ANNUAL REPORT
OF THE
GEOLOGICAL SURVEY
DEPARTMENT
FOR THE YEAR
1988

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I. GENERAL

The Geological Survey remained within the Ministry of Mineral Resources and Water Affairs and continued with its main functions of gathering, assessing and disseminating all data related to rocks, mineral deposits and groundwater resources of Botswana.

The departmental organisational structure continued to consist of the Directorate, four operational divisions of Economic Geology, Hydrogeology, Geophysics and Regional Geology together with an administrative division.

The staffing position within the department remained satisfactory throughout the year. The post of Deputy Director was filled with the promotion of Mr. J. Dowsett, a geophysicist seconded from CIDA. He also holds the post of Principal Geophysicist in the Department. Dr. Norman Lock continued as the Assistant Director. Two British Geological Survey seconded geologists, Drs Aldiss and Williamson left the department at the end of their contracts. Mr. S. McMullan joined the department late in the year as a geophysicist on secondment from CIDA.

Within the Economic Geology division work continued to be directed towards evaluation and reviewing of industrial minerals. Some work also concentrated on precious metals exploration in the North East District.

Mineral Exploration by the Private Sector was very active throughout the year and was directed at the discovery of precious stones, base and precious metals and platinum group metals.

One hundred and six prospecting licences and two reconnaissance permits were active at the beginning of the year. During the year, two of the licences were converted to mining leases and twenty-three were terminated, relinquished or surrendered. Fifty-six new licences were issued during the year so that there were one hundred and forty active licences at year end. An additional sixty-two licences were prepared with starting dates in December 1988 but were not approved until early 1989. Three reconnaissance permits were also active by year end.

Within the Hydrogeology Division, a number of groundwater exploration projects were carried out, and new projects were identified and proposed to the Ministry of Mineral Resources and Water Affairs. Two groundwater projects were completed during the year and include the Serowe Groundwater Evaluation Project (GS10) where a resource of 160,000 m^3 per day for 25 years was identified and the Lephehe-Mmamabula-Limpopo Groundwater Investigation Project (GS10) Phase I, where two areas have been identified for future exploration, the areas being the Zoetfontein and Khurutshe. Work will be carried out in the Khurutshe area first.

The new projects include the Letlhakeng-Bothlapatlou Groundwater Investigation where a contract was to be awarded in March 1989, TGLP Groundwater Potential Survey (GS03) where a desk study was completed and thereafter the project discontinued due to manpower constraints, and the Matsheng Groundwater Investigation where a project document was being compiled on behalf of the Ministry of Local Government and Lands.

Research programmes were undertaken to explore groundwater related processes such as recharge mechanisms in semi-arid climates, regional groundwater flow, chemical evolution of groundwater flow, chemical evolution of groundwater, detection of groundwater flow paths in fractured aquifers using remote sensing techniques. The research work was conducted in partnership with the University of Botswana, the Free University of Amsterdam and the Federal Institute for Geosciences and Natural Resources (BGR).

In the Regional Geology Unit, a number of publications were printed and made available during the year. They include Bulletin 34, describing exposures in the Okwa Valley Proterozoic inlier, 1:125,000 scale geological maps for quarter degree sheets 2128D (Semolale) and 2425C and D (Phitshane) and a map at a scale 1:250,000 scale covering the Molopo Farms area.

Mapping projects were carried out in five areas. These include Topisi (QDS 2227A), Marico River (QDS 2426B), Magogaphate (QDS 2128C), Matsitama (QDS 2126B) and Ghanzi-Chobe covering quarter degree sheet (QDS) 2022D and parts of 2023C and 2022C. The work in
The Ghanzi-Chobe Foldbelt is a prelude to a bilateral geological mapping and mineral exploration project conducted by the Geological Survey Department and the Institute for Geosciences and Natural Resources (BGR).

In the Geophysics Division, two major foreign aid projects were carried out in Botswana, namely the Petro Canada International Assistance Corporation (PCIAC) sponsored reflection seismic survey in the Passarge basin and the EEC funded integrated Geophysical Survey in the Nossop/Ncojane and Passarge basins. In addition, gravity surveys were carried out near Bothlapatlo for groundwater purposes and in the vicinity of Gweta and Serule for mineral resources purposes.

A considerable amount of time was spent on professional consultation and advice to the Hydrogeology Division in connection with groundwater evaluation projects.

In the support section the Drawing Office continued the production of maps and diagrams accompanying geological reports, bulletins and memoirs. The Chemistry and Industrial Mineral Laboratories provided the analytical facilities to other sections within the department. The Drilling Unit provided all the drilling input required by the department even though their work continued to be hampered by the breakdown of the drilling machines which are now obsolete.

The two CIDA projects continued to run smoothly during the year. These include the driller training project which came to an end in 1988 when the last two drillers returned from Canada after completing Diploma studies in drilling mechanics and hydraulics, and the localisation of the Geophysics Division project. Under the latter project Batswana students continued to pursue Degree, and Diploma studies in Geophysics and Geoscience at various institutions in Canada.
5. HYDROGEOLOGY DIVISION

5.1 Introduction

The Hydrogeology Division has the responsibility for the investigation of the country's groundwater resources, their assessment in terms of development potential and quality. In pursuance of this brief the Division carried out a number of groundwater exploration projects, and new projects were identified and proposed to the Ministry of Mineral Resources and Water Affairs.

Research programmes were undertaken to explore groundwater related processes like recharge mechanisms in semi-arid climate, regional groundwater flow, chemical evolution of groundwater, detection of groundwater flow paths in fractured rock using remote sensing techniques.

The research work was conducted in joint venture with the University of Botswana, the Free University of Amsterdam and the Federal Institute for Geosciences and Natural Resources (BGR).

Training of professional and technical staff continued to form a central concern for the Division. During the year one staff member obtained a diploma in geotechnical engineering and two trainees completed their basic technical training and were employed as Technical Assistants.

No progress was achieved, unfortunately, with the localisation of senior posts, when the officer earmarked for the post of the Senior Hydrogeologist resigned from the Government Service.

5.2 Development Projects

5.2.1 Evaluation of Underground Water Resources

5.2.1.1 Serowe Groundwater Evaluation Project (GSIO)

Total project cost: Pula 8,5 million.
Drilling contractor: TGB Drilling Company, Botswana.
The completion of the final report was much delayed.

Conclusions: The investigated area covers 3 300km². The main groundwater occurrence is in the Ntane Sandstone formation. Faults and dolerite dykes impose significant control on groundwater flow. The target yield of 35,000m³ per day, to be pumped over 25 years into the planned water axis, has been identified. Wellfield areas have been delineated for future resource development. In fact resources would allow a much larger exploitation of 160,000m³ per day for 25 years. That however would require very extensive wellfield installations. Water quality is good for the planned wellfield areas.

5.2.1.2 Lephephe-Mmamabula-Limpopo Groundwater Investigation Project (GSIO)

Total project cost: Pula 239,000
The final report was submitted in June 1988.

Conclusions: The major Karoo Supergroup aquifers are the Ntane Sandstone and the Mmamabula Sandstone. Recharge occurs in certain areas. The water within the Ntane Sandstone is generally of potable quality. The same is observed in the Mmamabula Sandstone, however very poor quality water is found in this formation south of Mmamabula, north west of Dinokwe and north of Mapashalala. Two areas have been recommended for future exploration, the Zoetfontein area and the Khurutshe area. They...
have been selected because they contain all the main aquifers, are intensely faulted and are down gradient from recharge areas. Government has decided to start with the exploration of the Khurutshe area.

5.2.1.3 Lethakeng-Botlapatlou Groundwater Investigation Project (GS10)

After approval of the project memorandum by the Ministry of Mineral Resources and Water Affairs, the tender document was prepared and fifteen companies were invited to tender. In December, five international consulting companies submitted technical and financial proposals together with proposals for project funding. Contract award will probably be in March 1989.

5.2.1.4 TGLP Groundwater Potential Survey (GS03)

In August, the Ministry of Agriculture submitted maps showing grazing areas for which groundwater potential surveys are to be carried out. A pre-assessment was carried out with the result that four areas were excluded from further investigation because of high groundwater salinity. Four areas were listed for detailed exploration. Work on the tender document commenced, but had to be discontinued in December, when a senior staff member left the department.

5.2.1.5 Matsheng Area Groundwater Investigation (GS10)

The project memorandum was prepared and submitted to the Ministry of Mineral Resources and Water Affairs in October. It was returned by the Ministry with the request for certain modifications regarding the work to be carried out under the project. Submission of the revised document is planned for March 1989.

5.2.2 Groundwater Resources Monitoring and Recharge Studies (GS04)

5.2.2.1 Groundwater Recharge Evaluation Study

Project duration: July 1987 to June 1980
Total project costs: Pula 680 000

The project is carried out in a joint venture with the University of Botswana and the Free University of Amsterdam. Funding is from the Government of the Netherlands to the larger part and from DDF.

Work carried out: Two more study areas were added, the Nnywane area north of Lobatse and the Molepolole wellfield area. Detailed geological and geomorphological mapping was done, soil profiles sampled, holes augered for neutron probe profiling and surface as well as groundwater was monitored. Soil moisture extraction continued throughout the year and samples were analysed for chloride, tritium, deuterium and O18. All incoming data and results were fed into a project data base.

5.2.2.2 Groundwater Resources Monitoring

Project duration: August 1987 to March 1991
Total project costs: Pula 566 000

Four additional groundwater monitoring networks were developed, two in Waterberg aquifers near Molepolole and Mochudi, two in crystalline basement aquifers near Mochudi and Gabane. Twelve water level recorders and four automatic rain gauges were installed complete with shelters and security fencing.

Manual water level dipping was carried out monthly.
5.3 Departmental groundwater exploration projects

5.3.1 Groundwater potential assessment in the Waterberg north of Molepolole

Having completed the investigations into the occurrence of Transvaal dolomite beneath Waterberg formation east of Molepolole, exploration commenced on the northern limb of the Waterberg syncline. After some geophysical ground surveying, drilling started in October. A depth of 184m had been reached by the end of December.

5.3.2 Groundwater Potential Assessment for the Waterberg Formation East of Mochudi

Archived and field gathered data have been evaluated. Regional groundwater flow directions have been determined and groundwater quality provinces delineated. An evaluation of drilling results has shown that in order to fully develop the Waterberg aquifers boreholes should penetrate to 300 metres depth. Applying scientific siting techniques yields occur, but the probability to drill higher yielding boreholes is small, even with more and then costly siting.

5.4 Hydrogeological Mapping Programme

During the year the mapping programme, which started in 1978, was completed. The final three sheets of the Hydrogeological Reconnaissance Map series, number 7, 9 and 10 were published. Also the Groundwater Resources Map of Botswana in scale 1:1 000 000 was printed.

5.5 Groundwater Basin Monitoring

Observations on water level fluctuations, rainfall, water abstraction, and water quality changes continued in the following basins: Maun Shashe Wellfield, Diphuduhudu Wellfield near Mochudi, Ramotswa Wellfield, Metsemothaba valley, Lobatse Wellfield, Kanye Wellfield. Monitoring in connection with pollution prevention was done in the Lobatse sewerage treatment area.

5.6 Borehole Records Archive and Data Base, Drill Sample Store

This department and the Department of Water Affairs designed the structure for a new computerised borehole data base to be shared between both departments. The development of the new data base was contracted out. Installation on the department's IBM computer was finalised in November.

In preparation for the new extended data base, new Borehole Completion Record and Pumping Test Record forms were designed and printed. Borehole data were encoded for the Tsau, Toteng, Tuli and Francistown sheet. Borehole location maps were prepared for the Tsau and Toteng sheets.

The existing data base comprising 5 000 boreholes was transferred from the Hewlett Packard to the new data base.

During 1988, 679 government and 105 private boreholes were registered. This reflects the large investment by Government in water development. The end of the drought has brought a sharp drop in drilling activities for the private sector.

The transfer of drill samples to the core shed continued and by the end of the year samples from 3227 private and 2934 government boreholes were catalogued and stored.
GEOLOGICAL SURVEY DEPARTMENT
PROGRESS IN COMPUTERISATION OF HYDROGEOLOGY WELL RECORDS AS AT 1.1.1989

Updated maps
Updated maps, partially computerised
Updated maps, computerised
Partially computerised

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5.7 Consulting Services for Government and the Public, 
Membership on Committees and Boards

Professional advice to the public and the dissemination of borehole and hydrogeological data has again been an all year round task.

Government bodies to which consulting services were provided are as follows:

- Department of Water Affairs: Input with the preparation of terms of reference for the planned National Water Master Plan consultancy.

- Water Apportionment Board: Geological Survey is a board member. Technical advice was provided in particular to the control of wellfield monitoring for Jwaneng, Orapa, Paje and Seleka farm.

- Water Utilities Corporation: Technical advice was given in connection with the consultancy "Ramotswa wellfield operational procedure and monitoring". Geological Survey provides a major input with the continued monitoring of the wellfield.

Geological Survey is a member on the following steering groups: "Okavango Integrated Water Resources Development Study", " Consolidated Water Supply Emergency Project". The Geological Survey has chaired the "Working Group for the Control of Water Borehole Drilling".

5.8 Hydrogeological Research Programmes

5.8.1 Cooperation with National and International Institutions

Cooperation with the University of Botswana and the Free University of Amsterdam continued under the Groundwater Recharge Evaluation Study (refer 5.2.2.1).

The Federal Institute for Geosciences and Natural Resources B.G.R. in Hannover completed the project concerned with the development of methods for the siting of high yielding boreholes in fracture aquifers of the crystalline basement in Eastern Botswana.

Conclusions: The interpretation of topographical and geological maps together with satellite images show sets of shear, faults and fracture zones related to the tectonic history of the region. It has not been possible to clearly discern young or recently reactivated structures, which control groundwater flow. Adding a detailed interpretation of the fluvial pattern has led to the detection of recent crustal movement. But this is "visible" at a few localities only and a consistent regional pattern is not apparent.

Field investigations in combination with the above findings led to the identification of target areas for borehole siting near four villages, Malete, Seleka, Lerala, Maabolwe, Mathathane.

5.8.2 Departmental Research Programmes

P. Phofuetsile presented his MSc-thesis entitled "Hydro-chemistry of the groundwater in the Kalahari, southwestern Botswana". The study comprises the area south of the 24°S and west of 24°E underlain by Pre-Cambrian arenaceous and dolomitic rocks, predominantly arenaceous and clayey Karoo sediments and Kalahari Beds.

Conclusions: The regional groundwater flow follows two directions, southwest and northwest. Dissolved solids increase in the direction of flow. Four water types are recognised: Ca++Mg++Na+HCO3-, Na+-HCO3-CI+SO4--, Na+-Cl+-SO4-- and Na+-Cl+-SO4-. The dominant type is Na+Cl+SO4-- occurring over wide areas. The first two fresh water types characterise recharge areas, like the Molopo Farms and outcrop areas of Precambrian and Karoo rocks. There is little lithological control. Residual connate sea water or solute derived from sea water is responsible for high salinities. C14 ages range from present to 25 000 years.
G. Gabaake completed a hydrogeological survey of Western Ngamiland. The interpretation of the data will be the contents of his MSc-thesis.

5.9 Staff and Staff Training

5.9.1 Staff Assignment and Staff Movements

Dr. M. von Hoyer, seconded from BGR, continued as head of the Division. Dr. S. Keller, also seconded from BGR, held the post of the Senior Hydrogeologist until December, when his secondment ended. The plan to localise this post with Mr. C. Marobela failed when Mr. Marobela resigned from Government Service at the end of the year. Mr. P. Phofuetsile returned from overseas studies in November, having obtained a MSc-degree in hydrogeology from the University of London. Mr. G. Gabaake left for England in September, to study hydrogeology at the same university. The three year ODA-sponsored contract of Miss R. Hargreaves ended in November. She signed on for another 2½ year contract, again under ODA funding. Mr. H. Timje's three year SIDA sponsored contract ended in October. He renewed his contract again for three years. SIDA will provide the topping-up.

Mr. T. Kgole returned from studies in Canada in June with a diploma in Geotechn. Engineering. Mr. A. Mogotsi, who also studied in Canada had failed his second semester. CIDA, providing the scholarship, in agreement with the department gave him another chance and he started again with his studies in September.

The technician trainees J. Setlhomo and N. Ramotsoko obtained a first class pass in their final exams and entered into the post of Technical Assistant. Another trainee, Mr. L. Kgosiemang, resigned from training in June.

Mr. F. Mokobela was recruited in replacement in September.

Mr. B. Mohamadi, an industrial class employee who has been in charge of the Drill Sample Store for many years, passed a professional experience and capability test. He was promoted to Technical Assistant post.

Mr. P. Kekopakgomo, Senior Administration Assistant in the Drill Sample Store and Data Archive, was dismissed in July on the grounds of his mental instability combined with alcoholism.

The staff situation of the Hydrogeology Division has been as follows at the end of 1988:

<table>
<thead>
<tr>
<th>Principal Hydrogeologist</th>
<th>Dr. M. von Hoyer (BGR seconded)</th>
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<tbody>
<tr>
<td>Senior Hydrogeologist</td>
<td>Dr. S. Keller (BGR seconded)</td>
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<tr>
<td>Senior Hydrogeologist</td>
<td>Mr. E. Selaolo (shadow post)</td>
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<tr>
<td>Hydrogeologist</td>
<td>Mr. C. Marobela</td>
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<tr>
<td>Hydrogeologist</td>
<td>Mr. P. Phofuetsile</td>
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<tr>
<td>Hydrogeologist</td>
<td>Mr. H. Timje (SIDA)</td>
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<tr>
<td>Hydrogeologist</td>
<td>Miss R. Hargreaves (ODA)</td>
</tr>
<tr>
<td>Assistant Hydrogeologist</td>
<td>Mr. G. Gabaake (in England for studies)</td>
</tr>
<tr>
<td>Technical Officer</td>
<td>Mr. T. Kgole</td>
</tr>
<tr>
<td>Senior Technical Assistant</td>
<td>Mr. J. Keakile</td>
</tr>
<tr>
<td>Senior Technical Assistant</td>
<td>Mr. K. Leetile</td>
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<tr>
<td>Senior Technical Assistant</td>
<td>Mr. T. Ntesang</td>
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<tr>
<td>Technical Assistant</td>
<td>Mr. J. Phiri</td>
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<tr>
<td>Technical Assistant</td>
<td>Mr. A. Mogotsi (in Canada for studies)</td>
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<tr>
<td>Technical Assistant</td>
<td>Mr. N. Ramotsoko</td>
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<tr>
<td>Technical Assistant</td>
<td>Mr. J. Sethomo</td>
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<tr>
<td>Technical Assistant</td>
<td>Mr. B. Mohamadi</td>
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<tr>
<td>Senior Admin. Assistant</td>
<td>Post vacant</td>
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</tbody>
</table>
5.9.2 Staff Training

Mr. Selaolo was further introduced to the work responsibilities of the Principal Hydrogeologist. Mr. Marobela familiarised himself with the responsibilities of the Senior Hydrogeologist, under the guidance of Dr. Keller. The in-house training of Mr. Gabaake continued with a study of the hydrogeology in Western Ngamiland.

After Mr. Kgole’s return from studies, he was introduced to the work in the Archive and Data Base by Miss Hargreaves. It is planned to hand over to him the control of the Archive, Data Base and Drill Sample Store after one year in-house training.

The training of more staff for the technical cadre continued and Mr. Ramotsoko and Mr. Setlhomo completed their training. Mr. Mogotsi continued his academic training in geotechnical engineering.

A course "Basics of the geology and hydrogeology of Botswana" was given by Mr. Marobela at the Department of Water Affairs, between March 7th to 25th. It was attended by 3 trainees from the Geological Survey and 15 trainees from the Department of Water Affairs.
8.4.1.3 Consultants reports received during the year included the following:

**Anglo American Corporation**

De Beers Mining Company (Pty) Ltd Jwaneng Mine.


**Botswana Development Corporation Ltd.**

Annual report on the Seleka farm groundwater use for 1987. GC41/1/1.

**Bureau de Recherches Geologiques et Minieres**

Kanye dolomite groundwater basin hydrogeological investigation resources assessment and development project phase II TB/10/1/4/85-86 - Structural geology of the Kanye dolomite. GC23/3/4.


Kanye dolomite groundwater basin hydrogeological investigation, resources assessment and development project phase II- Drilling and long-term pumping tests document No. 2 29th September 1986 TB 10/2/6/86-87. GC23/3/5.

Hydrogeological survey of Transvaal Supergroup dolomite in the Kanye area final report vol. 1. GC23/4/1.

Hydrogeological survey of Transvaal Supergroup dolomite in the Kanye area final report appendices. GC23/4/2.

Hydrogeological survey of Transvaal supergroup between Molepolole and Mochudi vol. 1 final report. GC23/4/3.

Review of BRGM hydrogeological survey of the Transvaal Supergroup dolomite in the Kanye Basin Botswana (Jan 1986). GC23/5/1/ (see also GC10/11/1).

Siting boreholes from Ramotswa Well field extension (Re; TB10/3/22/84-85) final report borehole location and hydrogeological investigation GC23/5/1a.

Kanye dolomite groundwater basin hydrogeological investigation resources assessment and development project phase II TB 10/1/85-86 main report vol. 1. GC23/5/2.

Kanye dolomite groundwater basin, hydrogeological investigation resources assessment and development project phase II TB 10.1/85-86. Appendix 2 geophysical report GC23/5/2b.

Kanye dolomite groundwater basin hydrogeological
Canadian International Development Agency CIDA

Kanye dolomite groundwater basin, hydrogeological investigation resources assessment and development project phase II TB 10/1/85-86 appendix 5 borehole logging technical and interpretation report. GC23/5/2e.

Kanye dolomite groundwater basin hydrogeological investigation, resources assessment and development project phase II TB 10/1/85-86 appendix 6 data book. GC23/5/2f.

Technical co-operation volume project drilling programme 20th November 1986. GC23/6/1.

Evaluation of private well drilling capabilities Botswana. GC42/1/1.

Final Assessment of wellfield 2 and 3 GC19/1/3.

Department of Water Affairs Ramotswa wellfield Groundwater contamination study, Technical proposals submitted GC19/2/1.

Hydrogeological investigations at Seleka II, Tuli Block: Development Phase Report Disk 17/MSc. GC19/3/1.

Technical data report for the monitoring Report No. 1 Orapa Wellfields. GC18/2/2.

Technical report No. 6 for period March to August 1986 for Orapa Wellfields report OGD/002/87 February 1987 GC18/2/3a.

Monitoring report No. 7 for period September 1986 to February 1987 for the Orapa Wellfields report No. OGD/003/87/April 1987 GC18/2/3b.

Technical data monitoring report No. 7 for period September 1986 to February 1987 for Orapa Wellfield report No. OGD/004/87/April 1987 GC18/2/3c.

Northern Wellfield groundwater monitoring report 15 July to December 1987 15.1 executive summary. GC18/2/3e.


Northern Wellfield groundwater monitoring report No. 10 January - June 1985. GC18/3/1a


Northern Wellfield groundwater monitoring report 13.2 data compilation. GC18/3/1c.

Northern Wellfield groundwater report 142 Data Compilation. GC18/3/1e.

Water right for Orapa Mine De Beers Mining Co. GC18/4/1.

Water right for Orapa Mine. GC18/4/11.

Report on activities and works carried out for flow improvements from the Okavango delta July 1983. GC18/5/1.

Geophysical borehole logging Techniques used in the Kanye II Dolomite groundwater project September 1987. GC39/1/1.

Phala estate Gaborone, Botswana Sewage treatment and reclamation plant. GC40/1/1.

Report on visit to Botswana March 1980. GC45/1/1.

A national plan for rural water supply and sanitation the Zimbabwe experience. GC38/1/1.

Concrete products description and prices. GC43/1/1.

Mmamabula groundwater resources investigations phase I contract No. 10/2/14/86–87 vol. 1 final report June 1988 GC11/1.

Test pumping evaluation of borehole along the Mahalapye Serule road Mahalapye to Palapye section. GC11/2/4.

Botswana Exploration land allocation study by N.W. Miller & Associates Ltd Calgary. Alberta GC46/1/1.

South East Botswana water development study. GC37/1/1.

South East Botswana water development study final report. GC37/1/1a.

Metsemotlhaba transfer scheme feasibility preliminary design study draft final report appendices November 1987. GC37/1/2.

Metsemotlhaba transfer scheme feasibility preliminary design study draft final report November 1987. GC37/1/2a.

Metsemotlhaba transfer scheme feasibility preliminary design study draft final report maps and drawings November 1987. GC37/1/2b.

Metsemotlhaba transfer scheme feasibility preliminary design study interim report September 1987. GC37/1/2c.

Metsemotlhaba transfer scheme feasibility preliminary design study progress report No. 3. GC37/1/3.
Metsomothehaha transfer scheme feasibility preliminary design study progress report No. 4, GC37/1/3a.

Metsomothehaha transfer scheme feasibility preliminary design study: Interim report appendices September 1987, GC37/1/3b.


Metsomothehaha transfer scheme feasibility/preliminary design study final report appendices February 1988, GC37/1/4a.

Metsomothehaha transfer scheme feasibility/preliminary design study final report maps and drawings February 1988 GC37/1/4b.

Molotloue Dam Feasibility preliminary design study. Scheme Interim report October 1988. GC37/2/1a.

Molotloue Dam Feasibility Design Study. Scheme Identification report Album of Drawings October 1988, GC37/2/1b.


Southern Okavango integrated water development phase I eastern fringe Okavango Delta Final report November 1987, GC35/1/3.


Southern Okavango integrated water development phase I. Final report vol. II Irrigated agricultural development potential June 1987, GC35/2/5b.

Southern Okavango integrated water development phase I. Draft Final report environmental impact study vol. II Annexes C.F. GC35/2/5c.

Southern Okavango integrated water development phase I. Final report technical study Vol IV. Geomechanics and hydrogeology June 1987, GC35/2/5d.

Southern Okavango integrated water development phase I. Final report vol. III water resource and development GC35/2/5e.
Study of open water evaporation in Botswana Final report March 1987. GC35/3/1g.


Serowe groundwater evaluation project 17th progress report 15th March–12th April 1987. GC30/2/1f.

Technical report No. 1 Mahatane BH 5301 GC30/3/1a.

Serowe groundwater project Technical report No. 3 1c altitude Aerogeophysical interpretation final report December 1986. GC30/3/1c.

Technical report No. 6 Geophysical borehole logging techniques used in the Serowe project. GC30/4/1a.

Serowe groundwater resources evaluation project technical evaluation project Technical report No. 2 Remote sensing activities. GC30/5/1a.

Technical report No. 4 Tshoswane BHS 5302 and 5303. GC30/5/16.

Technical report No. 20 Serowe groundwater evaluation project Technical report concerning the Airborne Geophysical survey. GC30/5/1c.

Serowe groundwater resources evaluation project Technical report No. 7 borehole 5305. GC30/5/1g.

Serowe groundwater resources evaluation Technical report No. 8 boreholes 5307 & 5308. GC30/5/1h.

Serowe groundwater resources evaluation project Technical report No. 9 boreholes 5306, 5309 and 5310. GC30/5/1i.

Serowe groundwater resources evaluation project Technical report No. 10 boreholes 5311 and 5312. GC30/5/1j.
Serowe groundwater resources evaluation project technical report No. 11 boreholes 5313, 5314, 5315 and 5320. GC30/5/1k.

Serowe groundwater resources evaluation project technical report No. 12 boreholes 5310 and 5317. GC30/5/1l.

Serowe groundwater resources evaluation project technical report No. 13 boreholes 5318, 5319 and 5325. GC30/5/1m.

Serowe groundwater resources evaluation project technical report No. 14 boreholes 5321 and 5322. GC30/5/1n.

Serowe groundwater resources evaluation project technical report No. 15 boreholes 5323, 5324 and 5326. GC30/5/1o.

Serowe groundwater resources evaluation project technical report No. 16 boreholes 5327, 5328 and 5329. GC30/5/1p.

Serowe groundwater resources evaluation project technical report No. 17 boreholes 5330, 5331, 5332, 5333 and 5334. GC30/5/1q.

Serowe groundwater resources evaluation project technical report No. 18 boreholes 5335, 5336, 5337 and 5338. GC30/5/1r.

Serowe groundwater resources evaluation project technical report No. 19 boreholes 5339, 5340 and 5341. GC30/5/1s.

Serowe groundwater resources evaluation project report No. 22 siting techniques used in the Serowe project. GC30/5/1t.

Serowe groundwater resources evaluation project technical report No. 21 hydrochemical investigation. GC30/5/1u.

Maun village development plan report of survey first draft November 1987. GC44/1/1.


Water Administration study revisions to draft final report. GC27/3/1b.


Appendices to note on the discharges of excess water from the ash disposal operations. GC27/5/1.

Control of effluent from the Morupule power station. GC27/6/1.
8.4.2 Reports and Publications

8.4.2.1 The following Departmental reports and maps were published during the year.

Reports:

- Annual Report 1986
- Bulletin 34.
- The Geology of the Okwa Valley by D.T. Aldiss

Maps:

- Semolale sheets 2128D and 2129C.
- Phitshane Sheet 2525C and 2525D: 1:125 000.
- Hydrological Reconnaissance Sheet 7: 1:500 000.

8.4.2.2 850 Publications were sold in 1987 for which a revenue of P4 198.27 was received. 1000 publications were distributed free or on exchange.

8.4.2.3 The following internal reports were filed.

- A comprehensive report on the Halfway Kop kyanite deposit. RK14/88.

Supplementary report on the Foley mudstone deposit. RK16/88.

A report on industrial mineral occurrences in the Moijabana - Kutswe - Mokgware area QDS 2226C2, 2226D1, and 2226D2, RK17/88.

An estimation of transportation needs for various locations of mini cement plants in Botswana. RK18/88.

MAROBELA, C.

Groundwater recharge studies using tritium and C^{14}. CM1/86.

Occurrence and movement of groundwater carbonate aquifers. CM2/87.


8.4.3 Records and Information

8.4.3.1 The computer database of the prospecting reports which has been established since 1986 to record companies, licence numbers and areas, minerals and financial aspects, is still temporarily not used because the Hewlett Packard computer used for it has broken down. The data-base will be transferred to the IBM computer.

8.4.3.2 The prospecting records were frequently studied by prospecting and mining companies and groundwater consultants, including Ampal, De Beers, Gold Fields, Aqua Tech, British Geological Survey, Cominco and Phelps Dodge Botswana etc.

8.4.3.3 Information and assistance were given to among others representatives from DTRP on soil map by Van Straten. Molopo Botswana PL 22/77 Molopo farms G.S. Ghanzi Chobe fold belt etc

8.5 Drilling Section

In May 1988, Two officers, M. Ntloedibe and M.L. Raditladi returned from the Haileybury School of mines in Canada, having successfully completed a 9 month course and obtaining Diplomas in Mechanical Engineering, Diamond Drilling Option.

With the success of these two officers the Drilling Division now has five qualified local Personnel and one expatriate.

In June 1988 a programme was implemented to select the most suitable officers to fill the two senior posts in the Drilling Division. This programme will be completed mid 1990, resulting in localisation of the Drilling Section.

Drilling was severely hampered by the condition of the Departmental Drilling rigs which are now old and constantly under repair. Negotiations for one new rig were finalised in September 1988. This new rig is being funded by A.I.D.A.B. (Australian Aid) and delivery is expected in mid 1989.
8.5.1 Drill Production

8.5.1.1 Hydreq Gryphon Drilling Rig

The Hydreq Gryphon was employed by the Hydrogeology Division for flushing out existing boreholes. Ten holes were completed. Unfortunately work was discontinued in September when the towing unit for this rig suffered a serious breakdown.

In mid 1988, between the flushing project, the Gryphon Rig also augered 5 holes to an average depth of 3.3m and one hole was hammer drilled to 80m.

8.5.1.2 Pro-line Auger Rig

The pro-line rig was also employed by the Hydrogeology Division in the Pitsanyane area where 9 holes were auger drilled to an average depth of 7 metres.

8.5.1.3 Hand Auger Drilling

The Drilling Division was also involved in the drilling of shallow holes again for the Hydrogeology Division.

9 holes were drilled using hand augers to an average depth of 4.1m. These holes were then installed with aluminium tubes to allow for humidity tests with neutron sondes.

8.5.1.4 Tone Rig I and Tone Rig II

Two tone rigs were employed for field mapping purposes to complete a project started in 1987 in the Mmamabula area. 8 holes were core drilled to an average depth of 31m.

Tone rig I

After Mmamabula Tone Rig I was employed by the Economic Geology Division, it moved to Tonota where 2 holes were cored, totalling 80 metres. These holes were to ascertain the quantity of sillimanite deposits.

Tone Rig II

Tone rig II continued to be used for field mapping for the remainder of 1988.

From Mmamabula this rig proceeded to Topisi where 7 holes were cored totalling 224m. This rig was at Olifant’s Drift at the year end. 2 holes were completed on this project in 1988 totalling 76m.

8.5.1.5 Longyear Rig

The Longyear Rig completed a coring hole at Gweta to a depth of 365m. This hole was cored for the Geophysics Division to ascertain the cause of a magnetic anomaly.

This rig then moved to Medie near Lentsweletau to core drill a hole for the Hydrogeology Section. Drilling reached 204 metres by the end of 1988.