is too expensive. The Buffels River runs close to an abandoned copper mine and this important source of water is thus being polluted by heavy metals in the effluent draining from the slimes dam and other mine-waste dumps. Remediation of this situation is therefore important as this scenario is not unique in Namaqualand. This study attempts to address such issues by research into the possible acid neutralisation effects of ore host rocks, occurring on mine waste dumps at mine sites and of the rocks and minerals of rock types in the area surrounding these mines. This could help to reduce the costs of remediation, thereby speeding up the remedial process, and ensuring the adjacent communities of their basic human right of access to clean drinking water.

Progress
A report has been completed.

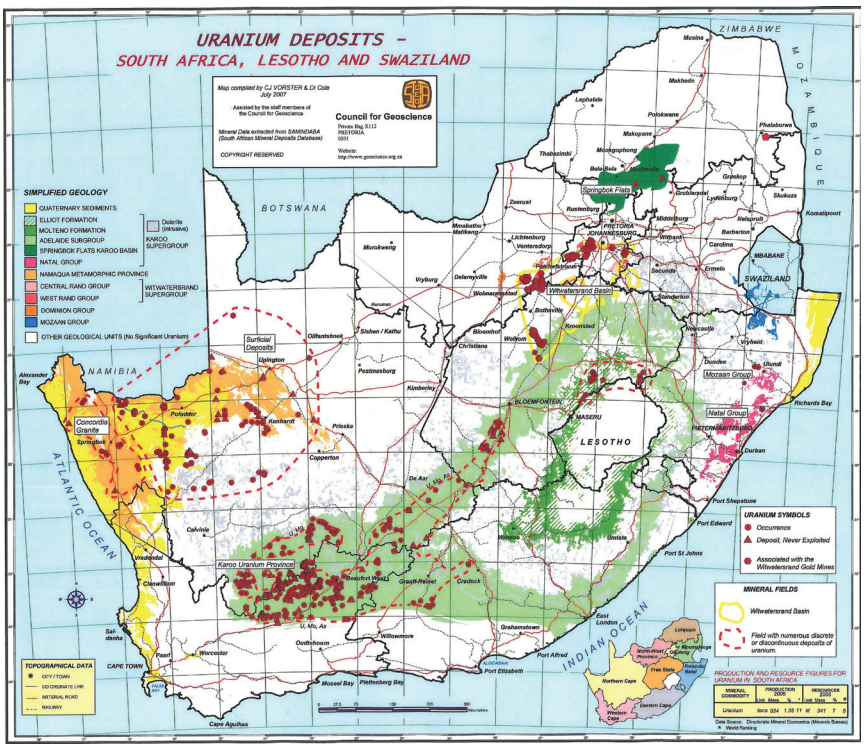
Future activities
Only a few samples of rocks and minerals in the immediate vicinity of the mine sites, as well as from an uncontaminated area, were collected and assessed for their acid-neutralisation potential. Additional samples from other rock types in Namaqualand will be selected for study, as there are mafic and ultramafic rocks in the area which have the potential to be used to neutralise acid mine drainage, and similar tests have been successfully completed in other areas of the world. The study will also be expanded to include the rocks and minerals constituting the wall rocks of the Witwatersrand gold mines. Gold mining in South Africa is on the decline, leaving behind it a legacy of over 100 years of mining. Large areas of agricultural land and important ground and surface water reservoirs have been contaminated by heavy metals and acid mine drainage flowing from the mining areas. Cost-effective remediation techniques are therefore needed, and these could be developed if local sources of acid-neutralising rocks and minerals can be found.

0986
URANIUM RESOURCES OF SOUTH AFRICA

Project leaders: D. Cole, Ph.D., D.L. Ehlers, B.Sc.Hons.
Project team: C.J. Vorster, M.Sc., S. Frost-Killian, M.Sc.
Primary objective: *to compile a summary of uranium occurrences and deposits in South Africa.*
Duration: 2007/8.
Budget: R35 040.

Motivation
The project was initiated at the request of the DME and was motivated by the current interest in uranium and uranium exploration, the high commodity price and the growing international demand.

With the increase in demand for nuclear fuel worldwide, there has been a major upswing in the uranium market. This has necessitated the need to compile a summary document on the known uranium occurrences and deposits in South Africa. This information will help expedite the issue of concessions to exploration companies wishing to explore for uranium in South Africa.



Progress
The summary document on known uranium occurrences and deposits in South Africa has been completed.

Conclusion
The project team has identified seven uranium mineral resource fields, the extent of which are shown in the following table:

Resource Figures (metric tons U) for Uranium Fields in South Africa					
Field	Identified Resources		Undiscovered Resources		Total
	Reasonably Assured	Inferred Resources	Prognostic Resources	Speculative Resources	
Witwatersrand Basin	192 314	129 147	108 518	620 000	1 049 979
Karoo Uranium Province	24 938	7 894	1 105	189 800	223 737
Springbok Flats	65 029	12 043		77 072	
Surficial (Northwest Cape)	721	405		9 000	10 126
Phalaborwa	1 351	1 175			2 526
Concordia Granite				100 000	100 000
Mozaan Group	25	46	687	15 500	16 258
TOTAL	284 378	150 710	110 310	934 300	1 479 698

Out of the seven uranium fields, the Witwatersrand Basin contains the majority of uranium resources in South Africa and has been the site of extensive prospecting activities. It is currently the only source of uranium production in South Africa and several new mines are coming on stream, with uranium being produced as a byproduct of gold except in the case of the Dominion Reefs Mine, near Klerksdorp. Extensive investigations are underway in the Karoo Uranium Province and it is possible that one mine will open near Beaufort West in 2009, with molybdenum being recovered as a byproduct. Very few activities are taking place in the other uranium resource fields, although they all have the potential to contain economically viable deposits. Of these, the Springbok Flats contains the largest identified resources, but is constrained by the lack of a metallurgical process that can extract the uranium from the coal host rock.

The availability of open ground in many of the significant uranium resource fields described above presents opportunities for further investigations and evaluation work by or under the aegis of the CGS with potential for future uranium discoveries. Furthermore, metallurgical studies are needed to establish an extraction process for the uranium from the coal host rocks in the Springbok Flats coalfield, as resources are potentially very large.

Future activities
A summary document on known uranium occurrences and deposits in South Africa has been completed.

0995
LIMESTONE RESERVES OF SOUTH AFRICA

Project leader: E. Long'a Tongu, Ph.D.
Project team: M. Makhado, B.Sc.Hons, C.J. Vorster, M.Sc.
Primary objective: *to compile data on limestone deposits of South Africa which are currently not being mined.*
Duration: 2007/8.
Budget: R252 377.

Motivation
The project was initiated at the request of the DME, and was motivated by the high demand for cement and resulting shortage. The cement industry has grown, from a 2.0-million ton industry in the 1950s to an industry expected to produce nearly 12.5 million tons of cement in 2005. The growth in cement demand is expected to continue well beyond 2010. This necessitated the need to compile the reserves data of limestone deposits which are currently not being mined.

The reserves data will help expedite the issue of concessions by the Department of Minerals and Energy (DME) to small-scale miners wishing to mine limestone deposits.

Progress
This project involves a search of reserves data from all available sources including databases (such as SAMINDABA) and from other sources such as the internet. The project has been completed with a summary report accompanied by maps showing the distribution of limestone in each province of South Africa.

Conclusion
The study has established potential reserves in nine South African provinces as indicated in the Table below.

Minimum Reserves Estimates (Mt)	
WESTERN CAPE	13 060.4
NORTHERN CAPE	51.3
NORTH WEST	1 515.8
LIMPOPO	2 215.4
MPUMALANGA	1 103.9
GAUTENG	1.5
KWAZULU-NATAL	3.0
EASTERN CAPE	17.1
FREE STATE	103.9

The potential target areas are:

Western Cape Province: Vredendal, Saldanha, Worcester, Oudtshoorn and Beaufort West. These areas are connected to rail and road infrastructure and are not too far from the coast. These occurrences could also benefit from further research to determine grades and reserves.

Eastern Cape Province: Occurences to the east and west of Uitenhage, near Cradock, Middelburg, Graaff-Reinet and the coastal deposits near Port Alfred constitute the best targets of the Eastern Cape Province. These occurrences also require further research to determine grade and reserves.

Northern Cape Province: Limestone occurrences in the Alexander Bay area and the deposits in the Postmasburg–Olifantshoek–Sishen (Kathu)–Kuruman area form the best targets of the Northern Cape Province. There are well-known cement and lime companies at Ulco, Lime Acres and Daniëlskuil sitting on vast limestone deposits. Further work to determine extensions from these known deposits could potentially yield significant limestone reserves. The area is serviced by good rail and road networks.

North West Province: The best limestone occurrences are near Delareyville, between Christiana and Bloemhof, and between the towns of Lichtenburg, Mafikeng and Zeerust. These occurrences are located close to rail and road infrastructure. Other occurrences are known in Pomfret or Morokweng, the reserves of which are potentially large. However, the lack of rail and road infrastructure downgrades the viability of this target for the foreseeable future.

Limpopo Province: The best limestone targets are those near the towns of Modimolle and Mokopane as they are situated close to rail and road networks. Other less significant targets are located north of the town of Lephalale (close to the border with Botswana), but these lack rail and road infrastructure and are relegated to a lowly rank.

Mpumalanga Province: Known limestone occurrences are found between the towns of Carolina and Lydenburg, to the south and northwest of Groblersdal, and north of Graskop. The rail and road infrastructure is generally adequate. Consequently, the deposits located between Carolina and Lydenburg represent resources that could benefit from further study.

Free State, KwaZulu-Natal and Gauteng Provinces: These provinces lack significant known limestone targets that could benefit from further research to bring them onboard for new investments. Most limestone occurrences in these provinces occur as single points with no continuity, a fact which downgrades them to secondary targets.

Future activities
The project is complete and a summary report, accompanied by maps showing the distribution of limestone in each province of South Africa, has been produced. The research findings have been used for the compilation of a report on cement for the DME.

0996

ADVANCED STUDY ON OXIDATION ZONE DEVELOPMENT PROCESSES IN THE WITWATERSRAND BASIN WITH EMPHASIS ON ACID MINE DRAINAGE DEVELOPMENT

Project leader: S. Foya, Ph.D.
Project team: B. Yibas, Ph.D., S, Lekoadu (CGS bursar).
Primary objective: *to research oxidation zones in the gold tailings dams and to identify the key parameters and characteristics of oxidation zones, which can be applied to Acid Rock Drainage (ARD) prediction, prevention and remediation.*
Duration: 2007/8 to 2008/9.
Budget: 2007/8: R300 000.

Motivation
The understanding of oxidation zones and phreatic water surfaces plays a very important role in the prediction of acid rock drainage (ARD). It has been experienced that the uncertainty regarding the depth and progression of the oxidation zones is one of the major drawbacks in geochemical assessment and predictive modelling, and that the establishment of accurate oxidation profiles and determination of the phreatic surface become important issues for ARD prediction. Recent research findings have established the average oxidation zones associated with tailings dams in the Witwatersrand basins, but the role of mineralogical and geochemical variation with depth on migration of the phreatic surface, and therefore oxidation progression with depth, has not been quantitatively established.

Progress
The following methodologies and experimental procedures will be adopted for this study:

Task 1 - Identify and select one or two tailings dams.
Task 2 - Carry out a detailed profile study of the tailings dams with the objective of classifying the oxidation zones into geochemical zones.
Task 3 - Collect representative samples along profiles and from auger holes.
Task 4 - Analyse the samples for geochemical and mineralogical characteristics.
Task 5 - Study the effect of variation in hydraulic properties (porosity, permeability, water content, preferential flow pathways such as cracks and fractures, megapores) with depth on oxidation processes.
Task 6 - Measure change in oxygen flux with depth.
Task 7 - Conduct an intensive literature review.

Tasks 1 to 3 have been completed. Tasks 4 and 5 are currently in progress, with some results such as moisture content, particle-size distribution, Paste pH and Paste electrical conductivity measurements having been received.

Conclusion
This research project was designed to target the group of mines, regulators and consultants who are involved in commissioning, undertaking or reviewing assessments for mine-waste-residue deposits. As part of capacity building the project will train junior scientists within the unit.

The project has the following deliverables:
A report on the characterisation of oxidation zones of the selected tailings dam profiles.
A detailed report on the interpretation of the laboratory results (Tasks 3 and 4).
A report on the characterisation of variations of geohydrological features including cracks, porosity, permeability, cracks with depth and all possible hydrologic path ways.
A report on the establishment of oxygen flux (diffusion, convection) profiles for oxidation zones.
A final and concise report that details the research results on the study of oxidation zones in the tailings dams.

Future activities
Complete Tasks 4 and 5 and continue with Task 6. Completion of the five deliverables as follows:
Report on the characterisation of oxidation zones of the selected tailings dam profiles;
Detailed report on the interpretation of the laboratory results (Tasks 3 and 4);
Report on the characterisation of variations of geohydrological features including cracks, porosity, permeability, cracks with depth and all possible hydrologic pathways;
Report on the establishment of oxygen-flux (diffusion, convection) profiles for oxidation zones;
Final and concise report that details the research results on the study of oxidation zones in the tailings dams.

5582
SMALL-SCALE MINING PROGRAMME

Project leader:	F.E.D. Senzani, M.Sc.
Project team:	N. Govender, B.Sc.Hons, L.B. Majokweni, B.Sc., M. Makhado, B.Sc.Hons, N.S. Mayekiso, B.Sc. Hons, C. Mohale, B.Sc.Hons, C. Zermatten, B.Sc.Hons, E.L. Tongu, Ph.D.
Primary objectives:	*to (i) help small-scale miners access the mainstream mining industry of South Africa; (ii) facilitate compliance with legislative and regulatory stipulations that govern the small-scale mining industry, and (iii) assist rural communities to participate actively in the exploration of natural resources and eradicate poverty.*
Duration:	Ongoing.
Budget:	R16 500 000.

Motivation
The Small-Scale Mining Programme aims to reduce poverty in underdeveloped rural communities through sustainable development and exploitation of small-scale mining enterprises. This is achieved by extending institutional support and

technical expertise to developers of deposits amenable to small-scale mining by means of feasibility studies. It is critically important that this assistance be provided to the small-scale mining and quarrying sectors, as they are particularly vulnerable to geoscientific risk. Assistance is made available in order to lower the risk inherent in their mining ventures by extending finance, and scientific and managerial expertise to those small-scale miners who can demonstrate a *bona fide* lack of resources. This approach has distinct advantages as it benefits mostly poor and needy communities, and therefore offers a mechanism having an impact on poverty alleviation through minerals development. It is hoped that this assistance will enable aspiring small-scale miners, most of whom often lack the scientific ability to lower the risk inherent in their projects, to acquire bankable mining proposals which can be used to apply for venture capital from traditional lending institutions.

Progress
Technical investigations have been approved for 171 projects (including both small-scale mining and beneficiation) by the Small-Scale Mining Board of the DME. Twenty-seven of these projects have been completed, and of these 14 had been capitalised and are in operation, while the rest have been terminated owing to lack of potential.

Nineteen projects involve beneficiation by the manufacture of jewellery. Feasibility studies have been completed for eight of these, with only one proving to be non-viable. Work on the others is continuing.

In the first year of the programme, 2004/5, only six projects had been approved. There has, therefore, been a large increase in the project workload of the programme mainly due to ever-increasing interest on the part of the public. This has necessitated higher staffing levels and strengthening of the programme's organisation. These interventions are ongoing.

Conclusion
The CGS recognises the enormous task of fulfilling the objectives of the small-scale mining programme. Three categories of experts are utilised. Firstly, in addition to their geoscience and mapping assignments, staff of the regional CGS offices are employed in the assessment of small-scale mining targets. They have the advantage of being close to the targets, as well as having in-depth knowledge of their geological and metallogenic settings. The CGS is therefore ideally positioned and has the technical, scientific and infrastructural capacities to implement the national programme successfully. The programme also accords well with the statutory mandate of the CGS, which includes initiatives to promote the alleviation of poverty through sustainable development and exploitation of mineral resources.

Future activities
The programme is ongoing and will continue into the 2008/9 financial year. The future of the programme will be determined in conjunction with the Small-Scale Mining Board of the DME.

Small-scale mining of sand deposits in the KwaZulu-Natal Province.

DATABASES

0166
SAMINDABA – THE SOUTH AFRICAN MINERAL DEPOSITS DATABASE

Project leader:	C.J. Vorster, M.Sc.
Project team:	R. Malan, P.A. Endres.
Primary objective:	*to capture, store and update mineral data from mines, mineral deposits and mineral occurrences in order to provide accurate mineral data to users.*
Duration:	Ongoing.
Budget:	R250 000.

Motivation
Building the economy requires access to information to identify opportunities. From this database numerous mineral-resource appraisals have been made, and reports and maps have been produced. These activities furnish the government and the mining industry with mineral-resource information and advice for informed decision making relating to mineral policy and development issues, and to promote exploration activity. The sterilisation of mineral deposits during the planning of permanent surface structures such as townships, dams, roads, pipelines and railways has also been prevented. SAMINDABA plays a positive role in rural development and poverty eradication.

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

Progress
During 2007/8, SAMINDABA was enlarged to 18 610 mineral records in total, providing information for both internal and external enquiries on South Africa's mineralisation, as well as for maps and other products. The Derelict and Ownerless Mines Database now contains 5 850 mineral records.

Future activities
SAMINDABA will be made accessible through the GEODATA portal, which will make data in the CGS's various databases accessible to the general public.

Fieldwork and research will be carried out to further enhance and update SAMINDABA and the Derelict and Ownerless Mines Database.

0167
SOUTH AFRICAN COAL DATABASE

Project leader:	M.M. Schalekamp.
Project team:	N. Mcilrae, M. Solomon, contract worker.
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
The CGS maintains a coal database as part of its statutory obligations In terms of the Geoscience Act. This database forms part of the CGS's corporate database GEODE, and interfaces with other systems, allowing easy access to users.

The facility is a centralised point of collection for most of the data available on the geology of coal deposits of South Africa. The availability of this information in electronic format facilitates dissemination of information, enabling further research work on the geology of the coal deposits and planning the optimal use of the country's coal resources and land management.

Progress
During the year 871 logs were prepared, 800 header details were coded and captured, and 11 246 lithologies for 353 boreholes were captured. Seven hundred and seventy-three borehole logs were electronically converted, and are still in the process of being added to the database. The coal database now contains 109 020 boreholes with 2 768 816 lithologies and 1 546 477 analyses. Two hundred and seven queries were carried out for external clients.

Conclusion
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 and better land management.

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 the general public.

0168
COREDATA DATABASE

Project leader: M.M. Schalekamp.
Project team: M. Solomon, N. Mcilrae, contract worker.
Primary objective: *to prepare, capture and curate geological information from borehole core logs and to make this information accessible to the public.*
Duration: Ongoing.

Motivation
The CGS has built up a large collection of borehole logs of South African geological strata over a period of more than 25 years, and is continuing to increase this collection in order to ensure that the information is managed in such a manner that it is easily accessible. COREDATA provides easy access to this collection.

Progress
During the year 28 logs were prepared for capture into the database, while 60 headers were coded and captured. The borehole core log database now contains a total of some 85 000 entries.

Conclusion
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
Future ongoing work will increase the amount of information contained in this database.

NORTHERN CAPE UNIT

0038
REVISION OF 1:250 000-SCALE GEOLOGICAL MAP 2722 KURUMAN

Project leader: A. Agenbacht, M.Sc.
Primary objective: *to produce a 1:250 000-scale geological map for sheet 2722 Kuruman, with an explanation.*
Duration: 2002/3 to 2008/9.
Budget: Total: R772 395.

Motivation
The latest 1:250 000-scale geological map and explanatory notes were partly revised and compiled by H.F.G. Moen in 1977. More recent mapping and research on the Ghaap Group carbonate rocks and iron formations in the Transvaal Supergroup have been carried out by Prof. N.J. Beukes of the University of Johannesburg since 1978, requiring a new edition of the map.

Progress
Mapping of the 1:50 000-scale sheets covering the eastern part of the map (Ghaap Plateau), and their explanation, are complete.

Conclusion
Large portions of the area are overlain by calcareous and dolomitic deposits and soils, as well as alluvium, and possibly strata of the Gordonia Formation of the Kalahari Supergroup. A new stratigraphic classification based on the work of Prof. N.J. Beukes is proposed. Dolerite dykes and breccia fractures have been mapped and Kuruman kimberlites have been located on the map. Current interest in the area is small-scale mining of:

- limestone
- kimberlite
- clay
- aggregates
- groundwater
- cave mineralisation

Future activities
The mapping will concentrate on the Ghaap Plateau which corresponds with the Kgalagadi poverty node.

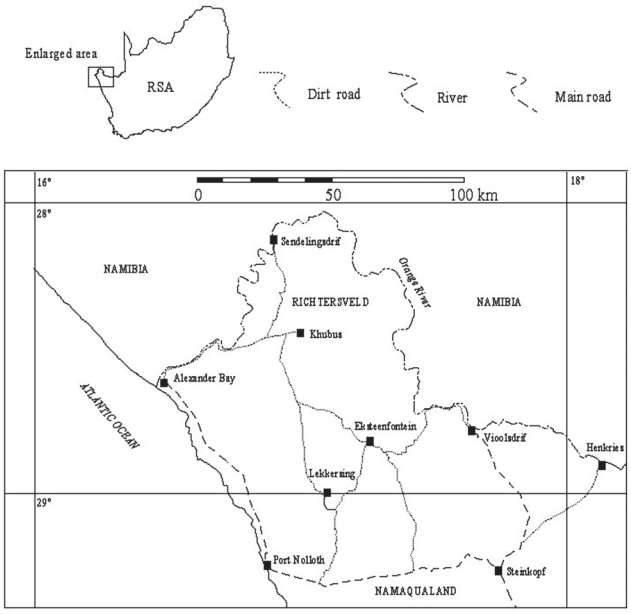
0378
COMPILATION OF THE 1:250 000-SCALE GEOLOGICAL MAP 2816 ALEXANDER BAY

Project leader: H. Minnaar, M.Sc.
Project team: P. Botha, B.Sc.Hons, D.L. Roberts, Ph.D.
Primary objective: *to compile a geological map at a scale of 1:250 000 of the Alexander Bay area and write an accompanying explanation.*
Duration: 2002/3 to 2007/8.
Budget: R1 800 000.

Motivation
This area provides opportunities for geological studies of two major orogenical cycles in the earth's history, namely the Kibaran and Pan-African cycles, which coincide with similar belts in Africa and South America. It also provides opportunities for assistance in local mining (especially small-scale mining) and other industry development initiatives, as well as in agriculture through groundwater investigations.

Progress
The map covers the extreme northwestern part of the Northern Cape Province. Inland the area is bounded by the 18th longitude to the east and the 29th latitude to the south. The area is a desert and can be divided roughly into the western coastal-plain area and eastern mountainous parts.

The map and explanation have been compiled and edited and are ready for publication.



Conclusion

The oldest rock unit in the area is the volcano-sedimentary Orange River Group (2 000 Ma), which forms a composite batholith together with the comagmatic Vioolsdrif Suite and was formed during the early stages of the Kibaran orogenic cycle which drew to a close at 1 000 Ma. This batholithic basement was intruded by the Gannakouriep Dyke Suite, and alkali granites and syenites of the Richtersveld Suite during onset of the Pan-African orogenic cycle. During the rifting stages of this cycle, the Gariep Supergroup and Nama Group were deposited in intracratonic depositional basins. During the waning stages of the orogeny, compressional forces led to the formation of an intense, regionally imprinted, N–S-striking foliation on all the older rocks to the west of the Nama Group. The Devil's Castle shear zone was formed during these stages. The Kuboos-Bremen Suite intruded during the Cambrian and small occurrences of the Karoo Supergroup are seen in the northern part of the map area. Both of these units have escaped the Pan-African foliation. Cenozoic deposits include alluvium, sand and calcrete while economically important diamond deposits are associated with gravels along the Orange River banks and the marine deposits along the west coast.

Future activities

The map and explanation are now ready to be published by the SDM and ICM Units respectively.

Bitterfontein Granite Quarry, where the Bloukop Granite is mined for dimension stone. Closely spaced boreholes are drilled to split blocks from the quarry face.

0797

1:250 000-SCALE METALLOGENIC MAP 3118 CALVINIA

Project leader: D.I. Cole, Ph.D.

Primary objectives: *to (i) capture commodity data on SAMINDABA; (ii) compile a mineral-deposit overlay; (iii) draft a geological background map, and (iv) compile a metallogenic map explanation.*

Duration: 2003/4 to 2008/9.

Budget: Total: R205 725.

Motivation

The Calvinia sheet is well endowed with mineral deposits, including diamonds and, by delineating metallogenic provinces, the prospectiveness of certain areas will be highlighted and the discovery of new deposits stimulated.

The compilation of a database of all known mineral deposits and resource fields of significant minerals is useful for organisations interested in land-use, exploration and resource-management studies. This is particularly pertinent for small-scale mining ventures by previously disadvantaged persons.

Progress
The draft copy of the metallogenic map was edited. This comprises a mineral overlay with 320 mineral deposits grouped into 285 points, a resource-field overlay with eight fields, namely West Coast Diamond, Knersvlakte Diamond, Ceres–Calvinia Gypsum, Vanrhynsdorp–Vredendal Gypsum, Nuwerus Kaolin, Vanrhynsdorp Limestone–Dolomite, Vanrhynsdorp Marble and Langebaan–Lambert's Bay Phosphate, a lithology overlay and an environmental overlay.

The explanation to the metallogenic map has been completed. Approximately half the mineral deposits consist of sedimentary and diagenetic deposits, which include alluvial diamonds, limestone, dolomite, phosphate, heavy minerals, lignite, sedimentary dimension stone and building sand. Other types of deposit are magmatic (dimension stone, stone aggregate, nickel and thorium), metamorphic (marble and kyanite), hydrothermal (iceland spar and quartz), residual (kaolin and brick clay), leachate (iron and manganese) and evaporite (gypsum and salt).

Conclusion
Some 22 mineral commodities are present with 14 presently having an economic potential. Nine are currently exploited, namely diamonds, limestone, dolomite, gypsum, granite dimension stone, sandstone dimension stone, stone aggregate, brick clay and building sand. There is a potential for further development of these deposits, together with marble, phosphate, heavy minerals and sepiolite.

SEISMOLOGY

0184
SEISMOLOGICAL MONITORING, ANALYSES AND BULLETIN COMPILATION

Project leader: I. Saunders, Nat.Dip.
Project team: L. Akromah, Nat.Dip., B. Sutherland, T. Molea, L. Brink, M.B.C. Brandt, M.Sc., E. Kgaswane, M.Sc.
Primary objective: *to provide essential instrumentally recorded data of earthquake occurrences within the borders of South Africa and southern Africa through the South African National Seismograph Network (SANSN).*
Duration: Ongoing.
Budget: R1 278 895.

Motivation
The continued operation of the SANSN is essential for providing daily 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 for prosperity through a National Earthquake Database and are presented in earthquake catalogues of southern African seismicity.

This project provides essential instrumentally recorded data on earthquake occurrences in southern Africa through the SANSN. Analysis of the recorded waveforms presents static and dynamic parameters of the focus emitting the energy and additionally provides information on the medium transmitting the energy. These data also reveal the properties of materials through which the seismic waves propagated.

The SANSN is the only vehicle capable of accurately reporting the distribution of seismic foci in South Africa, the distribution of seismic activity in time and providing a calibrated uniform magnitude scale of recorded events. The information gathered through SANSN is banked in digital format, which affords future generations the ability to revisit seismic data if and when more advanced analysis tools and techniques become available.

The data obtained through the analysis of waveforms is shared with a varied audience both nationally and internationally, and is distributed within the CGS contributing to the Geoscience Mapping and Physical Geohazards Thrusts.

Progress
Earthquake activity in South Africa for the period January to December 2007 was released through ad hoc reporting and quarterly seismological bulletins. The client database for bulletin distribution was expanded from 18 to 34, and now includes several mining houses and the geological surveys of southern Africa.

The SANSN was approached by the European Mediterranean Seismological Centre to participate in their activities through releasing phase data of earthquakes recorded in Africa. All operational SANSN stations have been equipped with near-real-time data-communication hardware. Further resource optimisation was introduced through automatic-event and phase-verification software. An automated watchdog circuit was implemented at SANSN stations to monitor and minimise failures in communication, recorder and A/D hardware.

Future activities
The focus of the 2008/9 programme will be on resolving remaining maintenance issues and investigating the implementation of an automatic earthquake locator.

0475
COLLECTION OF SEISMOLOGICAL DATA AND MAINTENANCE OF THE SOUTH AFRICAN NATIONAL SEISMOGRAPH NETWORK

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

Duration: Ongoing.
Budget: R333 000.

Motivation
To maintain the South African National Seismograph Network and produce high-quality seismic data from 21 remotely deployed seismograph stations while ensuring high station availability. The data are used to produce seismic information for bulletins and seismic-hazard maps.

Progress
The project team upgraded computer hardware and software to enable a seismograph system to send real-time seismic data to a central facility for analysis. The method uses the high-tech General Packet Radio Switching (GPRS) data-transmission protocol, and implements sophisticated data-acquisition software, enabling data to be received at a central site in Silverton in real time. In addition, with the deployment of the GPRS protocol, all the seismic stations were equipped with SeisComp data-acquisition software, and hardware was also upgraded accordingly. The implementation of this technology enables seismologists to have access to data immediately after a seismic event. So far all operational stations have been equipped with GPRS communication equipment. All EARS recording systems have been customised for optimal operation. Performance of the network can now be monitored through an internet-based interface allowing the operator to monitor parameters such as system uptimes and data-transmission delays.

Conclusion
By using the GPRS communications method, and implementing the advanced SeisComp data-acquisition software, analysts now are equipped for the timely production of seismic bulletins and the immediate release of earthquake information to stakeholders. Real-time transmission of data from the remote stations further offers the advantage that station performance can be monitored continually. The new version of SeisComp offers automatic seismic-event-location processes. This application has been tested to a limited extent. By implementing station-monitoring methods, and stabilising the hardware platform of the systems, network performance has improved.

Future activities
The technical team is in the process of implementing a Virtual Private Network (VPN) application which will secure the transmission of data over public-network connections. This method of data transmission makes it possible to receive data through the internet which will result in a 50% saving in transmission cost as opposed to the currently used method. The team will also implement and optimise the autolocation software which will ensure immediate release of earthquake information after data have been received from the network stations.

Table 1: Earthquakes with M_L ≥3.5 in the SADC region.

2007/4/7	14:45:31.3	Mozambique	4.7
2007/4/9	13:00:56.9	Wepener area	4.0
2007/4/12	16:24:42.8	Mozambique	4.5
2007/4/12	23:18:50.5	Mozambique	4.2
2007/4/15	03:20:44.3	Mozambique	4.2
2007/4/18	24:07:27	Mozambique	4.5
2007/4/20	11:36:59.4	Mozambique	5.0
2007/4/21	22:55:23.7	Mozambique	3.9
2007/4/24	23:31:53.3	Mozambique	3.7
2007/5/4	10:49:59.1	Mozambique	6.6
2007/5/4	16:40:05.8	Namibia	4.3
2007/5/6	03:02:24	Mozambique	3.8
2007/5/6	04:38:30.2	Mozambique	4.9
2007/5/6	05:30:08.5	Mozambique	4.5
2007/5/26	00:29:53.7	Atlantic ocean	4.5
2007/6/3	15:59:37.2	Mozambique	4.2
2007/6/3	24:58:24.3	Mahareng area	3.7
2007/6/10	14:06:27.3	Mozambique	3.5
2007/6/14	07:41:17.6	Mozambique	4.3
2007/6/15	15:50:41.5	Mozambique	3.6
2007/7/4	05:39:34.6	Mozambique	3.6
2007/7/5	02:50:42.5	Northern Botswana	3.5
2007/7/10	06:30:26.7	Mozambique	4.0
2007/7/10	22:09:54.7	Mozambique	5.2
2007/7/11	04:12:09	Mozambique	3.8
2007/7/11	10:17:05.8	Mozambique	4.0
2007/7/13	18:35:52.5	Mozambique	4.0
2007/7/13	18:39:31.2	Mozambique	4.0
2007/7/14	13:25:12.8	Mozambique	4.0
2007/7/22	21:13:36.8	Mozambique	4.0
2007/8/11	02:11:44.9	Mozambique	4.3
2007/8/14	05:04:44.3	Mozambique	3.7
2007/8/18	08:07:16.9	Mozambique	4.3
2007/8/18	09:02:57.2	Mozambique	3.8
2007/8/18	17:07:31.2	Mozambique	3.5
2007/8/20	21:17:43.1	Philipstown area	3.8
2007/8/27	09:37:09	Mozambique	4.9
2007/8/27	09:50:28	Mozambique Channel	3.8
2007/8/29	24:22:57.8	Mozambique	4.6
2007/9/2	08:06:24.7	Mozambique	4.8
2007/9/2	13:11:09.5	Mozambique	4.2

2007/9/2	14:44:36.5	Mozambique	5.0
2007/9/2	15:11:10.6	Mozambique	4.4
2007/9/2	15:39:30.6	Mozambique	4.1
2007/9/2	15:47:55.4	Mozambique	4.8
2007/9/11	09:08:57	Mozambique	3.5
2007/9/12	08:00:01	Mozambique	3.9
2007/9/14	19:39:00.3	Mozambique	5.5
2007/9/17	22:03:33.7	Bushmanland	3.9
2007/9/23	07:39:50.7	Mozambique	3.6
2007/9/25	20:26:52.9	Mozambique	3.8
2007/9/27	08:59:45.3	Mozambique	4.0
2007/10/3	04:50:20.7	Mozambique	3.8
2007/10/8	07:44:39.1	Mozambique	4.3
2007/10/10	17:25:45.7	Mozambique	4.4
2007/10/12	18:33:55	Mozambique	3.7
2007/10/19	22:01:08.5	Mozambique	4.7
2007/10/19	24:59:23.9	Mozambique	3.5
2007/10/23	04:05:52.3	Mozambique	3.9
2007/10/24	11:14:50.5	Mozambique	3.9
2007/10/24	11:22:19.8	Mozambique	3.6
2007/10/30	23:35:58.6	Mozambique	4.2
2007/11/3	11:03:53.6	Leeu-Gamka area	4.4
2007/11/6	11:51:26.9	Mozambique	3.9
2007/11/8	03:39:09.6	Mozambique	6.1
2007/11/9	15:03:34	Mozambique	3.7
2007/11/11	06:05:21.3	Mozambique	3.9
2007/11/16	02:22:36	Botswana	3.5
2007/11/17	19:51:58.3	Mozambique	3.6
2007/11/22	09:45:33.2	Mozambique	4.2
2007/11/25	19:30:16.1	Mozambique	4.8
2007/11/29	04:59:10.6	Mozambique	6.2
2007/11/29	22:34:19.9	Mozambique	3.9
2007/12/2	09:41:27.6	Zimbabwe	5.0
2007/12/2	13:27:50.7	Zimbabwe	4.7
2007/12/3	17:41:08.2	Mphahlele area	3.5
2007/12/9	10:02:14.1	Mozambique	3.9
2007/12/16	02:35:52.6	Mozambique	3.6
2007/12/26	13:02:24.8	Donnybrook area	3.7
2007/12/30	20:19:48.4	Mozambique	4.2
2007/12/31	02:26:24.2	Zambia	4.9
2008/1/2	08:03:39.2	Mozambique	3.5
2008/1/17	13:22:47	Mozambique	3.9
2008/1/20	19:41:11.8	Mozambique	4.0
2008/2/3	13:12:14	Mozambique	5.8
2008/2/3	15:09:52.8	Mozambique	3.6
2008/2/3	23:10:21.4	Mozambique	4.0
2008/2/4	21:11:48.1	Mozambique	3.5
2008/2/4	24:51:47.1	Mozambique	3.5
2008/2/18	03:53:16.9	Mozambique	3.6
2008/2/19	22:15:08.7	Bushmanland area	3.5
2008/2/21	16:53:32	Thohoyandou area	3.7
2008/2/23	07:11:02.5	Mozambique	3.7
2008/2/25	06:06:26.4	Kruger National Park	3.6
2008/2/28	06:16:49.1	Qudeni area	3.6
2008/3/24	03:01:51.9	Mozambique	4.3

Table 2: Mining-related earthquakes larger than ML=4 for the period April 2007 to March 2008.

Date	Time	Region	Magnitude (M_L)
2007/12/28	07:59:39.0	Klerksdorp gold mines	4.2
2008/03/08	06:20:12.2	Far West Rand gold mines	4.1

5606

OPERATION AND MAINTENANCE OF THE PRIMARY (PS39 - BOSHOF) AND AUXILIARY SEISMIC STATIONS AT SUTHERLAND AND 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), A. Graham, Nat.Cert.(IT), R.T. Kommetsi, Nat.Dip.(Elec.Eng), J.P. van Rhyn, Nat.Dip.(Elec.Eng), D.L. Roblin, B.Sc.Hons.
Primary objective: *to maintain the International Monitoring System (IMS) seismic stations at Boshof, Sutherland and the SANAE base in the Antarctic, and ensure a continuous flow of seismic data from these sites to the International Data Centre (IDC) in Vienna.*
Duration: Ongoing.
Budget: R250 000.

Motivation
Owing to South Africa's commitment to the Comprehensive Test Ban Treaty Organisation (CTBTO), the CGS is designated to act as the technical point of contact with respect to seismological and infrasound matters, and also operates a National Data Centre which functions within the framework of the CTBTO. The CGS is obliged to manage the various components

of the project and to ensure continuous data flow from the seismograph facilities. Apart from the CGS's active participation in CTBTO matters, the operation of the NDC and analysis of seismic data obtained from the centres, which form part of the IMS, contribute towards international cooperation and enhance the corporate image of the CGS.

Progress
The primary station PS39 entered its third year of operation since certification in December 2004. Technicians from the CGS visited the station on a regular basis in order to ensure proper operation of the data-communications and data-processing equipment deployed at the borehole site. One configuration-change notification, two outage requests and 56 problem reports were generated and communicated to the IMS's Operational Centre (IMS Ops). Monthly reports were also submitted to IMS Ops as required.

During the reporting period, the operator was in constant contact with experts at the Air Force Technical Application Centre (AFTAC) concerning discussions and resolutions in rectifying problems at the BOSA site. Problem messages regarding the VSAT data communications equipment were conveyed by the VSAT operator, AIS Engineering, to the operator in a timely fashion.

The main reason for most of the outages was 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.

A team of AFTAC officials visited the sites from 21 to 26 February 2007 to perform system upgrades. An expert group from AFTAC visited the central facility and remote site during November 2007. An assessment of the grounding of the remote site was performed while the recommendations for better grounding will be implemented later this year.

The batteries for the backup bank powering the borehole equipment were replaced during August 2007.

Conclusion
The station had been certified on 24 December 2004 and the CGS had entered into a contractual agreement with the CTBTO. During the third year of operation of the PS39 seismic station, the CGS attempted to improve the facilities at the central processing facility in order to optimise the general performance of the station. In contrast with previous years, the station did not experience outages related to defective data-communications or -acquisition equipment, but outages were recorded which were related to AC power outages, load shedding having caused the longest outage periods.

Future activities
The CGS will continue to improve operations and suggest system configuration changes to the IMS operational centre in order to ensure high-quality data availability from the PS39 seismic station.

CGS technicians will install a DC to AC converter backed up by a set of twelve 102 Amp-hour batteries. This configuration will ensure an uninterrupted AC supply of several hours in the event of a power outage. Controlled load shedding only lasts up to three hours per day. This arrangement will also ensure that the system configuration will not be not changed, but AC power capacity will be increased.

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, J. van Rhyn, Nat.Dip.(Elec.Eng), A. Graham, Nat. Cert.(IT), T.R. Kometsi, Nat.Dip.(Elec.Eng).
Primary objective:	*to operate and maintain the infrasound station IS47 at Boshof as part of South Africa's commitment to contribute infrasound data to the International Data Centre (IDC) in Vienna.*
Duration:	Ongoing.
Budget:	R250 000.

Motivation
Infrasound station IS47 is one of the 60 infrasound stations of the International Monitoring System (IMS) of the CTBTO. The technology of infrasound (very low-frequency sound waves) is important in the detection of atmospheric nuclear explosions and complements the other technologies chosen by the CTBTO, viz. seismic, hydroacoustic and radionuclide, for monitoring adherence to the CTBT. As a signatory to the treaty, South Africa is under obligation to work together with the CTBTO, and the CGS is privileged to have a major role in this international cooperation.

Progress
The CGS has operated and maintained the infrasound station since certification by the Preparatory Technical Secretariat in December 2005. Routine maintenance and ad hoc repairs have been performed from time to time. After the array elements

radios regularly suffered damaged related to severe lightning in the area, lightning-protection units were installed at all the sites. This effort resulted in no damage to telemetry equipment after installation.

Conclusion
Operation of the station offered CGS technical staff the opportunity to gain experience in maintaining the assortment of equipment used in this project. The station performed well over the period and no failures were experienced as a result of AC power outages. The equipment deployed at the central recording facility are backed up by a vast bank of batteries.

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

5619
INDIAN OCEAN TSUNAMI WARNING SYSTEM

Project leader:	J. Steyn. M.Dip.Tech.(Elec.Eng).
Project team:	F.A. Delport, B.Tech.(Elec.Eng), D.L. Roblin, B.Sc.Hons, J. van Rhyn, Nat.Dip.(Elec.Eng), T.R. Kometsi, Nat.Dip.(Elec.Eng).
Primary objective:	*to ensure that high-quality seismic data from five seismograph stations forming part of the South African National Seismograph Network contribute seismic data continuously 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 000 000.

Motivation
An interministerial committee comprising the Minister for Provincial and Local Government as Chairperson, Minister of Foreign Affairs, Minister of Health, Minister of Social Development and the Minister of Water Affairs and Forestry, supported by senior officials, met on 31 December 2004 to coordinate South Africa's response to the devastating Richter scale 9.0 earthquake of Sunday, 26 December 2004 off the northern tip of Indonesia's Sumatra Island and subsequent tsunami that left a 10-nation arc of destruction in South East Asia.

The CGS was designated by the South African Government as the scientific and technical point of contact for tsunami-related issues regarding seismological aspects. As the CGS operates and maintains an advanced seismological network capable of detecting 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
During the first phase, five of the South African National Network Seismograph Stations were upgraded and data were sent in real time from these stations to the International Data Centre (IDC) as part of South Africa's contribution towards the establishment of the IOTWS.

Funding has been allocated in order to equip an additional three stations with state-of-the-art broadband seismometers (KS2000). Data from these stations will also be sent to the IDC which is currently hosted by the GeoForschungZentrum Potsdam (GFZ), which is Germany's national research centre for geosciences, until the IDC is established in Indonesia. The orders for the new equipment were placed in January and February 2008.

Conclusion
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 maintain and constantly develop and implement aids in order to optimise network performance.

Future activities
Funds will be allocated for the operation and maintenance of eight stations, and for attending workshops and seminars which are related to the Intergovernmental Coordination's Group (ICG) objectives for the IOTWS. The CGS will also 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 has made a start in supporting this initiative.

System calibration forms an important part of the integrity of the recorded data. The CGS has recently purchased a state-of-the-art signal generator which will be used to perform station calibrations. A mass-storage RAID system has also been purchased and installed, capable of storing six terrabytes of seismic data originating from the dedicated tsunami stations. The orders for the equipment have been placed and the upgrade of the additional stations will commence after delivery.

0929
COMPILE AND EDIT THE ANNUAL EARTHQUAKE CATALOGUE FOR 2004

Project leader: E. Hattingh, M.Sc.
Project team: D.L. Roblin, B.Sc.Hons, I. Saunders, Nat.Dip.
Primary objective: *to publish a catalogue of earthquakes for Southern Africa for the year 2004 including data from the South African National Seismograph Network (SANSN), as well as data from the International Seismological Centre (ISC).*
Duration: Ongoing.
Budget: R63 408.

Motivation
This project produces catalogues of earthquakes on an annual basis, including all seismological data nationally and internationally available. Compilation of a catalogue containing all seismological data for southern Africa is crucial for centralising data and making these available to Africa. The catalogues are published as part of the Seismological Series of the CGS.

This project supports several thrusts of the CGS (Geoscience Mapping, Water Resource Assessment and Protection, The Environment and Chemical Geohazards, Minerals Development, Engineering Geology and Physical Geohazards) and key national priorities (Economic growth and employment, Sustainable development, Rural development, Development of Africa).

Future activities
The focus of the 2008/9 year will be to produce a Seismological Catalogue for southern Africa for the year 2005.

SPATIAL DATA MANAGEMENT

0785 (GEODE) and 0277 (SDE)
DATA ADMINISTRATION GEODE & SDE

Project leader: H.J. Brynard, Ph.D.
Project team: K. Wilkinson, H.Nat.Dip., S. Tucker, Dip.S.B.M., F. Nkosi, Dip.IT, C.W. Ries, B.Sc.Hons.
Budget: R285 418.

The spatial and non-spatial data that the SDM Unit captures and maintains must be managed and correctly administered for its effective usage.

0276
MAINTAIN GIS METADATA

Project leader: H.J. Brynard, Ph.D.
Project team: S. Ngesi, B.Sc.Hons.
Budget: R79 318.

Metadata, information on the source and reliability of data, must be maintained for all the spatial data that the SDM Unit generates.

0277
SYSTEM AND APPLICATION MAINTENANCE

Project leader: K. Wilkinson, H.Nat.Dip.
Project team: A. Voors, Nat.Dip., H.J. Brynard, Ph.D., R. van Rooyen, B.Sc.Hons, C.W. Ries, B.Sc.Hons.
Budget: R448 731.

Servers, workstations, operating-system software, peripheral devices and applications in the SDM Unit must be continuously maintained.

0473 (GEODE) and 0793 (SDE)
DATABASE ADMINISTRATION GEODE & SDE

Project leader: H.J. Brynard, Ph.D.
Project team: S. Tucker, Dip.S.B.M., F. Nkosi, Dip.IT, C.W. Ries, B.Sc.Hons, R. van Rooyen, B.Sc.Hons, S. Ngesi, B.Sc.Hons, D. Sebake, M. Environ. and Dev.
Budget: R233 305.

The ArcSDE/SQL Server and the Oracle database form part of the CGS's Corporate Database, and these databases must be administered and maintained for their effective operation.

0856
DEVELOPMENT AND IMPLEMENTATION

Project leader: K. Wilkinson, H.Nat.Dip.
Project team: H.J. Brynard, Ph.D.
Budget: R470 648.

This project involves the planning, development and implementation of a Geographic Information System (GIS) for the input, editing, storage, retrieval, modelling, as well as cartographic presentation of geologically related data which is a core function of the CGS.

0856
GEOPORTAL

Project leader: H.J. Brynard, Ph.D.
Project team: S. Tucker, Dip.S.B.M.
Budget: R115 000.

The GeoPortal is maintained by staff of the SDM Unit, who also develop new applications.

1:250 000 GEOLOGICAL MAPS (CARTOGRAPHY)

Project	Map Title	Project leader and team	Costs
0036	3018 Loeriesfontein	K. Wilkinson, H.Nat.Dip.(Cart.), D. Grobbelaar, Nat.Dip.(Cart.), M.H. Roos, H.Nat. Dip.(Cart.)	R26 936
0014	2622 Morokweng	K. Wilkinson, H.Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.), M.H. Roos, H.Nat.Dip.(Cart.)	R33 124

1:50 000 GEOTECHNICAL MAP

Project	Map Title	Project leader and team	Costs
0816	2730CC Osizweni	M.H. Roos, H.Nat.Dip.(Cart.), M. Nkosi	R29 704

1:50 000 GEOLOGICAL MAPS (GIS)

Project	Map Title	Project leader and team	Costs
0768	3418BB Somerset West	C.W. Ries, B.Sc.Hons, H. Sello	R22 263
0768	3418BD Hangklip	C.W. Ries, B.Sc.Hons, M. Letsoalo	R22 263
0711	3317BB & 3318AA Saldanha	C.W. Ries, B.Sc.Hons, P. Msiza, S. Ngesi, B.Sc.Hons	R25 891
0346	3217DB & DD Vredenburg	C.W. Ries, B.Sc.Hons, H Sello, S. Ngesi, B.Sc.Hons	R39 766
0711	3218CA & CC Velddrif	C.W. Ries, B.Sc.Hons, M. Letsoalo, S. Ngesi B.Sc.Hons	R26 689
0371	3326CA Springmount	C.W. Ries, B.Sc.Hons, C. Kgari	R26 689
0371	3326BD Trappe's Valley	C.W. Ries, B.Sc.Hons, C. Kgari	R26 689
0371	3326BC Grahamstown	C.W. Ries, B.Sc.Hons, P. Msiza, C. Kgari	R26 689
0371	3326DA & DC Boesmansriviermond	C.W. Ries, B.Sc.Hons, M. Letsoalo	R39 766
0371	3326DB Port Alfred	C.W. Ries, B.Sc.Hons, M. Letsoalo, P. Msiza	R26 689
0371	3326CB & CD Alexandria	C.W. Ries, B.Sc.Hons, P. Msiza, C. Kgari	R39 766
0601	2627SB Vereeniging	H.J. Brynard, Ph.D., S. Ngesi, B.Sc.Hons, M.H. Roos, H.Nat.Dip.(Cart.)	R26 689
0606	2628BA Delmas	H.J. Brynard, Ph.D., S. Ngesi, B.Sc.Hons, M.H. Roos, H.Nat.Dip.(Cart.)	R26 689
0762	2930DD & 2931CC Durban	C.W. Ries, B.Sc.Hons, C. Kgari, H. Sello	R39 766

1:50 000 GEOLOGICAL MAPS (CARTOGRAPHY)

Project	Map Title	Project leader and team	Costs
0769	3322CD George	C. Thomas, Nat.Dip.(Cart.), A. Voors, Nat.Dip.(Cart.)	R29 704
0701	2429AA Mokopane	C. Thomas, Nat.Dip.(Cart.)	R27 704

0019	2429BB Bewaarkloof	C. Thomas, Nat.Dip.(Cart.)	R 27 704
0371	3326CA Springmount	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 27 704
0371	3326BD Trappe's Valley	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 29 704
0371	3326BC Grahamstown	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 29 704
0371	3326DA & DC Boesmansriviermond	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 29 704
0371	3326DB Port Alfred	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 29 704
0371	3326CB & CD Alexandria	C. Thomas, Nat.Dip.(Cart.), M. Magagane, Nat.Dip.(Cart.)	R 29 704
0601	2627DB Vereeniging	M.H. Roos, H.Nat.Dip.(Cart.), A. Smith, Nat.Dip.(IT)	R 29 704
0604	2628BA Delmas	R. van Rooyen, B.Sc.Hons, A. Smith, Nat.Dip.(IT)	R 29 704

WATER GEOSCIENCE

0877
GENDER IN THE SOUTH AFRICAN WATER SECTOR — BULLETIN OF THE COUNCIL FOR GEOSCIENCE

Project leader: U.A. Rust, B.A., B.Sc., M.Phil.
Primary objective: *Gender equality and access to basic water services are complexly interlinked objectives for both poverty alleviation and sustainable development. In South Africa, research shows that gender-mainstreaming initiatives are not optimally successful in transforming the lives of poor women. The aim of the research was therefore to derive principles that would enhance the impact of gender mainstreaming in the water-services sector, and to evaluate current South African gender-mainstreaming guidelines according to these principles.*
Duration: 2007/8.
Budget: R8 725.

Motivation
Part of the CGS's strategy to achieve scientific excellence is to encourage scientists to publish their work. This also ensures that stakeholders have access to knowledge that has been developed by CGS scientists using statutory funding. The M.Phil. thesis of the project leader was therefore published as a bulletin of the CGS. The research was jointly funded by the CGS and the Water Research Commission (WRC), and the work is published with the approval of the WRC.

In the rural areas, communities are often dependent on groundwater. The contribution of the CGS in this regard mainly relates to the assessment of groundwater resources, in terms of the quantity and quality of water available. However, because of complex systemic interactions, it is not possible to separate the management of the resource from an engagement with the end users of the water services. Therefore, in its endeavours to facilitate the provision of basic services to alleviate poverty and to stimulate rural development, the CGS should also consider the impact of communities and institutional arrangements on the sustainability of the groundwater resources, and vice versa.

Conclusion
It is believed that this work could form the seeds of a more transformative engagement with gender dynamics in the water-services sector. The study resulted in a proposed framework of 14 focus areas for gender mainstreaming in the water services sector, among which the role of gender officials, the importance of cooperative governance, appropriate levels of public participation, access to basic services, developing leadership by women, ensuring environmental sustainability and engaging with traditional culture.

The derived framework was applied to the 2005 Gender Mainstreaming Strategy of the Water Services Sector Leadership Group (WSSLG), as well as to the 2007 Gender Policy Framework for Local Government of the Department of Provincial and Local Government (DPLG). In the case of the WSSLG strategy, it was found that the strategy does not engage with traditional culture nor advocates environmental sustainability. The strategy was also found to be lacking in terms of programme management and governance dimensions. In respect to the DPLG strategy it was found that the policy-formulation process was inclusive and that the multiple disadvantages faced by women were given sufficient attention. This strategy also attempted to engage with traditional culture.

Women collecting water from a community standpipe in the Eastern Cape Province (www.africanpictures.net).

0942

DELETERIOUS HEALTH ASPECTS RELATING TO THE CONSUMPTION OF GROUNDWATER FROM SOURCES IMPACTED BY RADIO-ACTIVE ELEMENTS (U, Th AND ASSOCIATED DAUGHTER ISOTOPES) IN NAMAQUALAND

Project leader: J.T. Leshomo, B.Sc.Hons.
Primary objectives: *to (i) study trace-element occurrences, physicochemical behaviour of radioactive elements, and relationships between groundwater chemistry and radioactive-element occurrences; (ii) identify possible high-risk boreholes in the area, which might pose health risks as a result of consumption of drinking water, and (iii) supply information on the macrochemical quality of selected water resources.*
Duration: 2007/8.
Budget: R87 557.

Motivation
Groundwater appears to be the all-embracing panacea for the water shortage in South Africa. Scarcity and high pollution levels of the little available surface-water resources leave groundwater as the sole water source. Much of the water for domestic use in rural areas, however, comes from fractured rock aquifers, some of which are severely overexploited. The quality of groundwater is generally good, but can also be of concern in some areas, as it can be contaminated by anthropogenic activities such as mining and farming, and by climate and host-rock chemistry.

Some metals have been extensively researched, and their sources, toxicity levels and the effects have been well documented. Others have been less documented and more research needs to be conducted to determine at what levels various health effects will occur. The exposure limits for these metals vary according to the length of time a person is exposed and the effects experienced.

The presence of the trace elements in high concentrations has a major impact on consumers' health. Illnesses resulting from these elements may be caused by toxicity, radioactivity or both. Specific investigations of these effects have been undertaken, but epidemiological evidence of their health effect has not been obtained on humans. For some radionuclides, data supporting their likely effect on health derive from related disciplines and are mainly based on experimental studies or models for assessment and prediction of risk. Water quality has different effects on users, ranging from chronic to acute, reversible to irreversible, and between recoverable and irrecoverable conditions.

Progress
The following strategy is used to achieve the objectives of this project:

- Conducting a desk-top study
- Collecting water and rock or soil samples and analysing them for trace elements and radionuclides.

Boreholes were randomly selected for water sampling using borehole information from the Atomic Energy Board data of the early eighties. One hundred and four samples were collected from twenty-six boreholes. The samples were collected from solar pumps and wind-pump taps in Namaqualand. Water samples were collected from the boreholes used for the supply of drinking water, as there is more than one borehole per farm. Other boreholes are used to water livestock.

The water samples were sent to the Geochemical Laboratory for major cation, trace-element, and anion analysis. The five-litre samples were sent to the NECSA Nuclear Technology and Services Laboratory for radioactivity analysis. Rock and soil samples were sent for analysis.

In general, groundwater in the study area is neutral to slightly alkaline (pH 6.72–pH 8.84). However, one sample (sample JL07/09) has slightly acidic water of pH 4.90. The water is brackish to saline with most samples having TDS ranging between 746 and 6 430 mg/l, and hardness ranges from moderately hard to very hard. Groundwater-type varies randomly, consisting of mainly sodium, chloride, calcium carbonate and sulphate.

Conclusion
Groundwater quality in the two catchments' (F30A and D82B) aquifers is variable, with groundwater ranging from saline to very saline. The geochemical compositions of groundwater in these catchments are generally similar. Saline groundwater that occurs in these aquifers results from natural processes. The process that might cause salinity in the groundwater is ion exchange and the long residence time of the water which promotes rock-water interaction.

The area generally has poor water quality that results from the weathering of local rock formations. The range of groundwater compositions in the aquifer suggests varying influences of evaporite dissolution, carbonate or silicate weathering. Sulphate- and chloride-dominated groundwater compositions are attributable to gypsum and halite dissolution. The occurrence of sulphate- and chloride-dominated groundwater in the area can be attributed to pyrite dissolution. The occurrence of the groundwater in the transition zone of the diamond shape in the piper diagram shows that the water

is evolving, meaning that there are many geochemical processes taking place. These processes might be sorption-desorption, dissolution, adsorption, ion exchange or precipitation. These processes are responsible for changing the water chemistry or water type.

The observed high concentration of iron and sulphate suggests pyrite oxidation and dissolution. The chemical constituents show good correlation with the sampled soils in the area. It can be concluded that the high amount of total dissolved solids results from the surrounding aquifers or the geology. Both the high total dissolved solids and the position of the plot in the Piper diagram implies that the groundwater in the area is old and discharging. This is because the area receives very little rainfall and has a high evaporation rate, which restricts infiltration. In return, groundwater recharge is very slow and the rainwater takes a long time to penetrate to the water table.

Future activities
This project is now complete.

0943

PREFERENTIAL FLOW MODELLING IN A VADOSE ZONE USING MACRO 5.0 — CAPE FLATS POROUS SANDS AND MPUMALANGA HIGHVELD CLAYS CASE STUDIES

Project leader:	K.A. Majola, B.Sc.Hons.
Project team:	N. Jovanovic, Ph.D. (University of the Western Cape), S.N. Ndengu, M.Sc.(Hydrogeol.), L.K.C. Strachan, Ph.D.
Primary objective:	*to research the movement of groundwater in the unsaturated zone, with emphasis on preferential flow, using available models and improving on them where necessary.*
Duration:	2007/8.

Motivation
This is a continuation of the groundwater vulnerability research which started in 2004/5, and it is linked to M.Sc. studies at the University of the Western Cape. Groundwater vulnerability research has shown that an understanding of the characteristics or factors presented by the environment is vital. The project concentrates on the unsaturated zone. The vadose zone forms the second line of defense against contaminants after the soil zone, which sometimes does not exist. Protection of groundwater from hazardous impacts has become one of the main priorities in South Africa as a large group of its population depends on groundwater for domestic purposes. Furthermore, it is aligned with the CGS strategy in the following ways:

- Focus on water and environmental geosciences;
- It addresses issues concerning the field of environmental and groundwater monitoring and protection.
- Supports the DWAF concerning the issue of groundwater-resource sustainability.

Case-study areas are the Coastal Park Landfill site located in the Cape Flats and the Goedehoop irrigation site used by Sasol from 1991 to 2000, with the permission from the DWAF located in Secunda (Mpumalanga Highveld). These were selected according to their differences in environmental properties and the availability of data.

Progress
During the year the thesis was rewritten as a bulletin of the Council for Geoscience. The project is in the advanced stages of completion. As the project was dependent on the completion of the M.Sc. thesis, which was delayed due to university procedures, its completion date was also delayed.

Conclusion
It was concluded that MACRO 5.0 is able to assess both micropore and macropore flow in vadose zones as both the Cape Flats (sandy environment) and Secunda (clayey environment) simulations yielded reliable results after the validation process. It is also able to simulate solute movement. Parameters for further studies were identified from sensitivity analyses to be:
For water balance — boundary hydraulic conductivity and diffusion pathlength;
For solute balance — sorption distribution coefficients, degradation rate coefficients, solute concentration in soil water and in bottom boundary, and other specific chemical properties.

Future activities
This project is complete.

0982

A PRELIMINARY UNDERSTANDING OF DEEP GROUNDWATER FLOW IN THE TABLE MOUNTAIN GROUP AQUIFER SYSTEM

Project leader: K.F. Netili, M.Sc.(Hydrogeol.).
Project team: Y. Xu, Ph.D., S. Adams, Ph.D. (University of the Western Cape).
Primary objectives: *to (i) review groundwater concepts in order to distinguish between deep and shallow groundwater; (ii) estimate depth of groundwater circulation; (iii) simulate deep groundwater flow paths, and (iv) estimate groundwater travel times from selected springs.*
Duration: 2007/8.

Motivation

The Table Mountain Group (TMG) Aquifer is the second largest aquifer system in South Africa, after the dolomites. This aquifer has the potential to be a significant source of water for the people of the Western Cape, but many uncertainties remain, considering the need to move groundwater exploration in this country an order of magnitude deeper, from 100 m to 1 000 m. The occurrence of hot water springs in the TMG in relation to the main geological fault systems shows that deep flow systems do exist, although little is known about these deep aquifer systems.

Although the aquifer system is used to some extent, a number of aspects relating to the aquifer system are poorly understood and unquantified. In deep aquifers the complex flow pattern originating from the geological structure often leads to difficult predictions of water origin, determination of the main flow paths, and potential mixing of waters. All these uncertainties prevent an efficient management of the groundwater resource.

Deep groundwater movement in the TMG Aquifer is via fracture systems, which are either horizontal bedding planes or vertical joints. The water demand is also increasing with increase in population. For the development and management of deep groundwater in the TMG, proper investigation of different aspects is crucial (i.e. deep groundwater recharge, flow mechanisms and mean residence times).

Progress

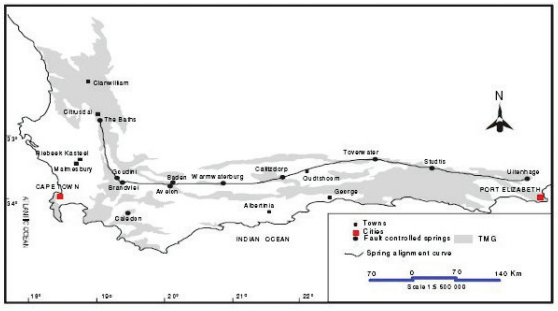
The project has been completed.

Conclusion

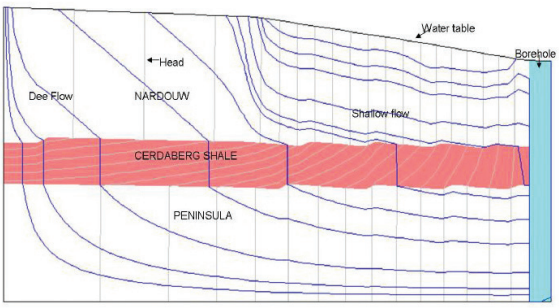
Temperature is regarded as the most suitable dividing line between shallow and deep groundwater for this study. The use of this dividing line in the TMG is limited by the lack of data regarding the distribution of the geothermal gradients.

The lowest K-value of 10^{-15} (from simulation results) makes the C/S act as a barrier, a situation where there is no water exchange between the upper and the lower deep aquifers. This situation is not realistic in the TMG as the area is structurally disturbed.

Flow paths with long travel times of about 405 years were estimated with the use of the software TopoDrive®. These ages do not correlate with the age-estimated ^{14}C data. These isotope analyses suggest several thousands of years for most of thermal spring water in the TMG. The reason for this may be the fact that the groundwater model presented here does not account for all the complexities of the fractured-rock aquifer. These include structural setting, distance from recharge to discharge point, and permeabilities of the aquifers. This analysis demonstrates the high level of uncertainty involved in calculating travel times from the recharge area to discharge area, given the current limited knowledge of the appropriate parameters. It is therefore recommended that further detailed research studies be conducted on the aspects of deep groundwater reviewed in this report. The M.Sc. research project findings will be published as a bulletin.



Distribution of the TMG and locations of thermal springs (modified after De Beer, 2002).



A schematic representation of the conceptual model (blue lines indicate flow lines).

0983
GROUNDWATER MONITORING SYSTEMS FOR KARST ENVIRONMENTS IN THE LIMPOPO PROVINCE

Project leader: V. Mawelela, B.Sc.Hons.(Hydrogeol.).
Primary objective: *to characterise the aquifers in the karst terrain of the Limpopo Province and determine pre-contamination conditions.*
Duration: 2007/8 to 2009/10.
Budget: R82 815.

Motivation
While still in a fairly pristine state, the karst terrain in the Limpopo Province is currently under pressure from agriculture and the mining industry. Characterisation of aquifers within this system should yield precontamination conditions and interactions, and are therefore ideal to investigate and monitor for any likely pollution sources. Understanding this system will aid in developing a methodology that can be applied to other dolomitic areas, which in turn could be used for DWAF and DME policies and regulations.

The most crucial area of research should focus on the characterisation of the dolomites, with particular reference to the interaction of ground and surface water. It is apparent from existing literature that only specific areas of carbonate rocks have been investigated over the years, and the focus has mainly been on stability and geotechnical aspects. However, information on the morphology and karst formation of some of these formations, and tectonic and structural events that altered and developed the karstification within these formations, is very important. This is critical when conceptualising and characterising the geohydrodynamics of these systems.

Modelling of groundwater flow in karstic aquifers has been less successful, while progress persists in the use of water budgets, tracer studies, hydrograph analysis and chemograph analysis for the characterisation of karstic aquifers. The bulk of the progress is due the introduction of a conceptual approach to karst taking into account its properties as an aquifer, which obviously makes the distinction between karst and non-karst aquifers.

Progress
A literature review on karst aquifers has been completed. At the commencement of the project, two study areas were selected for investigation, namely Bela-Bela (Warmbaths) and Mokopane (Potgietersrus). Fieldwork was expected to start at Bela-Bela, but was later not considered to be appropriate because of important environmental constraints. The dolomites in both Bela-Bela and Makopane are regarded as important aquifer sources, and thus are strictly environmentally protected by the DWAF. As a result tracer tests were not considered as an option in this dolomitic area. After a meeting with the DWAF, it was decided that the dolomites in Northam should be evaluated first as little information on them was available.

A census was undertaken in the Thabazimbi area between 28 January and 14 February 2008. Both dolomitic terrain and a buffer zone consisting of various rock types, quartzite, shales, and alluvium, formed part of the census. Approximately 34 boreholes were sampled and investigated. An important part of the census was to get approval from Kumba Iron Ore Ltd to sample groundwater on their premises, as it is a predominantly dolomitic terrain. The mountainous dolomitic area around Thabazimbi was difficult to access. Approximately 14 boreholes were sampled from these dolomites, however approval to access mine premises is still awaited. The mining operations use groundwater predominantly from these carbonate aquifers, but no sinkholes related to groundwater over-abstraction have been recorded.

Future activities
Work on this project will continue in the next financial year.

0984
SUSTAINABLE DEVELOPMENT AND SCIENTIFIC RESEARCH INSTITUTIONS — SUSTAINABILITY INDICATORS FOR CGS BUSINESS PROCESSES

Project leader: U.A. Rust, B.A., B.Sc., M.Phil.
Primary objective: *to investigate the integration of sustainable development imperatives into the current performance-management framework of the CGS.*
Duration: 2007/8.

Motivation
Globally, there is an increasing focus on sustainable development. Accordingly, government stakeholders expect science councils such as the CGS to integrate sustainable-development objectives into their projects. However, there are no guidelines on how to achieve this. The CGS operates in a number of fields that are closely linked to the achievement of sustainable development, for instance minerals development and small-scale mining, infrastructure development,

Training the next generation of geoscientists to ensure sustainability — participants in the CGS mapping field school for young geoscientists.

groundwater-resource assessment and protection, and environmental protection. This project was undertaken to create an understanding of how the CGS might facilitate sustainable development.

Sustainable development imperatives were regarded from two perspectives, namely related to the content of the research programme, and related to the approach of the CGS to its research mandate and operational culture.

Conclusion
It was concluded that there are a number of significant sustainable-development imperatives that fall within the ambit of the CGS, and that the current CGS performance-management system could be adapted to be responsive to these imperatives. In particular, it is recommended that impact measurement and the use of anecdotal reporting be investigated to make the CGS performance-management system more responsive to sustainable development. Furthermore, the achievement of sustainable-development imperatives should be monitored at corporate, cross-unit level in the CGS to ensure that these are integrated into all programmes of the CGS.

0985

ACID MINE DRAINAGE: ASSESSMENT OF PASSIVE TREATMENT TECHNOLOGIES FOR THE AMELIORATION OF AMD IN MINING ENVIRONMENTS IN SOUTH AFRICA

Project leader:	S.N. Ndengu, M.Sc.(Hydrogeol.).
Primary objectives:	*to assess appropriate passive treatment technologies that may be applied to treat acid mine drainage (AMD) in mining environments, and to test a preferred passive treatment method that is practical in a decanting or discharging surface environment.*
Duration:	2007/8 to 2008/9.
Budget:	R36 225.

Motivation
Acid mine drainage (AMD) is a collective term used for the accelerated oxidation of iron pyrite (FeS_2) and other sulphuric minerals resulting from the exposure of these minerals to both oxygen and water as a consequence of mining and processing of metal ores. AMD is a real threat because the vast majority of natural life is designed to survive at or near a pH of 7. Detrimental effects of the discharge of acidic mine-related water on fish and animals (lower mortality rates) have been noted in case studies in the Western Witwatersrand basin. Mining in the Witwatersrand dates back to the late 1880s and the gold mines were prolific producers of AMD. It has been estimated that approximately 500 megalitres of water per day have been pumped from underground in the Witwatersrand gold-mining area alone and discharged into the water courses to prevent seepage back into the ground. Once mining ceases, it is expected that these pumps will be switched off and groundwater will return to its pre-mining-industry levels leading to AMD.

Cessation of gold-mining operations poses an environmental threat due to the generation of AMD and the discharge into the surroundings of the abandoned mines. The discharged water poses an additional risk to the environment by the fact that it often contains elevated concentrations of metals (Fe, Al, Mn, Zn, Ni, Cu and heavy metals) and metalloids, arsenic being of great concern. The mine effluents have already threatened the integrity of streams and rivers such as the Wonderfonteinspruit in the Far West Rand Basin and Tweelopiespruit which drains into the Cradle of Humankind World Heritage Site.

Traditionally AMD was treated by erecting water-treatment works and the addition of lime to precipitate the iron before it reached the rivers and streams which resulted in voluminous residual solids posing a disposal problem. These conventional treatment solutions tend to be very costly and are thus not sustainable in economic and environmental terms. Traditional or conventional treatment technologies are often termed 'active' treatment as they require continuous input of energy, effort and chemical reagents. Innovative or 'passive' technologies which, on the other hand, treat water or solids using enhanced natural processes in situ, tend to be low cost and require minimal upkeep.

Passive methods include, amongst others:
Anoxic Limestone Drains (ALD)
Successive Alkalinity Producing Systems
Constructed Wetlands
Permeable Reactive Barriers (PRBs)
Bio-reactors
Biosolids
Phytoremediation (phytoextraction, phytostabilisation, rhizofiltration and phytovolatilisation).

Presently, the extent of passive treatment in the South African mining industry is limited to three installations.

The aim of this research is to focus on passive treatment technologies for the treatment of AMD in different mining environments in South Africa (gold and coal mining), reviewing their applicability in South Africa and their economic and environmental sustainability. This project will ensure the protection of the basic human right of access to potable water.

Progress
A literature review on passive treatment technologies for acid mine drainage was completed.

Several possible test sites were subsequently investigated in an attempt to identify a suitable test site to pilot in-situ passive treatment systems. The main criteria for the choice of a test site were the presence of acid mine drainage (AMD), low pH (<3), high sulphate (>400 µg/L), heavy-metal concentrations above the Department of Water Affairs Drinking Water Quality Guidelines and the SANS 241:2005, and that water flow should be all year through in order to ensure continuous monitoring.

Potential test sites in the Far East Rand Basin and the Western Rand Basin were investigated for use as piloting passive treatment systems.

Tables 1 and 2 show sites that were visited in the Far East Rand Basin and West Rand Basin respectively.

Table 1: Sites investigated for identification of test locations for passive treatment of acid mine drainage (AMD) in the Far East Rand Basin.

Site Name	South	East	pH	Note
Blesbokspruit Site 1	-26°13'56"	28°29'08"	7.70	pH too high
Blesbokspruit Site 2	-26°24'42"	28°29'02"	6.95	pH too high
Blesbokspruit Site 3	-26°18'46"	28°33'06"	7.75	pH too high
Van Rhyn	-26°10'59"	28°20'58"	6.78	pH too high
SAPPI Outlet	-26°12'34"	28°27'14"	7.80	pH too high

Table 2: Sites investigated for identification of test locations for passive treatment of acid mine drainage (AMD) in the Western Rand Basin.

Site Name	South	East	pH	EC (mS)	Eh (mV)	Note
Dry Dam	-26°05'57"	27°43'15"	6.71	353	122	pH too high
Spring 3	-26°05'54"	27°43'11"	6.65	1055	245	pH too high
Lion Camp Dam	-26°05'00"	27°42'25"	6.76	222	252	pH too high
N14 Bridge Culvert	-26°03'50"	27°41'45"	6.91	1892	250	pH too high
Camp Stream 1	-26°03'19"	27°42'01"	7.30	1759	235	pH too high
Aviary Dam	-26°04'25"	27°41'56"	6.89	1916	243	pH too high

All the potential test sites were found to be unsuitable. In all cases pH values were too high (ranging from pH 6.65 to 7.80) as a result of neutralisation interventions by the mines and possibly dilution. Other sites considered, particularly sites around tailings dams, did not meet the criterion of continuous flow all year round. Future investigations should consider decanting coal mines in Mpumalanga as possible test sites for passive treatment of acid mine drainage.

Conclusion
Although the use of passive treatment technologies for dealing with mine water is a relatively young field of study, the performance of many systems, particularly in the United States of America, has been encouraging. Mining-related passive treatment systems are aimed at acid neutralisation, dissolved metal recovery and sulphate removal through bacterial reduction in wetlands. The concept of passive treatment is the focus of intense studies as it offers a low-cost, low-maintenance solution to the treatment of poor-quality acid mine drainage. This has particular benefit for the post-closure period of mining operations when personnel and financial resources are no longer available for the treatment of such water.

While certain practical aspects, including fouling, life expectancy and wetland carbon-source replenishment require further study, the chemistry and technology involved are fairly well understood. Improvements in sulphate removal rate and carbon utilisation will reduce the required wetland areas required for effective treatment.

There have been significant challenges in locating a suitable test site to pilot a constructed wetland as a means of passive treatment in the gold- and coal-mining areas of the Witwatersrand and Mpumalanga. This has been the result of temporary remedial initiatives in some of the previously identified hot-spot areas for acid mine drainage, safety concerns for instruments and researchers in areas that are potentially crimeladen, and insufficient information on a sustained annual flow from decanting coal-mining operations.

WESTERN CAPE UNIT

0023
EXPLANATION FOR GEOLOGICAL MAP SHEET 3017 GARIES

Project leader: C.H. de Beer, M.Sc.
Primary objectives: *to compile an explanation to accompany the 1:250 000-scale geological map 3017 Garies.*
Duration: 1997/8 to 2007/8.

Motivation
Explanations to 1:250 000-scale geological maps are published by the CGS to provide descriptions of lithostratigraphic units, the structural geology and economic-geology aspects of the areas covered by geological maps.

Progress
The compilation of the explanation is the final phase of the task of systematic mapping of sheet 3017 Garies undertaken by the project leader between 1995 and 2001.

Conclusion
The geology of the area covered by sheet 3017 Garies includes rocks and unconsolidated sediments varying in age between Mesoproterozoic and Holocene. The rocky, inland areas are dominated by the granites (Spektakel Suite), metagranitoids (Little Namaqualand Suite), supracrustals (Bushmanland Group) and very minor metabasites (Oorkraal Suite) of the *ca.* 1 200–1 000-Ma-old Namaqualand Metamorphic Province. The metamorphic rocks have been subjected to upper amphibolite and granulite facies metamorphic conditions, and deformed under ductile conditions into a complex display of interference folds, mostly before 1 080 Ma ago. The granites are post-tectonic to the main shortening deformation, and were intruded before maximum metamorphic conditions were reached at 1 030 Ma. Outcrops of Neoproterozoic clastic (quartzite and phyllite) and chemical sedimentary rocks (dolomitic marbles) of the Gariep Supergroup, which overlie the granitic basement, have only rarely been preserved.

The Cambrian Vanrhynsdorp Group (Nama Group equivalent) overlies these rocks unconformably and have been well preserved in fault grabens. Folding, thrusting and metamorphism to lower-amphibolite grade in these rocks during the Pan-African orogeny led to the formation of extensive shear zones and retrogressive metamorphism of basement rocks. During the Early Cretaceous rifting that led to formation of the South Atlantic Ocean around 120 Ma ago, these rocks were intruded by an assemblage of igneous rocks belonging to the Koegel Fontein Complex. Most of magmatism was aligned along pre-existing north–south, northeast and west-northwest-striking structural fabrics, and occurred near Kotzesrus. Dolerite dykes of the West Coast Suite were emplaced contemporaneously along regional north-northwest-striking fractures.

Nearly half of the area covered by sheet 3017 Garies is overlain by Cenozoic sediments, possibly ranging in age from the Palaeogene to the Quaternary. A brief event of magmatic activity in the earliest Cenozoic led to the emplacement of alkaline mafic rocks of the Biesjes Fontein Suite and the Sandkopsdrif Complex. Marine deposits of Middle Miocene to Pleistocene age, belonging to the fossiliferous Alexander Bay (pre-Pleistocene) and Curlew Strand (Pleistocene) Formations, form a minor proportion of the Cenozoic sediments, yet are very important economically as diamond producers. The latter sequences are usually covered by extensive aeolian sands sourced from river mouths and fluvial plains. The older sediments commonly reveal evidence of wetter and warmer palaeoclimates than the later sequences. Evidence was found for Cenozoic, and possibly Quaternary, faulting between Hondeklip Bay and Koingnaas.

Brownish weathering granite of the Spektakel Suite north of Hoëkraal on Weltevrede 110 (3017BC). The granite contains xenoliths of supracrustal gneiss (foliated dark-brown band in the foreground) and is cut by bands of younger leucocratic granite.

0257
REVISION MAPPING OF 1:250 000-SCALE SHEET 3218 CLANWILLIAM

Project leader: J.H.A. Viljoen, Ph.D.
Project team: L.P. Chevallier, Ph.D., D.I. Cole, Ph.D., D.L. Roberts, Ph.D., H.P. Siegfried, Ph.D., C.H. de Beer, M.Sc., A.S. Lindeque, B.Sc.Hons.
Primary objective: *to remap the area covered by the 1:250 000-scale geological map 3218 Clanwilliam, and to compile a new explanation.*
Duration: 2002/3 to 2008/9.
Budget: 2007/8: R60 000.

Motivation
The 1:250 000-scale geological map 3218 Clanwilliam was one of the first of the series to be published. The old stratigraphic terminology was used on the map and only a short explanation was available, printed on the map. The mapping used for the original edition was carried out between 1954 and 1969, and, besides lacking the lithostratigraphic subdivisions accepted since its original publication in 1973, the original map is now out of print. Requests were made by Department of Water Affairs and Forestry at the end of 2002 to supply them with geological information of the area, and a report and maps were prepared for groundwater research. From this work it also became clear that the existing map needed revision. Requests from the Botanical Society to correlate geology and plant commodities also made revision mapping necessary.

Progress
The thirty 1:50 000-scale maps used to compile the 1:250 000-scale Clanwilliam map have now been revised. A preliminary compilation of the 1:250 000-scale map from the 1:50 000-scale maps has also been produced, as well as an isopach map of Cenozoic sediments.

Conclusion
The project is progressing according to schedule.

Future activities
The completion date of the map and explanation is March 2009.

The sharp transition between the Table Mountain (right and bottom) and Bokkeveld (left and upper) Groups to the east of the Cedarberg Mountain Range is not only visible owing to the difference in lithology and morphology but is also well illustrated by the difference in vegetation. It is a clear indication of the effect of geology on the vegetation. The village of Wuppertal can be seen in the valley.

0882
TSUNAMI OR LARGE WAVE RISK IN SOUTHERN AFRICA — A PRELIMINARY ASSESSMENT FROM EVIDENCE OF PAST EVENTS

Project leader: D.L. Roberts, Ph.D.
Project team: C. Dondo, M.Sc., L.P. Chevallier, Ph.D.
Primary objectives: *to extend the record of tsunamis into the Holocene and possibly the late Pleistocene, and acquire more information about their frequency, magnitude and impact.*
Duration: 2006/7 to 2008/9.
Budget: R82 125.

Motivation
The information supplied by this project will result in a refined assessment of the hazards and risks presented by these phenomena to coastal communities and installations, and promote the implementation of appropriate mitigating and adaptive steps.

Possible tsunami deposit at 11 m above sea level at False Bay.

Progress

A visit to Madagascar was undertaken to determine the magnitude and frequency of large tsunamis that would have impinged on the South African coast. Trenches were excavated along the northeastern shore to expose and log ancient tsunamis. A paper entitled 'Tsunami incidence, impact and future risk along the southern African coast' was submitted to the journal Geomorphology. Preparations for the International Association of Seismology and Physics of the Earth's Interior (IASPEI) conference in Cape Town, to be held in November 2008, commenced. The project leader was asked to act as co-convenor of the Tsunami Risk session of this major conference.

Future activities

This project will continue into the coming financial year.

0911

1:50 000-SCALE GEOLOGICAL MAPS 3318AD DARLING AND 3318AC YZERFONTEIN

Project leader: H.P. Siegfried, Ph.D.
Project team: L.P. Chevallier, Ph.D., D.L. Roberts, Ph.D., O.L.C. Nhleko, B.C. Oosthuizen.
Primary objective: *to produce a detailed geological map with a description, as well as a description of the distribution of soil types.*
Duration: 2007/8 to 2008/9.
Budget: Total: R366 406.

Motivation

The Darling and Yzerfontein sheets form part of the 1: 50 000-scale map series which will be completed in order to supply information for development of the Western Cape coast. The mapping will show subdivisions of all the lithostratigraphic units, as well as the distribution of all the soil types. Geophysical-data interpretation and a study of the geochemistry of the different granite types will also form part of this project, and the engineering-geological properties of the strata will be included where possible.

All economic possibilities, current and abandoned mineral localities and mines will be examined in this study; all areas of geological interest will also be noted on the map and a concise description will be given in the explanation.

Part of the area covered by this map, near the southern perimeter, has never been studied in detail. This area borders the townships of Atlantis and Mamre, and geological information is important to these municipalities, as large faults are known to underlie this region.

The Darling area has one of the largest wild flower attractions in South Africa, and geotourism in the area could enhance its popularity. The Department of Environment and Tourism and private tour operators could use the map for geological tours, as the Darling Batholith is one of the largest granite occurrences in the Western Cape.

The supply of water is becoming a major problem in the area, and groundwater-exploration targets can be delineated with the use of geological information. The Department of Water Affairs and Forestry will benefit from the detailed mapping which will enhance their geohydrological knowledge of the area.

Scenic view of the Darling Batholith looking north from Dassenberg.

Progress
The thirty-two 1:10 000-scale field maps had been completed by the end of October 2006. A detailed report was completed to accompany the 1:50 000-scale geological maps 3318AD Darling and 3318AC Yzerfontein. Twenty-two granite samples have been taken for geochemical analysis, in order to study major- and trace-element distribution.

Conclusion
The project is 95% complete, and is proceeding according to plan. Changes to the map introduced more subdivisions of the granite, which should elucidate the genesis of the Darling Batholith.

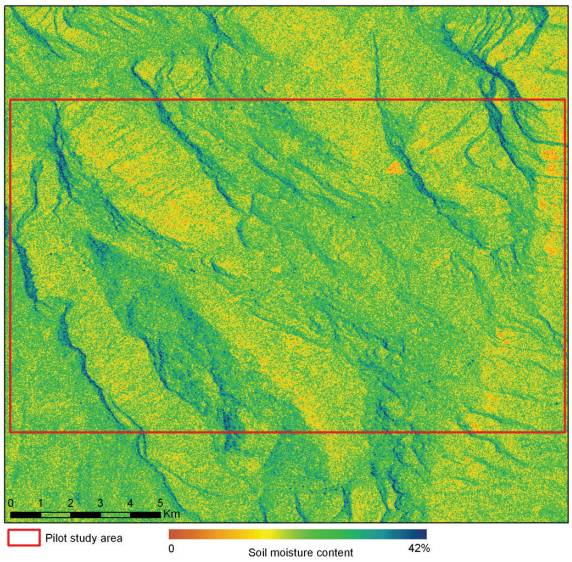
Future activities
Geochemical analyses of the new granite subdivisions will support the new classifications, and all of the granite units will be analysed for geophysical properties towards the end of the project. A study of the engineering-geological properties of the strata will be carried out.

0925
QUADRATURE POLARIMETRIC RADAR WITH APPLICATION TO WATER-RESOURCE MANAGEMENT

Project leader: J. Engelbrecht, M.Sc.
Primary objective: *to build capacity in radar remote sensing which can be used for mapping projects in Africa. The project will stimulate innovation, develop human capital and widen the current limited application of radar remote sensing for geoscience mapping in South Africa.*
Duration: 2007/8 to 2008/9.
Budget: Total: R99 480.

Motivation
Optical remote-sensing data are captured in the visible and near to thermal infrared regions of the electromagnetic spectrum (EMS). The use of remote-sensing data in geological mapping and water-resource assessment is severely limited by the amount of vegetation present on the ground and by cloud cover. In vegetated areas, information about vegetation cover is captured and used to determine the limitations on extraction of geological information. In addition, the visible portions of the EMS can be strongly reflected by clouds, causing the data to be useless for the determination of geological information. In contrast, radar remote sensors are unaffected by cloud cover and, depending on wavelength, can penetrate vegetation cover and possibly several centimetres into the subsurface. Thus, many of the problems experienced when using optical remote-sensing data are alleviated. Consequently, as the CGS tenders for and is awarded more projects in densely vegetated parts of Africa, the capacity to use radar remote sensing for geoscience applications becomes more crucial. This project aims to develop radar remote-sensing capacity by applying radar data for soil-moisture measurement in a quaternary catchment in the Western Cape Province.

Progress
Alternating polarisation Envisat ASAR data were acquired for a study area in the Bo-Piketberg region in the Western Cape Province of South Africa. Image processing commenced with the preprocessing of Envisat data to provide a measure of radar backscatter. Determination of soil-moisture content was achieved by simple linear regression using field-based soil-moisture data as input. The resulting soil-moisture maps could be used as input into hydrological models to determine the amount of water in the Quaternary catchment. The accuracy of the methodology is difficult to quantify since ground-truth data over the entire catchment were unavailable. The acquisition of fully polarimetric datasets for the retrieval of soil-moisture data will provide the means of extracting soil-moisture content without initial assessments of surface parameters.



Conclusion
Soil-moisture variability is an important factor for many applications including precision agriculture and hydrological models. Radar imagery for the quantification of moisture content of soil is the focus of many research programmes, and the results indicate that the data can be used with various levels of success. In general, SAR systems show a relatively high sensitivity to soil moisture owing to the large contrast in the dielectric constants of dry and wet soils at microwave frequencies. Capture of polarimetric radar datasets in the near future will enhance the ability to quantify soil moisture, while the availability of ground-truth data for a portion of the study area will provide a means of assessing the accuracy of the results. The ability to extract soil-moisture information will allow the results to be input into hydrological models to

quantify surface and groundwater use in the catchment. Furthermore, the capacity to retrieve information from radar remote-sensing data will be invaluable for the future of geoscience applications.

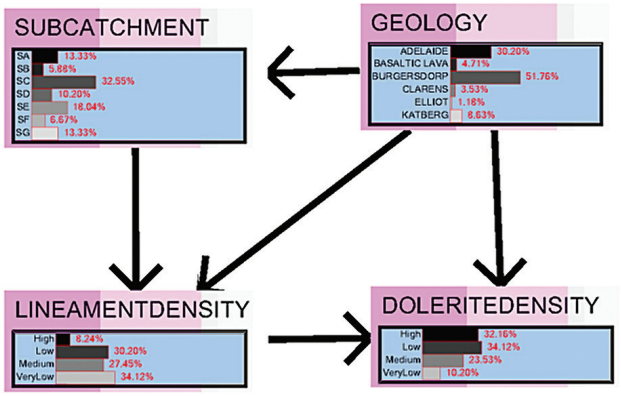
Future activities
The acquisition of polarimetric data in the study area will facilitate the quantification of soil moisture content without initial assessment of surface parameters, while making accuracy assessment through available ground-truth data a possibility. Future research will focus on the development of radar remote-sensing techniques for a variety of geoscience applications including the field of geohazards assessment.

0932
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 Bayesian Network technology for catchment management and to develop expertise for artificial-intelligence techniques in the Western Cape Remote Sensing and GIS Laboratory.*
Duration: 2005/6 to 2008/9.
Budget: Total: R341 262.

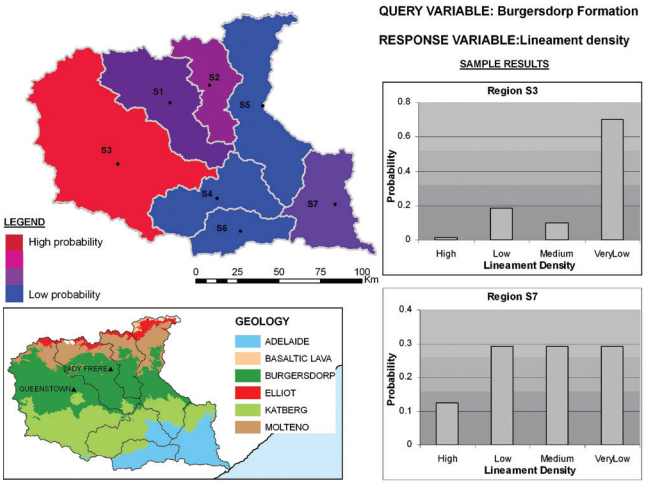
Motivation
The aim of the project is to develop a tool for the assessment of catchment resources for use in rural development. Bayesian Networks are used to determine cause-and-effect relationships in data. The strength of this technology lies in its ability to perform scenario analysis and predict the impacts of change in the data over time or under different management options. The prediction is based on a number of qualitative and quantitative variables and they can all be at different spatial and temporal scales. The variables can be measured or can be outputs from other models like surface water or groundwater models. It allows the incorporation of expert knowledge when measurements are missing, which is important in most geoscience problems where there is a paucity of data.

Progress
The software required for the modelling has been developed by a consultant and delivered to the CGS. The initial problem being addressed was that of assessing the groundwater and surface-water quality and the sustainability of the quantity of water supplied by a catchment. Data processing has commenced and some initial results have been obtained.



The software recognises patterns in the data and produces a network indicating the relationships between the input variables. The strengths of these relationships are shown by probabilities which can be automatically calculated from the data or manually input (informed by expert knowledge).

For example, the relationship between lineament density, dolerite-dyke density and geology for assessing the groundwater potential is provided for part of the Great Kei catchment in the Eastern Cape Province. An example of such a result is shown.



Queries are then performed on the result. The query being illustrated here is:
'What are the likely lineament densities given that the area is underlain by the Burgersdorp Formation?'

The responses provided are: 'For region S3, the density is 70% more likely to be very low'.
'For the region S7, the density has equal likelihood of being low, medium or high, although the probabilities are low, that is ~30%'.

These responses are then explained with respect to the expected groundwater potential of the catchment.

Conclusion
Data analysis will continue until the end of 2008, followed by time-series modelling of hydrological parameters. An important task still to be undertaken is the analysis of the sensitivities of the results to the change in parameters and the verification of the accuracies of the prediction results.

0932
MANUAL 'GIS' TOOLKIT FOR RURAL SCHOOLS DEVELOPMENT

Project leader: C. Petersen.
Project team: C. Dondo, M.Sc., J. Engelbrecht, M.Sc., L. Ngcofe, B.Sc.Hons, D. Williams, M.Sc.
Primary objective: *to produce an operational educational tool (manual GIS tool kit), adapted to disadvantaged learning communities, in three stages: to (i) develop the GIS educational tool and have it approved by the Department of Education; (ii) test the manual GIS toolkit in a Cape region rural school, and (iii) assist the teachers to use the tool.*
Duration: 2006/7 to 2007/8.
Budget: Total: R91 500.

Motivation
The aim of the project is to create an awareness of geographic information systems and earth observation among young scholars by developing strong geographical concepts and a scientific understanding of the earth. This type of initiative enhances the school system and assists young learners to reach a higher level of education, thus becoming competitive in the job market. The main disadvantage of the teaching of Geographic Information Systems is that they are computer based and factors such as electricity, computer hardware and software, and the training of teachers are needed.

It has been discovered through research over the past two years that the biggest difficulty that the Department of Education will face is not major expenditure on software and hardware, but the creation of an awareness of, and enthusiasm for, the subject amongst teachers.

Progress
A toolkit has been developed and tested at a rural school. The response from the school has been analysed.

Conclusion
The product has been tested and was well accepted by the curriculum advisors for geography educators, and learners generally have a full understanding of the product.

Future activities
More testing will be done at schools and the product will be marketed.

Contents of the manual GIS toolkit.

0974
DEVELOPMENT-POTENTIAL MAP OF THE BEAUFORT WEST TOWNLANDS

Project leader: F. Stapelberg, B.Sc.Hons, M.B.A.
Project team: S. Naidoo, B.Sc.Hons, L. Nhleco, M.Sc., L. Ngcofe, B.Sc.Hons, D. Cole, Ph.D.
Primary objective: *to map the area in detail, guiding urban expansion and advising on optimal groundwater utilisation and mineral development, thus contributing to sustainable rural development.*
Duration: 2007/8.
Budget: R98 000.

Motivation
Beaufort West is an expanding town located on the N1 and is situated within a provincial rural poverty area identified by the government's Integrated Sustainable Rural Development Plan (ISRDP).

Brick clay is extracted by small-scale operators on a part of the townlands, and a reconnaissance study was needed to locate possible additional reserves for future expansion of industrial activities. From a geohydrological point of view, this is an arid area, and the growth in population will put water resources under pressure. In addition, groundwater pollution must be controlled.

Progress

This project is now complete. Investigations have been completed, a map depicting preferential development zones for the town from an engineering-geological perspective has been compiled, and an accompanying report has been written. Recommendations have been made regarding construction-material availability and the optimal utilisation of groundwater.

Conclusion

The area has mostly shallow, stable soils and minor geotechnical problems. The most important geotechnical problems are:

- the possibility of flooding in areas adjoining the Gamka River and its tributaries;
- the shallow excavation depth to bedrock which limits the availability of cover materials at the municipal waste disposal site, and also restricts sites suitable for the placement of a graveyard, and
- the steep slopes associated with the east–west ridge occurring in the central part of the townlands.

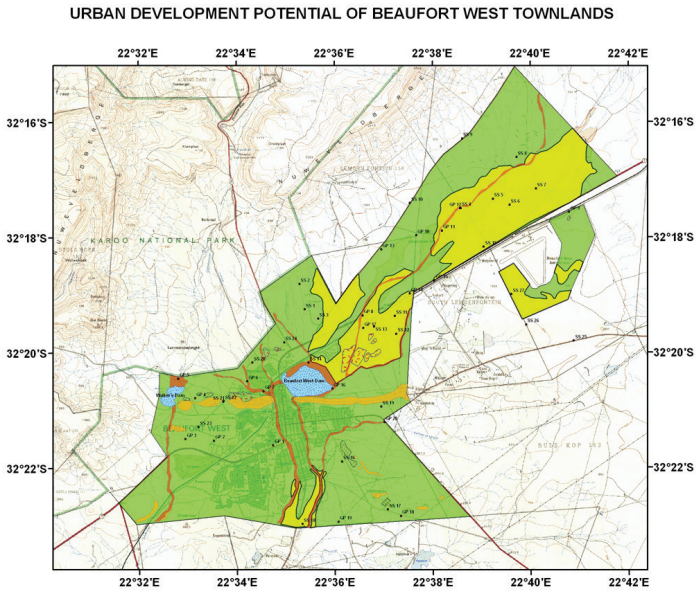
Limited groundwater sources could affect future growth.

The potential for extension of the brick-clay extraction operations northeast of the Beaufort West Dam to the northeast is limited. A potential source of brick clay occurs directly south of the townlands, but the quantity and quality of material must be investigated.

The large road-material/aggregate/railway-ballast quarry in the northern part of the townlands has limited potential for extension. However, similar material (dolerite) is available further towards the east, south of the Beaufort West Dam, along the east–west ridge.

Future activities

When the local municipality requires additional groundwater or construction-material sources, the CGS may be consulted. Furthermore, if the product of this investigation is found useful, similar exercises may be considered for Nelspoort and Merweville.



The boundaries of the study area (for the hydrogeological investigation, however, data from the entire 1:50 000-scale sheet were considered).

APPENDIX

REPRESENTATION ON COMMITTEES

Action Group of the Western Cape Wetland (L. Gibson).
Advisory Committee of the International Association of Gondwana Research (G.H. Grantham).
Advisory Committee on the West Coast Biosphere Project (D.L. Roberts).
Advisory Committee to the Makana City Council, Grahamstown (Member: M.L. Goedhart).
Board of the Council for Geoscience (T. Ramontja).
Board of Directors of the Museum Park (D.J. Barnardo).
Board of the Petroleum Agency of South Africa (T. Ramontja).
Council of the South African Institute for Engineering and Environmental Geologists (SAIEG) (President: G.N. Davis).
Council of the Southern African Society for Quaternary Research (SASQUA) (Treasurer: G.A. Botha).
South African Council for Natural Scientific Professions (SACNASP) (L.P. Maré, A. Kijko).
Committee of Heads of Research and Technology (COHORT) (formerly Committee of Heads of Science Councils (CHSC) (T. Ramontja).
Committee for Site Investigation of the Department of Water Affairs and Forestry (DWAF) (G.N. Davis).
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 the Association of African Women Geoscientists (A. Faull).
Central Energy Fund Governance and Nomination Committee (T. Ramontja).
Editorial Advisory Board Africa Geoscience Review (G.S. de Kock; M.R. Johnson; D.I. Cole).
Editorial Board of Gondwana Research (G.H. Grantham).
Executive Committee of the South African National Committee on Tunnelling (SANCOT), a committee of the South African Institute of Mining and Metallurgy (SAIMM) (G.N. Davis).
Geological Society of South Africa (GSSA)
    Council of the Geological Society of South Africa (Member: M.G.C. Wilson; D.J. Barnardo).
    Committee of the Mineralogical Association of South Africa (MINSA) (M. Cloete).
    Committee of the Limpopo Branch of the GSSA (N. Baglow, G. Brandl).
    Committee of the Western Province Branch of the GSSA (C.H. de Beer, A. Lindeque).
    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).
    Environmental and Conservation Committee (D.J. Barnardo; R.R.M. Price).
    Research, Education and Investment Fund (Member: M.G.C. Wilson).
Geology Subcommittee of the Mining Sector Coordinating 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).
Institute of Directors (IOD) (Member: T. Ramontja).
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 (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)
    Coordinator 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).
Makana Council Housing and Industrial Development Working Group, Grahamstown (Member: M.L. Goedhart).
Management Committee of the Far West Rand Dolomitic Water Association of the Chamber of Mines (G.J. Heath).
Middle East Seismological Forum (MESF) (A. Kijko).
Mining Qualifications Authority (MQA).
    Mining and Exploration Geology. Technical Review Group (SGG), South African Qualifications Authority and Department of Minerals and Energy (Member: C. Forbes).

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).
National Dolomitic Risk Management Working Committee (NDRWC) (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.K. Zawada).
Palaeontological Society of Southern Africa (Vice-President: J. Neveling).
Editor of the newsletter of the Palaeontological Society of Southern Africa (J. Neveling).
Quaternary Research Committee of the Southwestern Cape (QUARC) (Board member: D.L. Roberts).
Research Group in mining activities for the Succulent Karoo Ecosystem Plan for Conservation International (D.I. Cole, L.P. Chevallier).
Scientific Committee for Antarctic Research (SCAR)
South African National Committee (A. Bisnath).
Seismological Society of America (Member: A. Kijko).
South African Committee for Stratigraphy (SACS)
Secretary: M.R. Johnson, N. Keyser, P.K. Zawada.
Task Group for Alkaline and Basic Intrusives (Secretary: L.P. Chevallier).
Task Group for Cape Granites (Secretary: H.P. Siegfried, P.M.W. Botha).
Task Group for the Cenozoic Committee (Secretary: G.A. Botha).
Task Group for Chronostratigraphy (Secretary: G.S. de Kock).
Task Group for Gariep – Cape Rocks (Secretary: C.H. de Beer, P. Macey).
Task Group for Jurassic and Cretaceous Rocks (Secretary: J.S.V. Reddering).
Task Group for the Karoo Supergroup (Secretary: D.I. Cole, J.H.A Viljoen, J. Neveling).
Task Group for pre-Bushveld Intrusive and Swazian Rocks (Secretary: N. Baglow, Members: G. Brandl, R. Belcher).
Task Group for pre-Gariep Rocks in the Northern and Western Cape (Secretary: P.H. Macey, C.H. de Beer, H.F.G. Moen, A.L.D. Agenbacht).
Task Group for the Transvaal Supergroup east of 25°E (Secretary: P.J.A. Bosch, F.J. Hartzer).
Task Group for the Transvaal Supergroup west of 25°E, and Olifantshoek Supergroup (Secretary: H.P. Siegfried).
Task Group for the Waterberg and Soutpansberg Groups (Chairman: G. Brandl).
Biostratigraphy Committee of the South African Committee of Stratigraphy (J. Neveling).
South African Mineral Resource Committee (SAMREC) and the Working Group on the compilation of the main South African code for the reporting of mineral resources and mineral reserves (S. Foya).
South African National Commission for UNESCO's Focal Point for the International Geoscience Programmes (P.K. Zawada).
Steering Committee of South Africa's Africa's Shelf Claim Project led by the Petroleum Agency of South Africa (T. Ramontja; Alternate: P.K. 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).
South African Scientific Representative to Working Group G 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).
South Africa Geophysical Association (Member: A. Kijko).
South African Association for Geotechnologists (R.H. Stettler).
South African Bureau of Standards (SABS)
South African Qualification and Certification Committee (SAQCC) (Boreholes) (J.G. Barkhuizen).
Subcommittee on National Standards for Groundwater Extraction (J.G. Barkhuizen).
South African National Research Institutions Consortium (SANRIC) (L. van der Merwe).
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).
Steering Committee on the Ghana Project (Representative: G.H. Grantham).
Technology Demonstration Centre (TDC) – Zenzele (Board Member Trustee of the Fossil Fuel Foundation (T. Ramontja).
Technical Committee for the Development on Controls under the proposed Mineral and Petroleum Resources Development Act, 2002 (H.J. Brynard).
Working Group of Water Research Commission Strategic Planning for Groundwater Studies in the Eastern Cape (L.P. Chevallier).
Working Group of the Cradle Water (J. Groenewald).
Water Services Sector Leadership Group (WSSLG) Gender Task Team (U.A. Rust).
Western Basin Technical Working Group (H. Coetzee, N. van Wyk).

STRATEGIC PARTNERSHIPS

INSTITUTION / STRATEGIC PARTNER	PROJECT / INITIATIVE	PROJECT FUNDING	NOTES
University of the Western Cape (UWC)	Sampling and Monitoring Protocol for Radioactive Elements in Fractured Rock Environments	WRC	University of Western Cape is lead agent
University of Pretoria (UP)	Determining Sustainable Yields of Potential Productive Well Fields in the Basement Aquifers of the Limpopo Province (with special emphasis on the Limpopo (WMA 1) and Luvuvhu/Letaba (WMA 2) Water Management Areas)	WRC	University of Pretoria is lead agent
DME	A Strategic Water Management Plan for the Prevention of Water Ingress into Underground Workings of the Witwatersrand Mining Basins	DME - Parliamentary Grant	Agency Function Project
DST	The Witwatersrand Central Basin Mine Water Apportionment Pilot Study	DST	Agency Function Project
DWAF	Groundwater Flow Determination and Monitoring Systems for Karst Environments in the Limpopo Province	DME - CGS Statutory Grant	Statutory Project
Water Geosciences Consulting C.C.	Geohydrology Guideline Development: Implementation of Dolomite Guideline – Phase 1	DWAF	BEE Collaborator
	A Synthesis of the Hydrogeology of Basement Aquifers in Southern Africa: Research Needs and Priorities	WRC	
	Sampling and Monitoring Protocol for Radioactive Elements in Fractured Rock Environments	WRC	
Dr Hans Beekman	A Synthesis of the Hydrogeology of Basement Aquifers in Southern Africa: Research Needs and Priorities	WRC	Reviewer / editor
Zitholele-Golder	A Strategic Water Management Plan for the Prevention of Water Ingress into Underground Workings of the Witwatersrand Mining Basins	DME - Parliamentary Grant	BEE Collaborator
	DWAF Strategic Planning Guidelines project proposal	DWAF	
SRK Consulting	A Strategic Water Management Plan for the Prevention of Water Ingress into Underground Workings of the Witwatersrand Mining Basins	DME - Parliamentary Grant	Reviewer
Knight-Piesold	A Strategic Water Management Plan for the Prevention of Water Ingress into Underground Workings of the Witwatersrand Mining Basins	DME - Parliamentary Grant	Reviewer

INTERNATIONAL COOPERATION

Norwegian Institute for Water Research (NIVA)	Witwatersrand Central Basin Mine Water Apportionment Pilot Study	National Research Foundation (NRF) Grant	International Collaborator
Bureau de Récherches Géologique et Minières (BRGM)	P2R SAFe Water - Water Quality and Treatment Project	WRC SAFe Water Programme	International Collaborator
	Groundwater and Drought Management in Southern Africa Development Community (SADC) Tender Proposal	World Bank Global Environment Facility (GEF)	International Partner
Water Resources Consulting (Botswana)	Groundwater and Drought Management in Southern Africa Development Community (SADC) Tender Proposal	World Bank Global Environment Facility (GEF)	SADC Partner

ATTENDANCE AT NATIONAL SCIENTIFIC AND TECHNICAL MEETINGS

Local conferences

XVII biennial congress of the Southern African Society for Quaternary Research (SASQUA), Umgeni Valley Nature Reserve, Howick, KwaZulu-Natal, 10–13 April 2007 (G.A. Botha, M.L. Goedhart).

The annual S.A.M.A. (South African Museums Association) conference, May 2007 (A. Raath).

Courses and field trips

Quaternary history of the Coorong Coastal Plain, South Australia, 23–26 July 2007, Excursion A6, XVII Congress of the International Union for Quaternary Research (INQUA), Cairns, Australia (G.A. Botha, M.L. Goedhart).

Courses and lectures presented by CGS employees

'Challenges in Managing Mine Water and Closure' workshop, University of the Witwatersrand, 22–24 August 2007 (L.K.C. Strachan).

Workshops

African neotectonics and seismic hazard to mines, Council for Geoscience, Pretoria, 08 May 2007 (M.L. Goedhart, C.H. de Beer).
Tsunami hazard assessment for the Nelson Mandela Metro, Port Elizabeth, Nelson Mandela Metropolitan University, 12–13 July 2007 (M.L. Goedhart, J.S.V. Reddering).
IIR Biennial Nuclear Energy and Uranium Renaissance II, Sandton, Johannesburg, 26–28 Sept 2007 (M.L. Goedhart, C.H. de Beer).
Reporting Science Conference, Johannesburg, 19–20 November 2007 (S.J. van Eck, A. van Heerden, R.R.M. Price).
Radar Applications and Interferometry Processing Course, presented by the CSIR, Hartebeeshoek, 2–5 April 2007 (T. Mafanya, K.F. Netili, S. Esterhuyse).
Department of Minerals and Energy Witwatersrand Water Ingress Project/Department of Minerals and Energy Sustainable Development through Mining Government Task Team Workshop, presented by the Council for Geoscience, Pretoria, 31 May 2007 (L.K.C. Strachan, H. Coetzee, D. van Tonder).
K14 Driver Learner Training, Bonus Driving School, Pretoria, 28 June 2007 (F.H. Minnaar, D.M. Makgate).
DWAF Workshop 3 on Gender – Water Services Sector Leadership Group (WSSLG), presented by the DWAF, Pretoria, 26 October 2007 (U.A. Rust).
Advanced 4 x 4 Training, presented by Gerotek, Pretoria, 17–18 Sep 2007 (T. Mafanya, K.A. Majola, K.F. Netili, S.N. Ndengu, D.C. Samuels).
Workshop on Geoscience Act Amendments, presented by the DME, Pretoria, 15 October 2007 (T. Mafanya).
Effective Reading, presented by The Learning Revolution, Pretoria, 28–29 November 2007 (M. Groenewald).
'Apart not A Part' Diversity Workshop, presented by Absolute Ndaba, Irene, Centurion, 10 December 2007 (L.K.C. Strachan).

International conferences

Geohazards, Kampala, Uganda, July 2007 (H.J. Brynard).
International Cartographic Association Meeting, Moscow, July 2007 (K.J. Wilkinson, H.M. Roos).
2007 GSA Denver Annual Meeting, 28–31 October 2007 (J. Neveling).
XVII International Union for Quaternary Research (INQUA) Congress, Cairns, Australia, 28 July–3 August 2007 (G.A. Botha, D.L. Roberts, M.L. Goedhart, R.G. Singh).
Integrated Shared Aquifer Resource Management (ISARM) for Southern Africa Conference, 18–20 July 2007, Windhoek, Namibia. (S.N. Ndengu).
'Challenges in Managing Mine Water and Closure' Workshop, 22–24 August 2007, University of the Witwatersrand Centre for Sustainability in Mining and Industry (CSMI), Johannesburg, 22–24 August 2007 (L.K.C. Strachan).
'Groundwater 2007' Conference, 8–10 October 2007, Ilanga Estate, Bloemfontein. Groundwater Division of the Geological Society of South Africa and University of the Free State (L.K.C. Strachan, S. Esterhuyse, Y. van Wyk).
'Women in Mining — Taking Stock of the Present, Shaping the Future' Colloquium, 8–9 November 2007, University of the Witwatersrand. Presented by the Department of Minerals and Energy, MINTEK, Centre for Sustainability in Mining and Industry (CSMI), CSIR, and the University of the Witwatersrand (L.K.C. Strachan, S. Esterhuyse, S. Ndengu, T. Mafanya, J. Leshomo).
National Groundwater Archive Road Show, presented by the Groundwater Division of the Geological Society of South Africa and the University of Pretoria, 4 March 2008 (L.K.C. Strachan, H. Mengistu, K.F. Netili, Y. van Wyk).

FOREIGN COUNTRIES VISITED

Person	Country Visited	Purpose
I.G. Haddon	Australia	Africa Down-under Conference
J. Neveling	Botswana	Tri-Nations Project
T. Mafanya, L.K.C. Strachan	Democratic Republic of Congo	Bi-national Commission Meeting
R.P. Shelembe	Ghana	The Voltaian Geology Workshop Geological Mapping (European Union)
B.A. Ingram	Mauritania	Geological Mapping Supervision
B.A. Ingram	Madagascar	Geological Mapping (MRM)
B. Yibas	Madagascar	Tender for 1:1 000 000-scale map (World Bank)
G.S. de Kock	Madagascar	Mapping Supervision (World Bank)
P.J.A. Bosch	Mozambique	Borehole Logging (AquaEarth)
J. Neveling	Mozambique	Scoping Exercise (Riversdale Mining)
G.H. Grantham	Japan	International Association Gondwana Research Symposium
S.N. Ndengu	Namibia	Karoo Tri-Nations Project – visit to Namibian Department of Water Affairs
K.J. Wilkinson H.M. Roos	Russia	International Cartographic Association Meeting
G.H. Grantham	United States of America	10th International Symposium on Antarctic Earth Sciences
I.G. Haddon	United States of America	Carbon Dioxide Sequestration Forum
G.H. Grantham	United Kingdom	Recruitment
G.S. de Kock	United Kingdom	Mapping Supervision (World Bank)
R.P. Shelembe	United Kingdom	Recruitment
H.J. Brynard	Uganda	Geohazards Conference
T. Mafanya	Vietnam	Ministerial delegation from the Department of Minerals and Energy

MAPS PUBLISHED BY THE COUNCIL FOR GEOSCIENCE

The following maps were released during the year:

1:250 000-scale Geological Maps

2622 Morokweng
3018 Loeriesfontein

1:50 000-scale Geological Maps:

2627DB Vereeniging
3326CA Springmount
3326BC Grahamstown
3326DB Port Alfred
3322CD & 3422AB George
2628BA Delmas
3326BD Trappe's Valley
3326DA & DC Boesmansriviermond
3326CB & CD Alexandria
2429AA Mokopane

1:50 000-scale Geotechnical Maps:

2730CC Osizweni

The following Total Field Magnetic Data Maps (High-Resolution Series) were released during the year:

2328AC Abbotspoort
2624BD Papiesvlakte
2920AD Doringknie
2920CB Boomrivier
2920BC De Tuin
2528AD Hammanskraal
2816DD Holgat
2920AC Vaalkop
2920CA Lekdam
2920DA Drieboomlaagte

PUBLICATIONS IN ACADEMIC JOURNALS AND BOOKS

Bosman, C., Uken, R. and Ovechkina, M., 2007. The Aliwal Shoal revisited: New age constraints from nannofossil assemblages. South African Journal of Geology, 110 (4), pp. 647–653.

Bosman, C., Uken, R., Leuci, R., Smith, M. and Sinclair, D., 2007. Shelf sediments off the Thukela River mouth: complex interaction between fluvial and oceanographic processes. South African Journal of Science, 103 (11/12), pp. 490–492.

Bräuer, B., Ryberg, T. and Lindeque, A.S. 2007. Shallow seismic velocity structure of the Karoo basin, South Africa. South African Journal of Geology, Special issue dedicated to Inkaba yeAfrica, 110 (2/3), pp. 439–448.

Coetzee, H., Wade, P. and Winde, F., 2007. Understanding environmental geophysical anomalies — an interdisciplinary case study from the West Rand. South African Journal of Geology, 109, pp. 495–502.

Combrinck, L., Fourie, C.J.S., Croukamp, L. and Saunders, I., 2007. Report on preliminary geotechnical and tropospheric site investigation for a proposed space geodetic observatory near Matjiesfontein in the Great Karoo. South African Journal of Geology, Special issue dedicated to Inkaba yeAfrica, 110 (2/3), pp. 225–234.

Durrheim, R.J., Anderson, R.L., Cichowicz, A., Ebrahim-Trollope, R., Hubert, G., Kijko, A., McGarr, A., Ortlepp, W.D. and Van der Merwe, N., 2007. Risks posed by large seismic events in the gold mining districts of South Africa. *In:* Challenges in deep and high stress mining (Y. Potvin, J. Hadjigeorgiou and D. Stacey, eds). Australian Centre for Geomechanics, Perth, Australia, ISBN 978-0-9804185-1-4. pp. 33–40.

Durrheim, R.J., Cichowicz, A., Ebrahim-Trollope, R., Essrich, F., Goldbach, O., Linzer, L.M., Spottiswoode, S.M. and Stankiewicz, T., 2007. Guidelines,Standards and Best Practice for Seismic Hazard Assessment and Rockburst Risk Management, Proceedings of SANIRE 2007, 30–31 August 2007, Maccauvlei, pp. 136–149.

Durrheim, R.J., Cichowicz, A., Ebrahim-Trollope, R., Essrich, F., Goldbach, O., Linzer, L.M., Spottiswoode, S.M. and Stankiewicz, T., 2007. Guidelines,Standards and Best Practice for Seismic Hazard Assessment and Rockburst Risk Management in South African Mines, Proceedings of the 4th International Seminar on Deep and High Stress Mining, 7–9 November 2007, Perth Australia, Y. Potvin (editor), Australian Centre for Geomechanics, ISBN 978-0-9804185-2-1, pp. 249–261.

Goedhart, M.L., 2007. Seismicity along the southern Cape Fold Belt, South Africa, association with geological structures, and early-Holocene reactivation of the Kango Fault. INQUA XVII 2007 Congress, Cairns, Australia. *In:* Catto, N.R., van Kolfschoten, T, and Rutter, N, Eds), Quaternary International, Vol. 167–168 Supplement 1, pp. 142 –143.

Isbell, J., Cole, D.I. and Catuneanu, O., 2008. Carboniferous to Permian glaciation in the main Karoo basin, South Africa: stratigraphy, depositional controls, and glacial dynamics. *In*: Resolving the Late Palaeozoic ice age in time and space (C.R. Fielding, C.R. Frank and J.L. Isbell, eds). Special Paper, Geological Society of America, 441, pp. 71–82.

Lindeque, A., Ryberg, T., Stankiewicz, J., Weber, M.H. and De Wit, M.J., 2007. Deep crustal seismic reflection experiment across the southern Karoo basin. South African Journal of Geology, Special issue dedicated to Inkaba yeAfrica, 110 (2/3), pp. 419–438.

Linzer, L.M., Bejaichund, M., Cichowicz, A., Durrheim, R.J., Goldbach, O.D., Kataka, M.O., Kijko, A., Milev, A., Saunders, I., Spottiswoode, S.M. and Webb, S.J., 2007. Recent research in seismology in South Africa. South African Journal of Science, 103 (9/10), pp. 419–426.

Morita, H., Hiroi, Y. and Grantham, G.H., 2007. Prograde andalusite in kyanite-bearing siliceous rocks in the Ilangwe Greenstone Belt, southeastern margin of the Kaapvaal Craton, South Africa. South African Journal of Geology, 110 (1), pp. 55–58.

Nengovhela, A.C., Yibas, B. and Ogola, J.S., 2007. An investigation into the availability of oxygen in gold tailings dams of the Witwatersrand basin with reference to their acid mine drainage potential. Water SA, 33 (2), pp. 271–274.

Roberts, D.L., Bateman, M.D., Murray-Wallace, C.V., Carr, A.S. and Holmes, P.J., 2007. Last Interglacial fossil elephant trackways dated by OSL/AAR in coastal aeolianites, Still Bay, South Africa. Palaeogeography, Palaeoclimatology, Palaeoecology, 257, pp. 261–279.

Roelofse, F., 2007. An exploratory study into the multidimensional nature of quality in analytical laboratories: Managerial implications. The Quality Management Journal, 13 (3), pp. 7–14.

Roelofse, F. and Horstmann, U.E., 2007. A case study on the application of isotope ratio mass spectrometry (IRMS) in determining the provenance of a rock used in an alleged nickel-switching incident. Forensic Science International, 174, pp. 63–66.

Stankiewicz, J., Ryberg, T., Schulze, A., Lindeque, A., Weber, M.H. and De Wit, M.J., 2007. Initial results from wide-angle seismic refraction lines in the southern Cape. South African Journal of Geology, Special issue dedicated to Inkaba yeAfrica, 110 (2/3), pp. 407–418.

Strachan, L.K.C., 2007. SusIT: A software tool for auditing rural water services schemes to identify water supply problems. Arab Water World, Chatila Publishing House (CPH), XXXI (7), pp. 48–50.

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CONFERENCE ABSTRACTS AND POSTERS

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Bosman, C., 2007. The marine geology of Aliwal Shoal. XVII SASQUA Congress, Umgeni Valley Nature Reserve, Howick, KwaZulu-Natal, 11–13 April 2007.

Botha, G.A. and Porat, N., 2007. Soil chronosequence development on the southeast African coastal plain, Maputaland, South Africa. Abstract, Quaternary International, XVII INQUA Congress, Cairns, Australia, 28 July–3 August 2007, 162–163, pp. 111–132.
Botha, G.A. and Willard, C.A., 2007. Regional geotechnical mapping in KwaZulu-Natal, South Africa. Abstract, Quaternary International, XVII INQUA Congress, Cairns, Australia, 28 July-3 August 2007, 167–168, Supplement 1, p. 41.
Brynard, H.J., The Development of a National Geohazards Programme for South Africa. Geohazards, Kampala, Uganda, July 2007.
Cawthra, H., 2007. A marine geophysical study of Blood Reef, Bluff, Durban. XVII SASQUA Congress, Umgeni Valley Nature Reserve, Howick, KwaZulu-Natal, 11–13 April 2007.
Cichowicz, A., 2007. Method for estimation of source parameters at regional distances. 10th SAGA (South African Geophysical Association) Biennial Technical Meeting, Wild Coast Sun, South Africa, 22–26 October 2007.
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Cichowicz, A., 2007. Tectonic background in mining districts and source dynamics — examples. AfricaArray Workshop, University of the Witwatersrand, Johannesburg, South Africa, 17–18 July 2007.
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Cloete, M., 2008. Carbon-dioxide storage atlas: The aim of an exploration programme for geological structures for storing CO_2 in South Africa. Abstract Volume, Conference, Carbon Capture and Storage in South Africa, Fossil Fuel Foundation (FFF), Johannesburg, South Africa, 20 February 2008.
Cloete, M., Strauss, S.W. and Elsenbroek, J.H., 2008. The use of regional geochemical data in exploration. Abstract Volume, Conference, Applications of Geochemistry in Exploration, Ore Deposit Evaluation and Metallurgy, Geological Society of South Africa Professional Programmes, Johannesburg, South Africa, 14 March 2008.
Cloete, M., Elsenbroek, J.H., Strauss, S.W., Van der Walt, D. and Atanasova, M.T.G., 2007. Geochemical mapping in South Africa and its value to environmental and public health. Abstract, Enviromin 2007, Environmental Aspects of Mining, Refining and Related Industries, Bakgatla, Pilanesberg, South Africa, 22–26 July 2007, p. 27.
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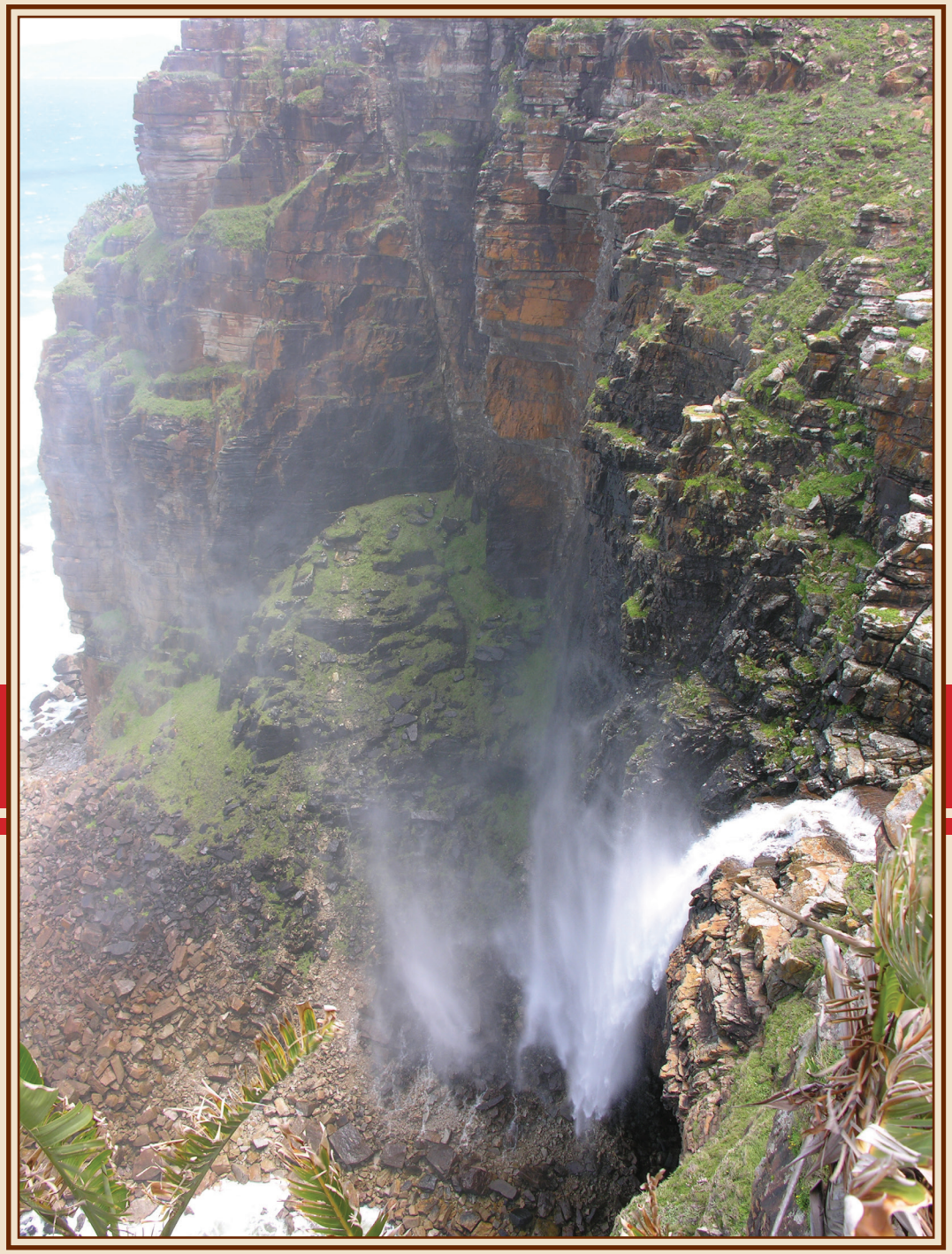

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