SWAZILAND

MINISTRY OF COMMERCE INDUSTRY
AND MINES

ANNUAL REPORT
of the
GEOLOGICAL SURVEY AND MINES DEPARTMENT

FOR THE YEAR ENDING
31ST DECEMBER 1970

PRICE — 50c (S.A.)

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CONTENTS

I. GENERAL

(a) SUMMARY OF THE YEAR'S WORK

Retirements and resignations of senior staff and delays in recruitment of replacements had the effect of severely curtailing the Department's activities. At the end of the year three of the eight professional posts and one of the two senior technical posts were vacant.

2. Detailed geological mapping revision for the new series of maps on a scale of 1:25,00 continued in the north-west part of the country. This work involved an area of 62 square kilometres in the Motjane and Usushwana valleys, covering the southern extremity of the Swaziland System outcrops.

3. The strip of rocks of this System, lying along the north-western border, was the principal objective of the United Nations Development Programme project "Mineral Survey, Swaziland" which ended in March after four years of operation. Project funds remain available however for upgrading tests on low-grade iron ores. Samples for this purpose were obtained by drilling from two localities, Nottingham Peak and Iron Hill, in the Project area.

4. Assessment of the coalfield in the eastern part of the country, as part of a bilateral aid feasibility study for possible thermal power generation, continued by means of mapping, supported by geophysical surveys, and drilling. An area of 140 square kilometres was mapped on a scale of 1:10,000, aided by about 50 line-kilometres of magnetometer surveying to locate doleritic intrusions. Eighteen holes were drilled to intersect coal horizons in the Upper Ecca beds which are situated about 300 metres above the coal horizon (of the Middle Ecca Series) presently being exploited in the Mpaka Colliery.

5. An atomic absorption spectrophotometer was installed in the Department laboratory in March. This unit will greatly facilitate the geochemical surveys to be undertaken when the staffing position improves. Only 5706 analyses were made on soil and stream sediments during the year. Problems of technique and instrument sensitivity in the early part of the year and the departure of the geochemical analyst at the end of his contract in May account for the low through-put of samples.

6. In the drawing office 104 plans were drawn and 3,354 prints produced. Scribing and colour separations for Sheet 3 of the 1:25,000 geological map series were completed in preparation for printing of the map in early 1971. Work on the base maps for Sheet 4 of the same series was commenced.

7. The Works Machinery Regulations were promulgated by Legal Notice No. 29 of 1970. The regulations apply to all premises, other than mines, where industrial machinery, boilers and pressure vessels are used.

(b) STAFF

8. The year was marked by further resignations and retirements of staff which, following those of the previous year, placed the Department in a critical position. Staff shortages severely curtailed the Department's activities and placed a heavy burden on the few remaining senior officers.

9. The vacant post of Inspector of Mines was filled but resignations created vacancies for a Geologist, the Geochemical Analyst and the Drilling Superintendent. The Director (Dr. D. R. Hunter) was absent on leave including leave pending retirement for a total of about six months. During this time the Senior Geologist acted in his stead and himself gave notice of retirement late in the year.

10. Recruitment of professional and technical staff through both United Nations and bilateral (United Kingdom) technical aid channels promised some alleviation of the position early in 1971.

(c) TRAINING.

11. Mr. R. Maphalala, who was awarded a Fellowship under the provisions of the United Nations Development Programme Project, is attending a course for geological technicians at Cambrian College, Sault Ste Marie, Canada. Mr. Maphalala successfully completed his first year and an extension for a further year was granted. He is expected to complete the course by mid 1971 and will assume duty as geochemical analyst in the Department on his return to Swaziland.

(d) VISITORS

12. In addition to regular visits from staff members of the various mining companies operating or holding mining rights in Swaziland, numerous visits were received from representatives and senior staff of other mining and industrial companies interested in mining development in Swaziland.

(e) EXTERNAL TECHNICAL AID

13. The United Nations Development Programme Project "Mineral Survey, Swaziland" was completed early in the year and the Project Manager, Mr. A. Hatton, having compiled the report on both the geochemical and geophysical surveys, left Swaziland on the 26th of March.

14. A Techtron AA4 atomic absorption spectrophotometer purchased by the Project during the previous year arrived during March and was installed in the laboratory.

15. As an extension of the Mineral Survey Project the United Nations Development Programme provided finance for laboratory-scale beneficiation tests on low-grade iron ore samples from four deposits in Swaziland. Borehole core samples from three of the deposits were despatched to the investigating laboratory during the course of the year. A serious breakdown of one of the drilling rigs and severely

broken ground greatly hampered drilling operations at the fourth deposit and a core sample sufficiently large to be both representative of the deposit and to allow tests to be conducted had still not been obtained by the end of the year.

16. At the completion of the Mineral Survey Project valuable geophysical and laboratory equipment and chemical reagents were handed over to the Department.

17. Dr. J. V. Hepworth of the Institute of Geological Sciences, London, arrived in the country in mid-April. The purpose of his visit was to establish ground controls preparatory to photogeological study and interpretation. A three months period was spent in Swaziland during which time a wide-ranging reconnaissance was carried out across the north-central, central and southwestern portions of the country. The photogeological interpretation based on this field work, the processing of structural data and a study of the relationship to aeromagnetic and gravity data is to be undertaken by Dr. Hepworth and reported upon in due course.

18. Through the co-operation of the United States Charge d'Affaires in Mbabane a set of analytical standards was supplied by the Analytical Laboratories of the Geological Survey in Washington.

19. As described under "Economic Geology", British technical aid continued to finance a feasibility study of the coal resources in relation to the possibility of using them to generate electrical power.

II. GEOLOGICAL SURVEY

(a) REGIONAL MAPPING

(i) *Sheets 2630 BD (10) 2631 AC (11) (Motjane Valley, Hhohho District).*

20. Mr. J. G. Urie mapped an area of 62 square kilometres using aerial photographs at a scale of 1:10,000 for plotting on to 1:25,000 base maps.

21. The mapping covered the southern terminus of Swaziland System rocks in Swaziland. Here metavolcanic and metasedimentary rocks of the Onverwacht Series occur in a strongly folded narrow syn-formal keel virtually encompassed by granite. Post-granite dykes and intrusions abound.

22. The Onverwacht Series comprises a layered sequence of metamorphosed ultramafites, metasedimentary and metavolcanic beds.

23. The ultramafites are now represented by serpentinites, antigorite-tremolite-chlorite schists, talc-chlorite and talc-carbonate schists and rarely by almost monomineralic chlorite schists. Interlayered horizons of sedimentary and predominantly basaltic volcanic rocks are represented by quartzites, some chert, highly siliceous hornblendic and diopsidic horizons, siliceous gneisses, hornblende-actinolite schists and subordinate hornblende gneisses.

24. The intrusive granite, classified as Ag3, is typically a grey, medium-grained, homogeneous biotite granite. Marginal foliation is evident in places and quite commonly the granite is finer-grained and gneissose near its contacts. Marginal foliation was presumably acquired during emplacement. The gneissosity, however, is a feature which appears to have been inherited from siliceous members of the lower Onverwacht which the granite swamped and evidently feldspathized to some degree.

25. Post-granite intrusives include innumerable diabase and dolerite dykes and bodies of gabbro and hybrid granodiorite regarded as belonging to the Usushwana Complex.

26. Two prominent directions of folding are evident in the area, an early north-northeasterly direction and a later northwesterly direction. The later direction of folding is the more conspicuous of the two and a major and strongly compressed northwest-trending fold is one of the more prominent structural features of the area.

27. There is evidence of much strike or near-strike faulting and shearing all of which appears to pre-date the emplacement of the granite. Faults which post-date the granite occur in two sets, one in a northwesterly direction and the other in a north-northwesterly direction. These faults, which are near-vertical and normal, offset the granite and Onverwacht rocks in a series of stepped blocks and finally truncate the Onverwacht to the south of the Usushwana River.

(ii) *Sheets 2631 BB (8) (Mhlume) 2631 BD(14) (Siteki) 2631 DB(20) (Mtendekwa).*

28. Mr. McKeown mapped an area of 140 square kilometres at a scale of 1:10,000 on these three sheets.

29. The mapping was confined to the outcrop of the Ecca Series of the Karroo System. The continuation of the coal-bearing Upper Ecca succession was traced north and south of its proven positions near the Manzini-Siteki road as far as the Siteki-Sipofaneni road to the south and the White Mbuluzi River to the north.

30. The Upper Transition Beds (of the Middle Ecca Series), which consist of sa dstones and siltstones with smaller amounts of grey shale and limestone, were taken as the western limit of mapping.

31. The overlying Upper Ecca Series is formed mainly of black carbonaceous shale containing numerous, generally thin, coal seams. Beds of white feldspathic sandstone alternate with zones of shale, a maximum of four such sandstones having been recognized over the strike length mapped. Attenuation appears to take place either by faulting or facies change. Except where affected by faults or intrusions the dip of the strata is between 5° and 10° to the east.

32. Of the overlying Stormberg Series the Molteno Beds consist of about 50 metres thickness of massive coarse-grained quartz-rich sandstones. A distinct topographic step is sometimes formed at their surface crop and they also form prominent fault-bounded outliers. In the central area the prominent Molteno Beds features are capped by a layer of fine sand up to three metres thick. The variegated sandy shales of the overlying Red Beds were recognised only in the northern area where the Molteno Beds are less well developed.

33. The Cave Sandstone, which formed the eastern limit of mapping, has a distinctive lithology of pale green or buff-coloured fine-grained equigranular sandstone containing abundant nodules and stringers of calcite.

34. The simple eastward-dipping structure of the Ecca and Stormberg sediments is complicated by northerly (strike) faults and east-northeasterly faults. A well developed dolerite dyke swarm intrudes parallel to the strike of the enclosing sediments, and dolerite sills of up to 50 metres thickness occur in the Upper Ecca Series. Several boreholes have intersected dolerite/country rock contacts which appear to be diffuse and there is good evidence that some degree of assimilation of the host rock by the intrusion has taken place.

35. During the year a close correlation has been obtained between the results of magnetometer traverses and geological mapping in the positioning of dykes and sills.

(b) ECONOMIC GEOLOGY

(i) Departmental Activities

36. The Department's work in the field of economic geology was confined almost exclusively to an investigation of the coal zone of the Upper Ecca stage of the Karroo System and to the drilling of low grade iron ore occurring in the Pigg's Peak and Havelock areas.

Coal, Mtendekwa valley, Lubombo District.

37. Following the grant of funds by the British Government to finance a feasibility study into the economics of establishing a thermal power station in Swaziland, a programme designed to evaluate the coal reserves of the country was initiated in 1969. As part of this programme the Department undertook an investigation of the coal zone of the Upper Ecca stage on behalf of the Swazi Nation, the owners of the mineral rights.

38. The programme of investigation, prepared in conjunction with the consultants conducting the feasibility study, includes geological mapping, magnetometer surveys and a series of diamond drill holes. Initially the drilling programme was intended to provide wide coverage of the coal zone over a lengthy strike to enable rapid assessment to be made of the continuity of the coal seams. However, it was established at an early stage that the Upper Ecca Series is complexly faulted, that dolerite intrusions are common and that the coal shows broad variations of quality. The programme was thus altered to concentrate geological and drilling activities on the more promising central portion lying within ten kilometres north and south of the Manzini to Siteki road.

39. During the course of the year seventeen holes were drilled and the eighteenth was nearing completion at the year end. A total of 1,185 metres of drilling was completed.

40. Geological mapping of the Upper Ecca stage between the White Mbuluzi in the north and the Siteki to Sipofaneni road in the south was undertaken by Mr. McKeown. This mapping, carried out as part of the programme of evaluation, is reported on under the section on regional mapping.

41. A magnetometer survey, to ascertain the extent and abundance of dolerite intrusions in the area was completed by Mr. A. Vilakazi. A total of 50.49 kilometres of surveying was carried out along traverse lines spaced at 0.4 kilometre intervals in the central portion of the area and at 0.8 kilometre intervals towards the extremities of the area. Stations along the traverse lines were established 10 metres apart. A further magnetometer survey was undertaken by Mr. Vilakazi at the site of the proposed thermal power station and entailed 17.5 kilometres of traversing.

Low grade Iron Ore, Nottingham Peak and Iron Hill, Hhohho District.

42. As an extension of the Mineral Survey Project, funds were made available by the United Nations Development Programme to enable beneficiation tests to be carried out on drill core samples of low-grade iron ore from four deposits in Swaziland. Core samples from two of the deposits had been obtained during 1968 and 1969 and during the course of the year further holes were drilled at Nottingham Peak and Iron Hill.

43. At the Nottingham Peak deposit the hole which was started in 1969 with the objective of providing a representative core sample of the magnetite-bearing banded ironstones had not reached target ground at a depth of 161 metres. In view of the drilling difficulties encountered at this depth and the rising costs the hole

was stopped. A new site, 70 metres above and 140 metres west of the earlier site, was selected. The hole drilled here intersected magnetite-bearing ironstones between the depths of 31.7 metres and 125.9 metres before striking a diabase dyke. The core from this hole was sent to the investigating laboratory.

44. In April the rig was moved to Iron Hill, the fourth deposit from which a core sample is to be taken. Here the low-grade ore is a banded ironstone also but the magnetite content is lower than that at Nottingham Peak. Shortly after drilling had commenced on this deposit a serious mechanical breakdown of the rig occurred. Necessary spares were unobtainable and the drill did not operate from May to mid-August. Progress was further hampered by the unusually difficult drilling conditions. The broken banded ironstones which were intersected allowed only very short drill runs and core recovery was poor. By the year end the hole had reached a depth of 154 metres but a core sample of sufficient size to be both representative of the deposit and to meet the minimum weight requirement for beneficiation tests had not yet been obtained.

(ii) Private Sector

Asbestos, Hhohho District

45. In order to gain access to the lower levels of ore the main vertical shaft at Havelock Mine was deepened. At the year end the extended shaft had been equipped but not commissioned.

46. Lonrho Limited continued underground development and diamond drilling at their asbestos prospect near Bulembu. A new adit was commenced to provide access to the western portion of the fibre-bearing zone.

Coal, Lubombo District

47. At mid-year Swaziland Collieries Limited launched an extensive diamond drilling programme designed to evaluate the reserves of coal within the concession area held by them. This programme is in part intended to ascertain the tonnage of coal available for support of the proposed thermal power station.

Regional Prospecting

48. The right to collect soil and stream sediment samples over the whole of Swaziland, except those areas already the subject of mining and prospecting rights, was granted by His Majesty the King to the Anglo-American Corporation of South Africa Limited towards the end of 1969. The collection of samples which began in December 1969 was completed by mid-year, but no results had been notified to the Department by the end of the year.

(c) MISCELLANEOUS

Underground water supply, Lowveld area.

49. During 1969 several water boreholes were drilled in the Ehlane Game Reserve and reported upon in the Annual Report for that year. All the holes were

sited at or near the contacts of dolerite dykes intruding either Cave Sandstones or shale. Due to excessive weathering and high clay content along the dyke contacts the holes were all dry with exception of L 407 and L 408 which yielded 0.6m³/h and 0.9m³/h respectively.

50. During August of 1967 hole L 408 had been test-pumped for three periods of eight hours each with no noticeable lowering of the rest level. However, when in early 1970 a diesel pump was installed on the hole it was pumped virtually dry after only 48 hours. Hole L 407 had been used to supply water for drilling at site L 408 and had been pumped for a total of some 60 hours over a period of eight days. This hole was reopened in early 1970 but it was found that, despite it having been sealed, it had dried completely in the five months which had elapsed since the initial period of pumping.

51. The reasons for the drying of these holes are not obvious. The very low permeability of the Cave Sandstone and the cons quent very slow recharge of the previous contact zone provides an explanation in the case of L 408. Partial draining of a restricted reservoir by pumping and high evapotranspiration during the summer months possibly account for the drying of L 407.

52. The results at Ehlane Reserve demonstrate that the Cave and other massive sandstones and shales of the Karroo System in Swaziland are unlikely to provide adequate sources of groundwater. They also illustrate that more sophisticated tests will have to be conducted on holes drilled in the lowveld areas in the future.

Dwaleni Meteorite fall

53. At 10.30 hours South African time on the 12th October, 1970 a meteorite fall occurred in southwestern Swaziland near Nhlangano. Following a report received from the Police Mr. J. G. Urie visited the area.

54. Three meteorite fragments centering around 27° 12' S Lat and 31° 19' E Long were recovered. Observers report that loud explosions accompanied the disintegration of the meteor and the descent of the fragments was marked by a high-pitched whine. The recovered fragments which are of siderolite type are strongly magnetic, carry disseminated sulphide and have burnt crusts with characteristic indentation. Two of the fragments were found buried in moist soil at a depth of 18 centimetres and the third and smallest at a depth of 15 centimetres in moist pebbly soil.

55. The weight and dimensions of the three specimens are given below:—

	A	B	C
Long Axis	16.5 c.m.	10.0 cm.	7.5 cm.
Intermediate Axis	10.0 cm.	5.5 cm.	5.0 cm.
Short Axis	7.5 cm.	4.0 cm.	4.0 cm.
Weight	2.37 Kg	0.51 Kg	0.35 Kg

72. Production of pyrophyllite was less than half of that of the previous year. Sales of 254 tonnes were valued at R1,405.

73. Sales of quarry stone decreased by 7,562 cubic metres to 32,678 cubic metres valued at R102,266.

(c) INSPECTIONS

74. The following visits were made by the Inspector of Mines to mines and quarries as well as to explosive and anti-hail rocket magazines in his capacity as Inspector of Explosives.

Purpose of visit	*No. of visits*
Mines and Quarry inspection and inquiries	51
Explosive Magazine inspection	25
Anti-hail rocket magazine inspection	45

(d) LICENCES AND PERMITS

75. The following licences and permits were issued during the year.

Type of licence or permit	*No. issued*
To purchase explosives locally	79
To import explosives	11
Magazine licences	11
Blasting licences	43
Mineral Dealer's licences	17

(e) ACCIDENTS

76. Accidents reported in mines and quarries which cause an injured person to be absent from work for three or more days are reportable to the Inspector of Mines.

The following mining accidents were reported during the year:—

Fatal	*Non-fatal*	*Total*
Nil	90	90

Locations of the various injuries are classified as follows:—

Location of Injury	(*a*)	(*b*)	(*c*)
Arms, hands or fingers	4	—	29
Legs, feet or toes	2	—	25
Eyes	—	—	9
Body and head	—	—	21
Total	6	nil	84

In this table:-

(a) Indicates loss of member.
(b) Indicates loss of use of member.
(c) Indicates injury to member.

Classification by cause is as follows:—

Cause of accidents	*No. of accidents*
Fall of ground	12
Fall of material	17
Transport of material	28
Loading by hand	17
Explosives	—
Sundry	16
Total	90

77. The total time in shifts lost is given below with the 1969 figures for comparative purposes.

Total No. of Shifts lost		*Average shifts lost per accident*		*No. of accidents*	
1969	1970	1969	1970	1969	1970
1,953	1,356	18.42	15.06	106	90

78. There were no fatal accidents during the year and both the total number of accidents and the average number of shifts lost per accident were less than during the previous year. The accident rate is still disquietingly high however and the Inspectorate is pressing for more intensive safety campaigns and training measures.

(f) LABOUR

79. The mining labour statistics are given in Appendix IV. Earnings have increased by 6.6% over the year. Part of this increase however is attributed to high bonus rates paid by contractors during shaft sinking operations at Havelock Mine.

80. The average monthly earnings of all employees in the mining indu try rose from R71.2 in 1969 to R76.3 in 1970 while the mean number of employees for the year rose by 113 to 2,716.

IV. MACHINERY DEPARTMENT

(a) INSPECTION

81. There was no change in the number of mines which came under statutory inspection during the year.

82. The number of premises using plant and machinery in addition to registered passenger and goods elevators which came under statutory inspection was reduced from fifty-eight to fifty-three during the year.

83. The number of registered steam boilers increased to fifty-eight. Fifty-four of these were working and, apart from three exemptions, all received statutory examinations in addition to interim inspections and inspections after repairs. Numerous pressure vessels were similarly examined and inspected.

84. Approved Inspecting Authorities continued to operate satisfactorily on installed plant, imported machinery and materials, and repairs requiring certification at source.

85. Some of the larger concerns in the country are able to undertake their own repairs but apart from these few exceptions local engineering repair facilities for this class of work remain very limited in scope and function.

(b) LEGISLATION

86. The Mines and Quarries Machinery Regulations promulgated by Legal Notice No. 66 of 1969 continued in force.

87. The new Works Machinery Regulations were promulgated by Legal Notice No. 29 on the 5th June, 1970 and apply to all premises, other than mines, where industrial machinery, boilers and pressure vessels are used.

(c) ACCIDENTS

88. Accidents reported in connexion with machinery at mines (not mining) resulting in lost time of three days or more, are shown in the following table:—

No fatal accidents were reported.

Classification	*No.*	*Location of injury*	*No.*
Mechanical	4	Arms, hands and fingers	5
Electrical	1	Eyes	1
Sundry	4	Legs and feet,	1
		Head and body	2
Total	9		9

89. Accidents reported in connexion with machinery at works (industry) resulting in lost time of three days or more are shown in the following table:—

One fatal accident was reported, an electrocution caused by deficient insulation of a power line.

Classification	*No.*	*Location of injury*	*No.*
Mechanical	15	Arms, hands and fingers	17
Electrical	3	Eyes	6
Sundry	11	Legs and feet	2
		Head and body	4
Total	29		29

V. HEADQUARTERS

(a) DRAWING OFFICE

90. One hundred and four drawings were produced during the year. Thirty seven of these were plans to accompany the Gravity Survey Report.

91. Scribing and colour separations for sheet 3 of the 1:25,000 geological map series were completed in preparation for printing of the map in early 1971. Work on the base maps for sheet 4 of the same series was started.

92. The printing machine was fully employed during the year and 3,354 prints were produced.

93. The construction of additional shelves and the extension of the vertical map filing rack allowed re-organization of the map filing system.

(b) LABORATORY

94. The geochemical laboratory carried out 5706 analyses during the year. The analyses were made for the following elements:—

Antimony	225
Chromium	500
Cobalt	200
Copper	770
Lead	200
Nickel	3,811

95. An atomic absorption spectrophotometer was installed in the laboratory during March. This unit will allow rapid analyses of a wide range of elements and will greatly facilitate geochemical work. During the past year, however, relatively few samples were run for problems of technique and instrument sensitivity were experienced. Geochemical work virtually ceased when Mr. Sobey, the geochemical analyst, left the Department at the end of his contract in May.

(c) LIBRARY

96. The library has a comprehensive range of textbooks on geology, mining and mining machinery.

97. Publications and reprints are received on an exchange basis from Geological Survey and Mines Departments in Africa, Europe, Australia and the Americas.

98. The Department subscribes to some of the more important geological and mining journals and magazines published in Europe, Africa and North America.

(d) PUBLICATIONS

99. The following maps and reports were published during the year:—

(i) Annual Report of the Geological Survey & Mines Department for the year ending 31st December 1969.

(ii) Geological Map Sheet II, Pigg's Peak.

(iii) A paper by Dr. D. R. Hunter entitled "The Ancient Gneiss Complex in Swaziland" was published in the Transactions of the Geological Society of South Africa Vol. LXXIII.

J. G. URIE

Acting Director of Geological Survey and Commissioner of Mines.

APPENDIX II

MINERAL PRODUCTION FOR 1970

MINERALS	1969		1970		*Increase*		*Decrease*	
	Metric Tons	*R*	*Metric Tons*	*R*	*Metric Tons*	*R*	*Metric Tons*	*R*
Iron ore	2,302,098	12,797,394[1]	2,552,107	14,074,346	250,109	1,276,952		
Chrysotile Asbestos	39,079	6,267,233	33,057	5,309,290			6,022	957,943
Coal	104,232	281,904	122,946	383,330	18,714	101,426		
Quarry Stone	40,240[2]	121,066	32,678[2]	102,266			7,562	18,800
Kaolin	1,657	19,732	1,620	19,592			37	140
Barytes	571	7,858	338	7,525			233	333
Pyrophyllite	599	3,300	254	1,405			345	1,895
Totals		19,498,487		19,897,754		1,378,378		979,111

[1]Revised 1969 value received in 1970
[2]Cubic metres

APPENDIX I

STAFF LIST

Establishment	*Designation*	
1	Director of Geological Survey and Commissioner of Mines	Vacant
1	Senior Geologist	J. G. Urie, M.Sc., (acting Director)
3	Geologists	A. S. Dlamini, B.S., M. C. McKeown, B.Sc. Vacant.
1	Inspector of Mines	J. W. Williamson, A.C.S.M., M.I.M.M.
1	Inspector of Machinery	T. G. Blofeld, E.D., A.I.Mech.E., A.M.I.E.E.
1	Drilling Superintendent	Vacant
2	Drillers	J. Motha P. Gama
1	Senior Draughtsman	C. G. Matthews
1	Draughtsman/Geological Technician	A. M. Vilakazi
1	Draughtsman	S. Dry
1	Geochemical Analyst	Vacant
1	Senior Accounts Officer	H. M. Dlamini
1	Personal Secretary	Miss J. White
2	Typists	Mrs. A. Mkhonza Mrs. N. Dlamini
21	Technical Assistants	21
2	Drivers/Operators	2
3	Messengers	3

APPENDIX III

MINERAL EXPORTS, 1970

Mineral	*Country to which exported*	*Metric Tons*	*Value R*
Chrysotile Asbestos	Belgium	744	132,020
	Denmark	751	106,333
	France	453	80,500
	Italy	68	12,075
	India	89	17,079
	Ireland	490	76,620
	Republic of South Africa	7,717	1,071,939
	Uganda	453	72,500
	United Kingdom	22,057	3,691,290
	Yugoslavia	234	48,856
	United States of America (sample)		78
	Sub-total	33,057	5,309,290
Iron ore	Japan	2,552,107	14,074,346
Coal	Mocambique	41,397	82,726
	Kenya	33,677	127,629
	Republic of South Africa	202	606
Kaolin	Republic of South Africa	1,620	19,592
Barytes	Republic of South Africa	373	7,525
Pyrophyllite	Republic of South Africa	281	1,405
	Total		19,623,119

APPENDIX IV

LABOUR STATISTICS

Month	SKILLED					UNSKILLED						TOTALS		
	Below Surface	*On Surface*	*Total*	*Earnings*		*Below Surface*	*On Surface*	*Total*	*Earnings*		*Value of food*		*Total Labour*	*Total earnings and food*	
				R	*c*				*R*	*c*	*R*	*c*		*R*	*c*
January	32	235	267	87,079	38	806	1,499	2,305	93,142	91	15,954	97	2,572	196,177	6
February	33	243	278	86,179	02	806	1,544	2,250	91,252	60	16,505	45	2,528	193,937	07
March	34	232	266	87,514	28	861	1,553	2,414	95,639	39	17,406	00	2,680	200,559	67
April	43	239	282	91,887	86	856	1,539	2,395	93,504	01	15,426	20	2,677	200,818	07
May	32	229	261	84,859	67	800	1,528	2,328	90,986	86	15,992	20	2,589	191,838	73
June	63	217	280	104,978	40	1,107	1,558	2,665	100,022	02	18,253	80	2,945	223,254	22
July	31	221	252	87,300	12	817	1,535	2,352	88,161	20	15,920	30	2,604	191,381	62
August	64	228	292	103,873	29	1,165	1,560	2,725	101,905	70	20,833	50	3,017	226,612	46
September	46	229	375	99,271	43	1,032	1,528	2,561	97,255	40	17,456	65	2,835	214,183	38
October	48	229	277	99,050	30	1,015	1,513	2,528	102,893	34	17,823	00	2,805	219,766	64
November	46	229	275	98,409	16	927	1,536	2,463	104,344	38	16,636	00	2,738	219,335	54
December	32	231	263	92,792	41	861	1,574	2,435	98,204	87	16,935	00	2,696	207,932	28
TOTALS	504	2,764	3,364	1,123,195	32	11,053	18,467	29,421	1,157,312	68	205,143	07	32,686	2,485,796	94

APPENDIX V

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDED DECEMBER, 1970

B.H. No.	*Depth metres*	*Formation*	*Locality*	*Remarks*
358	15.2	Banded ironstone	Nottingham Peak	Iron ore sampling
360	87.2	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
361	139.3	Banded ironstone	Nottingham Peak	Iron ore sampling
362	89.9	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
363	75.6	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
364	97.2	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
365	154.2	Chert and ironstone	Iron Hill	Iron ore sampling (unfinished)
366	120.1	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
367	96.3	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
368	54.6	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
369	67.4	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
370	56.4	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
371	40.8	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
372	39.0	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
373	35.4	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
374	37.5	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
375	31.7	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
376	68.3	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
377	61.6	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
378	55.5	Sandstone, shale and dolerite	Mtendekwa	Coal exploration
379	70.7	Sandstone, shale and dolerite	Mtendekwa	Coal exploration (unfinished)
TOTAL	1,493.9			

APPENDIX VI

LIST OF REPORTS
by the Professional Staff

J.G.U.1/70	Recent Geological and Mining development in Swaziland.
J.G.U.2/70	Note on the Kaolin Deposits, Mahlangatsha Mountain, Swaziland.
J.G.U.3/70	Note on Coal and Iron Ore in Swaziland
J.G.U.4/70	Proposed dam sites. Confidential.
J.G.U.5/70	Note on the Dwaleni Meteorite, Swaziland.
J.G.U.6/70	Proposed dam site. Confidential.
J.G.U.7/70	Proposed dam site. Confidential.
D.R.H.1/70	Note on Mining in Swaziland 1969.
D.R.H.2/70	Ground Water, Swaziland.
D.R.H.3/70	Summary of Mineral Resources, Swaziland.
R.P.E.1/70	Preliminary report on the Ancient Gneiss Complex, Sheet 18.
M.McK.1/70	Preliminary report on Upper Coal Zone. Confidential.

APPENDIX VII

LIST OF DRAWINGS
prepared in 1970

No.	*Title*	*Scale*	*Authors*
846	Metric Conversion Table	—	C.G.M.
847	Field Sheets: C. Beggs.	—	C.J.B.
848	Swaziland Population Distribution Map	1:250,000	H.M.J.
849	Original drawings Sheet II Pigg's Peak	1:25,000	D.H.J.
850	Base Map of Swaziland	1:250,000	C.G.M.
851	Magnetic Profiles, Coal Zone Sheet I	—	A.M.V.
852	Magnetic Profiles, Coal Zone Sheet II	—	A.M.V.
853	Magnetic contour map. Mpaka, Sheet III	—	A.M.V.
854	Magnetic contour map. Mpaka, Sheet I	—	A.M.V.
855/58	Diagrams of Geochemistry utensils	—	M.B.D.
859	Flow chart of Laboratory Procedures	—	M.B.D.
860	Trench profiles from trench 73/1	—	R.P.E.
861	Metric grid for plotting S.S.S. Values	—	C.G.M.
862	Index map showing progress of 1:50,000 Geological sheets	—	C.G.M.
863	2.m.m. base grid for profile plotting	—	C.G.M.
844/81	Maps and drawings to accompany Gravity Survey report	Various	D.M.S.
882	Magnetic susceptibilities of Swaziland rocks	—	D.M.S.
883	Tectonic features from isostatic anomaly map	1:250,000	D.M.S.
884	Magnetic structure map of Swaziland	—	D.M.S.
885	Upper Coal Zone Geology Sheet II	1:10,000	M.McK.
886	Upper Coal Zone Geology Sheet III	1:10,000	M.McK.
887	Upper Coal Zone Geology	1:50,000	M.McK.
888	Applications for prospecting and/or mining rights	1:500,000	C.G.M.
889	Upper Coal Zone Geology Sheet I	1:10,000	M.McK.
890	Foliation plan of Ancient Gneiss Complex Sheet 25	—	J.V.H.
891	Sketch map to accompany third note on Swa iland Project	1:250,000	J.V.H.
892	Chart for listing explosive magazines	—	J.W.
893	Chart for listing Hail Rockets	—	J.W.

No.	*Title*	*Scale*	*Author*
894	Chart for listing mining properties	—	J.W.
895	Working sepia of Upper Coal Zone	1:10,000	M.McK.
896	Grid for plotting Location 76	—	C.G.M.
897	Vehicle movement chart	—	C.G.M.
898	Borehole section B.H.367	—	
899	Magnetic profiles, Sheet III Mpaka area	—	A.M.V.
900	Geochemical soil sample plan	—	A.S.D.
901	Magnetic profiles, Sheet 4 Mpaka area	—	A.M.V.
902	Magnetic profiles, Sheet 5 Mpaka area	—	A.M.V.
903	Mining applications Nos. 20 and 23	1:50,000	J.W.
904	Mining application No. 3	1:50,000	J.W.
905	Mining application No. 26	1:50,000	J.W.
906	Swaziland revenue and expenditure chart 1970/71	—	C.G.M.
907	Mining application No. 6	1:50,000	J.W.
908	Mining application No. 14	1:50,000	J.W.
909	Swaziland Mineral Production chart	—	J.W.
910	Mining application No. 24	1:50,000	J.W.
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912	Magnetic contour map, Mpaka area	—	A.M.V.
913	Magnetic profiles site No. 4 Lowveld Thermal Power Scheme	—	A.M.V.
914	Magnetic contour plan site No. 4 Lowveld Thermal Power Scheme	1:2,500	A.M.V.
915	Swaziland mineral survey: Forbes Reef	1:25,000	M.McK.
916	Magnetic contour map vertical field, Sheet 4, Mpaka area	—	A.M.V.
917	Geological map of Location 78, Nickel values in p.p.m.	—	R.P.E.
918	Application for mining lease	—	C.G.M.
919	Map showing positions of mineral claims No. 29	1:50,000	J.W.
920	Reproduction of portion of Forbes Reef area, after J. G. Urie	1:25,000	M.McK.
921	Aerial mosaic of Swaziland	Various	J.W.
922	Stream sediment sampling	1:50,000	R.P.E.
923	Mining application Diagram No. 7, Kaolin	1:10,000	J.W.
924	Mining application No. 9 Molybdenum	1:50,000	J.W.
925	Mining application No. 22 Gold	1:50,000	J.W.
926	Mining application No. 16 Kaolin	1:50,000	J.W.
927	Mining application No. 21	1:10,000	J.W.

No.	*Title*	*Scale*	*Author*
928	Mining application No.26A Gold	1.50,000	J.W.
929	Mining application diagram, A.W.e.	1:50,000	J.W.
930	Mining application diagram, M. and M.	1:50,000	J.W.
931	Departmental chart	—	
932	Mining application No. 3 Tin	1:50,000	J.W.
933	Plan showing position of Dwaleni meteorite	1:50,000	J.G.U.
934	Magnetic profile, Upper Coal Zone, Sheet 12	—	A.M.V.
935	Magnetic profile, Upper Coal Zone, Sheet 8	—	A.M.V.
936	Magnetic profile, Upper Coal Zone, Sheet 9	—	A.M.V.
937	Magnetic profile, Upper Coal Zone, Sheet 7	—	A.M.V.
938	Mpaka Power Station Investigation, Borehole Logs	1:1,000	M.McK.
939	Mpaka Power Station, Pit Investigations	1:1,000	M.McK.
940	Mpaka Power Station, Pit Investigations	1:1,000	M.McK.
941	Mining application No. 25	1:100,000	J.W.
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943	Magnetic profile, Upper Coal Zone, Sheet 11	—	A.M.V.
944	Geochemical map of Location 78 Nickel Values	—	R.P.E.
945	Magnetic profiles, Upper Coal Zone, Sheet 6	—	A.M.V.
946	Plan of Hail Rocket locations	—	J.W.
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949	Magnetic profile vertical field U.K.A.E.A. Field Station.	—	A.M.V.

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LIST OF PUBLICATIONS

SPECIAL REPORTS

1. The Haematite Deposits, Mineral Concession No. 41, Northwestern Swaziland, by A. T. M. Mehliss, 1946 (out of print).
2. Mineral Ownership as Effecting Mineral Development in Swaziland by H. J. R. Way, 1949 (price 75 cents).
3. The Bomvu Ridge Haematite Deposits, C.M.A. No. 7, Mbabane District, by D. N. Davies and J. G. Urie, 1955, (price R1.50).

BULLETINS

Bulletin No. 1 (1961, price R2.00) containing:–

(i) The Results of Eighteen years Organized Geological Work in Swaziland by H. J. R. Way.

(ii) The Zones of the Ecca Series, Karroo System in Swaziland by D. N. Davies.

(iii) The Trend of Mineral Production in Swaziland from 1907 to 1960 by D.A.C. Purser.

(iv) The Geological Evolution of Swaziland during the Precambrian by D. R. Hunter.

(v) Notes on the Jamestown Complex, northwestern Swaziland by J. G. Urie.

(vi) The Geology of a Portion of the Country between Mankaiana and Hlatikulu, Mankaiana District by A. T. M. Mehliss.

(vii) The Geology of a Portion of the Country between the Komati and Usushwana Rivers, Northwestern Swaziland by D. A. Pretorius.

(viii) The Karroo System sediments of Eastern Swaziland by J. L. Scogings and C. J. Lenz.

(ix) Radiometric Survey as an Aid to the Geological Mapping of the Ancient System in Swaziland by H. J. R. Way.

(x) Major Structures in Swaziland by H. J. R. Way.

Bulletin No. 2 (1962, out of print). The Mineral Resources of Swaziland.

Bulletin No. 3, (1963, price R3.00) containing–:

(i) The Mozaan Series in Swaziland by D. R. Hunter.

(ii) The Geology of the Malatotsha Valley by D. H. Jones.

(iii) The Geology of the Stormberg Volcanics by J. G. Urie and D. R. Hunter.

(iv) The Geology of the Gold Mines and Prospects at Horo, Pigg's Peak District by D. R. Hunter and D. H. Jones.

Bulletin No. 4, (1964, price R3.(0) containing:–

(i) The Alumina, Pyrophyllite and Silica Deposits in the Insuzi Series, Mahlangatsha and Mkopelele Areas, Shiselweni and Manzini Districts by D. N. Davies, J. G. Urie, D. H. Jones and P. E. Winter.

(ii) Pyrophyllite occurring in the Mozaan Series by J. G. Urie.

(iii) Two Sillimanite-bearing Zones occurring on Lapsed Mineral Concession No. 50, Mahlangatsha Area, Manzini District by D. H. Jones.

(iv) The Kaolin Deposits, Mahlangatsha, Manzini District by D. R. Hunter and J. G. Urie.

(v) The Mhlosheni Fluorspar Prospect, Mineral Concession No. 31, Shiselweni District by J. G. Urie.

(vi) The Nickel and Tungsten Mineralization at Forbes Reef by D. N. Davies.

Bulletin No. 5, (1965, price R3.00). The Usushwana Igneous Complex by P. E. Winter.

Bulletin No. 6, (1966, price 75 cents) Analyses of Rocks, Minerals, Ores and Water.

SHORT REPORTS IN ANNUAL REPORTS

Part II of Annual Report for 1958 (price 30 cents).

(i) An Occurrence of Chrysotile Asbestos, Mineral Concession No. 25, Mbabane District by D. R. Hunter.

(ii) Recent Coal Investigations on Crown Mineral Area No. 27, Stegi District by D. R. Hunter.

(iii) Some Recent Investigations on Stormberg Volcanics by D. R. Hunter and J. G. Urie.

(iv) The Ngwavuma Gravels, Maloma Area, Hlatikulu District by J. G. Urie.

(v) Cinnabar Prospect, Mineral Concession No. 41, Pigg's Peak District by J. G. Urie.

Part II of Annual Report for 1959 (out of print)

(i) The Geology of the Wyldsdale Ridge Gold Mine, Mineral Concession No. 51, Pigg's Peak District by D. R. Hunter.

(ii) The beryl-cassiterite-bearing Pegmatites of the Sinceni Area, Hlatikulu District by J. G. Urie.

(iii) Mhlosheni Fluorspar Deposit, Mineral Concession No. 31, Hlatikulu District by J. G. Urie.

Part II of Annual Report for 1960 (price 35 cents).

(i) Copper-Nickel Mineralization in the Usushwana Complex by D. R. Hunter and P. E. Winter.

(ii) Notes on the Swaziland System and Jamestown Igneous Complex with Particular Reference to the Area between the Komati River and Havelock and Pigg's Peak Mines by J. G. Urie.

ANNUAL REPORTS

(i) Government Geologist for 1942 and 1943 (both out of print)

(ii) Geological Survey Department for year 1944 (out of print), 1947 (out of print), 1948 (price 15 cents), 1949 (price 20 cents, 1950 (price 30 cents), 1951 (price 30 cents), 1952 (price 25 cents), 1953 (price 30 cents), 1954 (price 30 cents), 1955 (price 30 cents), 1956 (price 30 cents), 1957 (price 30 cents).

(iii) Progress Report of the year 1945 and 1946 (price 50 cents).

(iv) Geological Survey and Mines Department for the years 1958 (30 cents), 1959 (out of print), 1960 (price 35 cents), 1961 (price 50 cents), 1962 (price 50 cents), 1963 (price 50 cents), 1964 (price 50 cents), 1965 (price 50 cents), 1966 (price 50 cents), 1967 (price 50 cents), 1968 (price 50 cents), 1969 (price 50 cents).

MAPS

(i) Geological Map of Swaziland Scale 1:125,000 1959 (price R6.30). Explanation of above Map entitled The Geology of Swaziland, 1960 (price R2.00).

(ii) Geological Map of Swaziland Scale 1:250,000, 1966 (price R1.00).

(iii) 1:50,000 Geological Maps with Explanatory Notes (price 35 cents each).

Sheet 2531 CD (2) 1966
Sheet 2631 BA (7) 1967
Sheet 2631 AD (12) 1968
Sheet 2631 BC (13) 1968
Sheet 2631 BD (14) 1968
Sheet 2631 DA (19) 1968
Sheet 2631 DB (20) 1967
Sheet 2631 CD (24) 1968
Sheet 2631 DC (25) 1967
Sheet 2631 DD (26) 1967
Sheet 2731 BA (30) 1968
Sheet 2731 BB (31) 1967

(iv) 1:25,000 Geological Map Series (price R1.50 each), (No Explanatory Notes).

Sheet 1 Hhohho 1968
Sheet 2 Pigg's Peak 1969.

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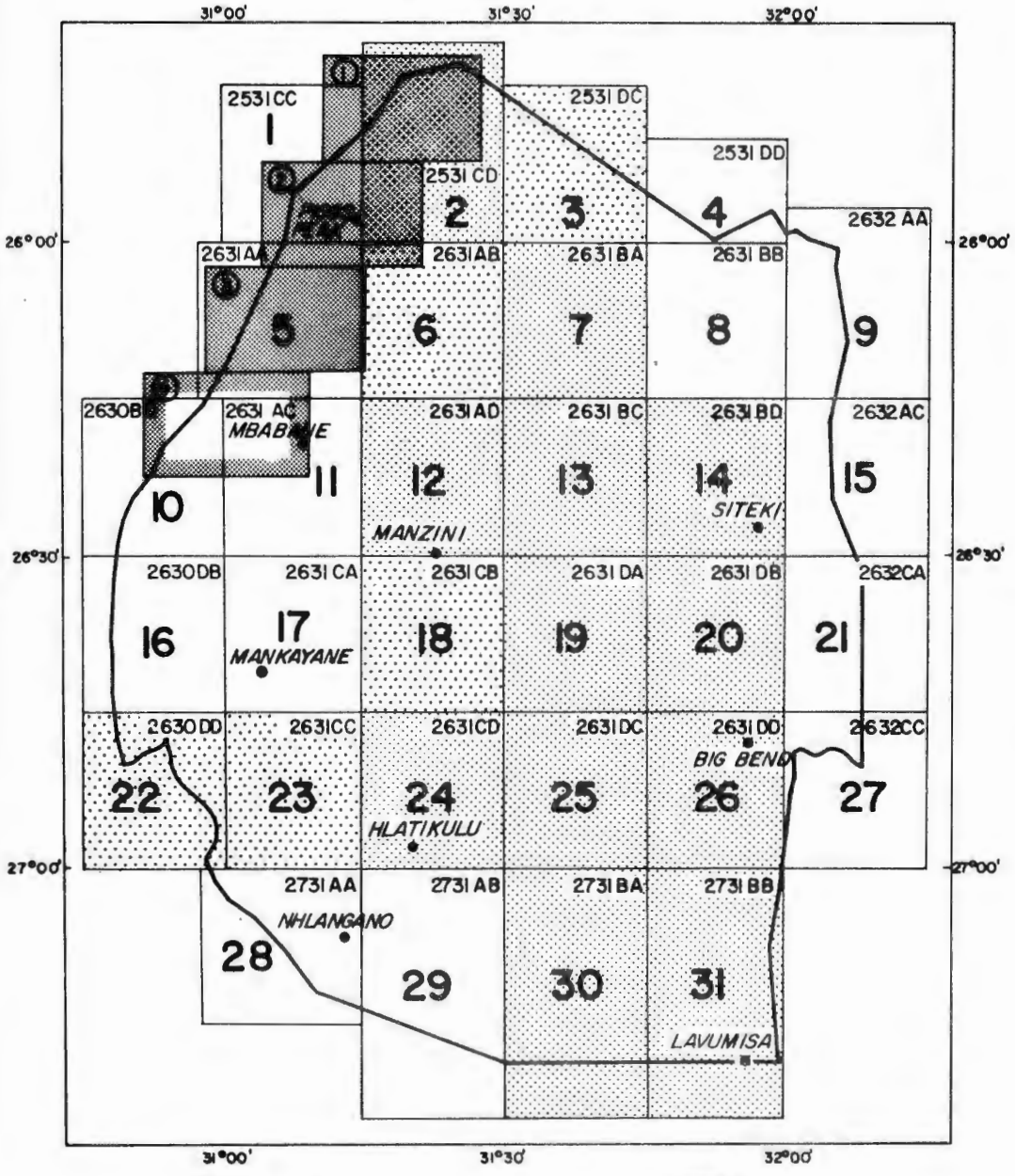
INDEX TO GEOLOGICAL SHEETS



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FOR THE YEAR ENDED
31ST DECEMBER 1968

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CONTENTS

I. GENERAL

(a) INTRODUCTION

Swaziland attained full self-government on 6th September, 1968.

2. Prior to 6th September, the Department formed part of the Ministry of Finance, Commerce and Industry. A re-organization of Ministerial responsibilities after Independence resulted in the creation of the Ministry of Commerce and Industry, of which the Department now forms a part. The title of the Ministry was expanded to Commerce, Industry and Mines by notice in the Government Gazette of 8th November, (General Notice 77 of 1968).

3a. The Department is organized into three branches, namely, Geological Survey, Mines, and Machinery. The fundamental aim of the Geological Survey is the assessment of the mineral resources of Swaziland and the stimulation of investment with a view to the eventual exploitation of these resources. This objective is achieved by the publication of maps and reports describing the many aspects of the geology of Swaziland. Constant revision of the basic geological maps is undertaken as new mapping techniques, concepts and advances in related scientific fields combine to assist the better understanding of local geology. Mineral exploration work is carried out, involving detailed mapping, supplemented by laboratory investigations, trenching and diamond drilling programmes. The sum total of information from these different sources is used to assess the economic potential of a particular deposit, its persistence in depth and grade, together with the prediction and location of further deposits in similar geological environments.

3b. Exploration to satisfy the World demands for ores of all kinds is becoming more expensive and time consuming as the more readily exploitable deposits become exhausted. Technological progress creates new demands for minerals, many of which may be of only academic interest today. An important aspect of the work of mineral exploration includes maintaining a close association with prospecting companies and operating mines, and providing technical advice and assistance when requested by these organizations. A third task of the Geological Survey is the assistance which can be given to other Government departments such as in certain engineering problems. Swaziland is favourably situated in that a number of major rivers flow across the country. The need for extensive surveys of underground water supplies has not the same urgency as in many other countries, but, nevertheless, the Geological Survey selects sites for boreholes when so requested by other Government departments or private individuals and companies. The Geological Survey keeps records of boreholes drilled for water but such records are difficult to maintain in the absence of adequate legislation to control the drilling of water boreholes.

4. The Mines branch of the Department has specific functions to perform in connexion with prospecting and mining, as well as the inspection of mines and quarries, the issue of blasting licences and the implementation of explosives regulations. Since Independence, the granting of prospecting and mining rights is vested in the Nggwenyama who is advised by a Minerals Committee. Close co-operation is needed between the Minerals Committee and the Mines branch of the Department

to ensure that applications are dealt with expediously and that interest in mineral exploration in Swaziland is stimulated. Delays can only result in investors losing interest or diverting capital into other spheres. Revenue from mineral exports continues to play a very significant role in Swaziland's economy and, because the exploitation of mineral deposits leads to their ultimate exhaustion, it is vitally necessary that the search for new deposits is prosecuted vigorously.

5. The activities of the Machinery branch extend to industrial concerns in addition to mines. Inspections are carried out of all plant to ensure that the provisions of the various regulations are observed. Close liaison is maintained with the Labour Commissioner. The advice of the mines and machinery inspectorate is given to Government departments and private concerns in the same way that geological advice is given.

(b) SUMMARY OF YEAR'S WORK

6. With the retirement of Mr. D. N. Davies, O.B.E. and Mr. J. K. Whittingham, and the absence of Mr. D. A. C. Purser on overseas leave the professional staff of the Department was considerably reduced throughout the year.

7. Three hundred and forty nine square miles were geologically mapped and for the first time geochemical stream sediment sampling formed part of the mapping programme. The mapping was done at scales varying from 1:10,000 to 1:30,000.

8. In addition to this work, ten sites were selected for water boreholes in various parts of Swaziland. One of the Department's drilling rigs drilled five boreholes for water at Ehlane where it is proposed to establish a Game Reserve. The Department's rigs are not normally employed on this type of work but on this occasion assistance was given to the organizers of the reserve who, under the King's patronage, are endeavouring the preserve of the rapidly diminishing natural fauna as a national asset.

9. The drilling section completed a further 15 boreholes of which 8 were drilled in connexion with the United Nations Development Programme, Mineral Survey project. The total footage drilled during the year totalled 6,837 feet an increase of 1,091 feet over the previous years total.

10. In the laboratory 34,891 determinations were made on soil and stream sediment samples in connexion with the geochemical survey of the United Nations Mineral Survey. A further 303 samples were collected and prepared for assay by a commercial bank in Johannesburg.

11. The Department's own investigations into deposits of potential economic interest have been restricted due to other commitments. However 5 boreholes were drilled at an asbestos prospect in the Usushwana Valley, at an iron occurrence north of Ngwenya beacon and at the dormant Forbes Reef gold mine. The asbestos deposit proved to be disappointing and work at Forbes Reef had to be suspended when more urgent work arose. However, the preliminary boreholes showed that the granite reported by the now defunct Swazieland Corporation, who owned the mine at the beginning of the century, to terminate the ore horizon does not in fact do so.

12. Throughout the year advice was given by both geological and mining staff to Swaziland Barytes Limited and Kaolin (S.D.) Limited. It is gratifying to record that production of barytes increased by 57 per cent as compared with 1967 as a result of this advice, the value of sales of barytes increasing by 90.4 per cent over the 1967 figures. This provides a good example of the value of the services which the Department is able to provide.

13. The results of water boreholes drilled at ten of the sites selected by the Department were received during the year. Seven boreholes had yields ranging from 112 to 800 g.p.h.

14. The value of minerals produced in Swaziland reached a new record level in 1968. An overall increase of 4.6 per cent brought the total value to R18.27 million as compared with R17.46 million in 1967; the largest proportionate increases being the sales of coal, quarry stone and barytes.

15. Prospecting by private companies was limited to the operations carried out by Lonrho Limited, Swaziland Barytes Limited and Kaolin (S.D.) Limited. In the last month of the year Swaziland Collieries began a short prospecting programme to the south of their existing colliery to establish the best site for a prospect shaft. Until the outstanding applications for prospecting rights have been approved, prospecting by private companies will be on a limited scale.

16. A disturbing feature is the increase in the number of fatal and other accidents in the mining industry from 135 in 1967 to 178 in 1968 accompanied by an increase in the number of shifts lost per accident. An increase is also recorded in the number of shifts lost per accident involving machinery, although the number of accidents decreased.

17. Three new factory installations came under inspection by the Inspector of Machinery during the year.

(c) STAFF

18. Mr. D. A. C. Purser, Inspector of Mines, was made a Member of the Order of the British Empire in Her Majesty the Queen's Birthday Honours List.

19. The year has seen a number of changes in the staff of the Department. In April, Mr. D. N. Davies, O.B.E., Director of Geological Survey and Commissioner of Mines, gave notice of his intention to retire in terms of the scheme of compensation for pensionable officers, designated under the Overseas Service (Swaziland) Agreement, 1962. Mr. Davies proceeded on overseas leave in April and on terminal leave in August, his final retirement being effective from 27th October, 1968. Mr. J. K. Whittingham, Geologist/Geophysicist, proceeded on leave in May prior to the expiry of his contract in July. Mrs Bain, Senior Accounts Officer, terminated her contract in January. Mr. R. A. M. Myburgh, Driller, retired with effect from 19th December in order to facilitate the localization programme. Mrs. Richards, Stenographer, was transferred to the Swaziland Broadcasting Service at the end of July.

20. Mr. W. Mhlotha succeeded Mrs. Bain as Senior Accounts Officer, taking up his duties in January. Mr. A. S. Dlamini was appointed to the post of Geologist in September, following his return from the Colorado School of Mines where he attended a one year course in mineral exploration techniques under the aegis of a

United Nations Fellowship. Mr. Dlamini had served in the Department in a training grade for ten months in 1967 following his graduation from Colorado State University. Mrs. N. Dlamini was appointed to the post of Typist in October. Mr. P. Gama was promoted to the rank of Driller in October following his period of in-service training. Mr. C. G. Matthews, Draughtsman, was promoted to the new post of Senior Draughtsman as from 1st April.

21. Technical assistants, formerly employed under C. D. & W. schemes, were transferred to the pensionable establishment as from 1st April, when the C.D. & W. schemes terminated. Expatriate staff employed under these schemes continued on contract terms.

22. Mr. D. R. Hunter, Senior Geologist, acted as Director of Geological Survey and Commissioner of Mines from April to July and from August to the end of December. Mr. J. G. Urie, Geologist, acted as Senior Geologist from April to July and from August to the end of December. Mr. Urie also acted as Inspector of Mines from 18th March to 24th June, 1968, during the absence on overseas leave of Mr. Purser, Inspector of Mines.

23. Mr. D. R. Hunter, acting Director of Geological Survey and Commissioner of Mines, submitted a thesis on the granitic rocks of Swaziland to the University of the Witwatersrand which was approved for the award of the degree of Doctor of Philosophy.

(d) TRAINING

24. Mr. P. Gama continued to receive in-service training as a diamond driller until the end of September. On completion of the period of training, Mr. Gama was appointed as supernumerary driller pending the final retirement of Mr. R. A. M. Myburgh.

25. Mr. Vilakazi, Trainee Draughtsman, continued his training in Canada, after nomination to the Geology Technician course at the Cambrian College in Sault Ste. Marie by the Canadian authorities. This course provides instruction in geology and mining which will qualify Mr. Vilakazi to hold a senior technical post in the Department on his return to Swaziland. Technical officers of this calibre have been required in the Department for some years in order to relieve the professional officers of certain routine jobs.

26. In-service training has been given to technical assistants working with geologists in the field and with the geochemical analyst in the laboratory. These technical assistants were instructed in the use of compass and tape in laying out soil sampling grids for geochemical surveys and in sampling techniques. In the laboratory, training has been given to two technical assistants in elementary geochemical analytical methods.

27. At the request of the Principal of the Swaziland Agricultural College and University Centre at Luyengo, Dr. D. R. Hunter conducted a course of eight lectures and four practical classes in elementary geology to forestry students at the college in February and March.

28. In April Dr. D. R. Hunter, gave a talk on mineral development to officers attending the joint Botswana/Swaziland Training Course held at the Staff Training Institute, Mbabane, during March and April.

29. Senior pupils of the Mater Dolorosa School, Mbabane, were shown over the Department in March when a number of demonstrations were arranged to illustrate the work of the Geological Survey.

30. Mr. Shongwe, a student at the University of Botswana, Lesotho and Swaziland, who wishes to become a mining engineer, was employed during his University vacation. He was taken on visits to mines in addition to being given instruction in elementary surveying. During his period of employment he gained some knowledge of laboratory procedures when he worked in the geochemical laboratory.

(e) CONFERENCE AND EXHIBITIONS

31. No extra-territorial conferences were attended by any member of the staff during the year. At the end of June the first Departmental conference was held. It was attended by all members of the Department's geological staff, the staff of the United Nations Mineral Survey and two geophysicists on secondment from the Institute of Geological Sciences, London. The discussion which followed enabled officers working on different problems to integrate their results with those of the geochemists and geophysicists. It is intended to repeat the experiment next year for, apart from other considerations, it was found to be of value in stressing the essential team-work which makes for an efficient organization.

32. Mr. J. G. Urie, acting Senior Geologist, arranged the Department's exhibit at the Swaziland Independence Show organized on behalf of Government by the Manzini Town Board as part of the Independence Celebrations. The co-operation of New Amianthus Mines Limited, Swaziland Collieries Limited and Swaziland Iron Ore Development Company Limited in providing material for exhibition and assistance with the cost of the exhibit was of considerable help which is gratefully acknowledged. During the week that the Show was open the staff of the Department were fully occupied giving explanations and demonstrations to the large number of visitors. At a time when there were so many visitors from beyond the borders of Swaziland, the demeanour of the officers concerned reflected credit to themselves and their country.

(f) VISITORS

33. In addition to regular visits from members of the local mining and prospecting community, visits were received from various senior geological and mining staff of the larger mining companies who wished to be kept informed of the latest information on mining developments in Swaziland.

34. A party of geologists toured Barberton and Swaziland under the aegis of the Economic Geology Research Unit of the University of the Witwatersrand, following the Annual Congress of the Geological Society of South Africa in July. The Department arranged their itinerary in Swaziland.

35. Other visitors to the Department have included Mr. H. Brown of the United Nations Headquarters, New York, who had discussions with the United Nations

Development Programme, Mineral Survey Project Manager and the acting Director, and Mr. A. Savornin, a United Nations consultant, who visited Swaziland in connexion with problems of mineral beneficiation. During the three weeks Mr. Savornin was in Swaziland he made a comprehensive study of the Department's files on this subject, in addition to material generously supplied by various local mining companies.

(g) EXTERNAL TECHNICAL AID

36. The United Nations Development Programme Mineral Survey continued throughout the year. Geophysical work was delayed due to the difficulty of recruiting a suitable person to replace Mr. W. Robinson, following the completion of his contract in May. His replacement, Mr. H. Joshi, arrived in Swaziland in October.

37. The Institute of Geological Sciences, London, seconded two geophysicists (Mr. R. B. Evans and Dr. A. Burley) to Swaziland for the period May to early July. Provision of the services of these two geophysicists enabled Swaziland to meet its counterpart contribution to the United Nations Development Programme Mineral Survey.

38. The Directorate of Overseas Surveys, Tolworth, continued to prepare and print in colour the 1:50,000 geological sheets of Swaziland. To date thirteen sheets have been printed, but only eight sheets have been placed on sale by the Department, because the explanatory notes of the remainder have not yet been printed.

II. GEOLOGICAL SURVEY

(a) REGIONAL MAPPING

(i) *Sheet 2631 AA (5), Forbes Reef, Hhohho District*

39. Mr. J. G. Urie mapped two areas of the sheet totalling 21 square miles at a scale of 1:10,000.

40. The larger area mapped overlaps the contact between the granite and the Onverwacht Series, extending from south of the Mbabane-Johannesburg road, to a point some 5 miles north of the Forbes Reef Store.

41. The rocks of the Onverwacht Series encountered in the vicinity of the contact comprise a broadly layered sequence of metamorphosed ultramafites, and meta-sedimentary and meta-volcanic beds.

42. The ultramafites are represented by serpentinites, antigorite-tremolite-chlorite schists and, at greater distances from the granite contact, by talcose schists. Interlayered rocks of sedimentary and volcanic origin are represented by banded or schistose actinolitic or hornblendic amphibolites and gneisses with narrow interbedded quartzites.

43. Post-granite intrusives include northwesterly and northeasterly striking diabase dykes, younger dolerite dykes and a granophyre dyke characterized by an abundance of feldspar insets and smaller insets of amethystine quartz.

44. Pre-granite intrusives include a body of medium-grained, dark grey actinolite-albite fels occurring to the east of Forbes Reef store amid hornblende gneisses of the Onverwacht Series. This body is intruded by a small plug of granite at its western margin and by a narrow granite dyke along its northern margin.

45. Two major amphibolite dykes occur some four miles north of Forbes Reef store. The more southerly of these has a length of some 4,000 feet and the more northerly, which bifurcates southwards, a length of 8,000 feet. Both these dykes invade quartz-mica schists of the Moodies Series and lie parallel to the north-northeasterly strike of the country rock. These dykes manifestly pre-date the north-westerly striking diabase dykes for they are cut by them. The dykes are in places sheared or vaguely foliated in a direction parallel to the cleavage of the country rock. Metamorphism has reconstituted the dyke rock so that the original texture has been obliterated, and actinolite, sodic feldspar and subordinate quartz are the primary constituent minerals. It is evident, therefore, that these dykes are pre-granite in age.

46. The nine square miles of mapping completed to the north of the She gold mine covered terrain largely underlain by quartzites of the Moodies Series. Sandy shales, and talcose and serpentinous rocks occur amid the Moodies quartzites. The shales were originally thought to be members of the Moodies Series and the talcose rocks to belong to the intrusive Jamestown Igneous Complex. The recent mapping, however, suggests that the shales are members of the Figtree Series and the talcose and serpentinous rocks members of the Onverwacht Series and that these

formations have been folded and faulted into the position which they now occupy amid the Moodies sedimentary rocks.

(ii) *Sheet 2731 AB (29) Mhlosheni, Shiselweni District*

47. Mr. D. H. Jones mapped 228 square miles of this sheet, using aerial photographs at a scale of 1:30,000, the data being plotted onto a 1:50,000 base map.

48. The majority of the sheet is underlain by various granitic rocks but rocks of the Karroo and Pongola Systems crop out in the central and southern portions.

49. Three granites have been recognized, the oldest of which crops out west of the Mhlosheni Hills and also in a more restricted area in the southeastern corner of the sheet. This granite (Ag3) is a medium-grained, grey rock which is locally porphyritic. Numerous xenoliths of the Pongola System occur in the granite west of the Mhlosheni Hills, tongues of granite being intruded along the more argillaceous horizons in the xenoliths. The contact of the granite with the main outcrop of the Pongola System is faulted. One and a half miles southwest of Warren's Store, the granite intrudes various gneisses regarded as being remnants of the Ancient Gneiss Complex.

50. Gently undulating country east of the Mhlosheni Hills is underlain by a coarse-grained, porphyritic granite (Ag4). Some of the potassium feldspar insets are surrounded by rims of plagioclase, thus suggesting that the granite has rapakivitic affinities.

51. The younger granite (Ag5) builds the prominent Mhlosheni Hills which form a central spine of high ground extending northwards through the centre of the sheet. The granite is coarse-grained, and has a distinctive greyish pale olive green colour. Well developed joints in the granite have resulted in the development of a markedly rectilinear drainage pattern. No pegmatites are associated with this granite.

52. The Pongola System, represented on this sheet by a dominantly argillaceous succession belonging to the uppermost beds of the Mozaan Series, is intruded by the Ag4 and Ag5 granites, which have caused low grade contact metamorphism extending over a distance of less than 100 yards from the contact. Both granites are sharply cross-cutting. The intrusive relationship of the Ag3 granite with the Mozaan Series cannot be seen on this sheet.

53. The Mozaan Series consists of a succession of slightly ferruginous shales with thin manganiferous interlayers, quartzites and andesitic lavas, all of which reflect a low grade of regional metamorphism. The Mozaan Series has been folded about axes striking north-northwest.

54. Outliers of the Karroo System occur east of the Mhlosheni Hills. They are composed of tillites and shales of the Dwyka Series. Southwest of the Mhlosheni Hills, similar rock types form a more continuous outcrop along the Transvaal border.

55. Minor intrusives include granophyre, gabbro, diabase and dolerite. The granophyre and gabbro are confined to the north central area of the sheet where they intrude the Mozaan Series. Diabase dykes striking north-westwards occur in the Ag4 granite, southeast of the Mhlosheni Hills. Sheets of fresh dolerite, provisionally regarded as post-Karroo in age, occur in the Ag4 granite building isolated

flat-topped hills. In the southeast corner of the area, an extensive sheet of dolerite crops out along the Transvaal border.

56. A unique occurrence of ultrabasic rock was noted in the Mozaan Series near the northwestern flank of Mhlosheni Hills. The age and correlation of this occurrence is uncertain.

57. A prominent feature of the area is the zone of shearing and mylonitization which extends from beneath the cover of the Karroo System in the south to the northern edge of the sheet. Along most of this distance it follows the contact of the Ag3 granite and the Mozaan Series which has been thrust over the granite.

58. No new discoveries of economic interest were made during the survey. In the past fluorspar was mined from a quartz vein southeast of Mhlosheni but detailed investigation some years ago proved that the lenses of fluorspar in the vein are very sporadic.

59. Samples of the ferruginous and manganiferous shales were submitted for assay but the results were all of sub-economic grade.

60. For the first time during regional mapping in Swaziland, geochemical stream sampling formed an integral part of the work. In this area 2,904 samples were collected and await analysis in the laboratory.

(ii) *Sheet 2631 CB (18), Manzini District*

61. Mr. R. P. Edwards began detailed revisionary mapping of this sheet in September and had completed 100 square miles by the end of the year. The majority of the rocks which have been mapped are migmatites which have been intruded by an igneous complex of which granodiorites and tonalites appear to be the main components.

62. The migmatites are considered to represent an anatectic complex. They have been mapped on the same basis as Mehnert's (Migmatites and the Origin of Granitic Rocks, Elsevier, 1968) sub-division of the migmatites of the Black Forest and include metatexites, homogenous diatexites and inhomogenous diatexites. The metatexites comprise biotite gneisses and amphibolites which are frequently characterized by differentiation into leucocratic and mesocratic layers. The homogenous diatexites are of tonalitic composition and represent the product of anatexis. They are generally grey medium-grained rocks with quartz, oligoclase and biotite being the main minerals. The inhomogenous diatexites comprise discontinuous laminae of biotite gneiss and amphibolite intimately associated with tonalitic gneiss.

63. It is considered that migmatization took place firstly by metamorphic differentiation forming the metatexites. At a later stage anatexis resulted in a second generation of migmatites which are represented by the diatexites.

64. The diatexites sometimes possess a weak foliation but are commonly without any planar fabric. In contrast the structure of the inhomogenous diatexites is very complex presumably due to the variable competence of the rocks at the time of deformation. The metatexites show evidence of two major fold movements. Firstly forces acting from the northwest and southeast have imposed a foliation which trends to the northeast and is the product of tight isoclinal folding with gently dipping axes. A later stage of deformation has produced a more open folding on axes which plunge gently to the north.

65. The migmatites are intruded on the western portion of the sheet by a series of coarse-grained rocks which vary in composition from tonalites to granodiorites. In the bed of the Usushwana River, near to the old Matsapha power station the tonalites form dykes intruding the migmatites which confirm their intrusive character.

66. In thin section the rocks are composed of quartz, highly sericitized oligoclase, and minor amounts of microcline. The main ferromagnesian minerals are chlorite (commonly the variety penninite), biotite and hornblende. Epidote is a common accessory mineral and apatite is ubiquitous.

67. A total of 250 stream sediment samples were collected at major stream confluences or at half mile intervals for submission to the geochemical laboratory.

(b) ECONOMIC GEOLOGY

(i) Departmental Activities

68. Most of the Department's work in the field of economic geology during the past year has been concerned with the United Nations Development Programme, Mineral Survey. In addition one of the Departmental drilling rigs was employed at an asbestos prospect near Emlembe on contract to the concessionaires. As a consequence of these activities, investigations at other deposits of potential economic interest have been curtailed. However, it was possible to complete drilling at an asbestos prospect in the Usushwana valley, and to make a start on the investigation of low-grade iron ore north of Ngwenya, and the dormant Forbes Reef gold mine.

Asbestos, Hhohho District

69. Three further boreholes were drilled at the asbestos occurrences in the Usushwana valley which was investigated in 1966 (see Annual Report for 1966, paragraphs 15-16). The previous drilling had shown that short fibre occurs in blue-black serpentinite over a true width of 15 to 45 feet, along a strike length of 800 feet. The percentage of fibre amounted to 1.2%, which is below an economic grade. The present programme was designed to test the possibility that the blue-black, fibre-bearing serpentinite formed an outer sheath to a zone or zones carrying fibre in economic quantities. The boreholes failed to intersect such fibre but did prove that there are two fibre-bearing zones present in this area. In view of the disappointing results further work was suspended.

70. The boreholes showed that there was a persistent horizon of pyrrhotite mineralization in the amphibolite gneiss forming the footwall of the eastern fibre-bearing zone. This horizon was assayed for gold and nickel with negative results in both cases.

Clay, Manzini District

71. A sample of clay was submitted by Mr. M. H. S. Dlamini, from Swazi Nation land in the Mahlanya area. The local people have been using the clay for the manufacture of pots and it was requested that the clay should be investigated with a view to determining its uses.

72. A sample was submitted to Messrs McLachlan and Lazar Limited of Johannesburg who analysed the clay as follows:–

Lost on ignition	12.98	per cent
SiO_2	42.10	" "
TiO_2	0.77	" "
Al_2O_3	23.55	" "
Fe_2O_3	9.04	" "
CaO	6.87	" "
MgO	4.34	" "
Na_2O	0.08	" "
K_2O	0.13	" "
P_2O_5	0.19	" "

73. The report states further that the low silica: alumina ratio indicates a fairly refractory material but the presence of appreciable amounts of CaO and MgO will lower the fusion temperature. The presence of iron calls for firing in an oxidizing atmosphere to give a good red colour and prevent additional FeO fluxing. The high linear shrinkage (11.1%) indicates possible unsuitability for complex pottery but admixtures of other material could counteract this. The McLachlan and Lazar report concludes that the clay is suitable for brick-making.

74. The Department has agreed to supervise the laying out of a pitting programme to define the extent of the deposit should the surface rights owners decide to proceed with the investigation.

Gold, Forbes Reef mine, Hhohho District

75. The Forbes Reef gold mine has lain dormant for nearly 60 years, although a company made an attempt to re-open the mine after World War I. The company exhausted its capital before the mine was fully re-opened. When the mine was owned by the Forbes Reef Gold Mining Company Limited and later by the Swazieland Corporation in the last decade of the 19th century and the early years of the present century, the mine was an important producer. A vertical shaft was sunk to 375 feet below surface which was linked to an inclined shaft in the footwall of the ore-body. At the lowest levels in the mine an intrusive body of granite was reported by the Swazieland Corporation to cut-off the orebody. South of the mine more granite was encountered in shallow boreholes. All the workings of the mine have now collapsed so that it is not possible to gain entry.

76. It was decided to drill boreholes in an attempt to re-locate the ore horizon if it existed below the 325 foot level. An inclined borehole was sited to intersect the ore horizon at approximately this level. No ore was found but the footwall granite was intersected at the anticipated depth. The granite is in fact a coarse-grained pegmatite. A second borehole was drilled vertically from the same site, which entered pegmatite at a depth of 84 feet. At 207 feet the borehole passed into massive tremolite rock which, with interlayers of serpentinite, persisted to the final depth of the borehole (803 feet). Some narrow quartz veins were intersected which, however, carried no gold.

77. Work had to be suspended in order to meet drilling commitments to the United Nations Development Programme Mineral Survey. The preliminary results

show that the ore-body is not terminated to the south by granite and that the foot-wall pegmatite does not persist in that direction either.

78. It is proposed to drill further boreholes at this mine when more urgent work allows. It is of interest to note that at the Consort mine near Barberton pegmatite intrusions cut the ore-body. The geological setting of the Consort and Forbes Reef mines is similar in their relationship to intrusive granitic rocks and pegmatites.

Iron Ore

79. Low grade jaspilite crops out on the western slopes of Ngwenya Mountain, north of the Swaziland Iron Ore Development Company Limited's present mine. One borehole was drilled through the jaspilite to obtain information about its width and grade. On outcrop the iron-rich interlayers appear to be coarse-grained and hence it was assumed that such ore would be amenable to beneficiation. The borehole showed that this coarseness of grain size is only a surface phenomenon, the iron-rich layers in the borehole core being fine-grained.

80. The jaspilite horizon was intersected over a borehole length of 265 feet and consisted of an upper jaspilite having a true width of 103 feet separated by 42 feet of indurated ferruginous shale from the lower jaspilite which has a true width of 94 feet. The jaspilite horizon dips at 65° to the east, and crops out over a strike length of 9,000 feet building precipitous cliffs overlooking the Londosi valley.

81. No samples of the core were submitted for assay and it is proposed to retain the core for projected beneficiation tests.

(ii) Private Sector

Asbestos, Hhohho District

82. One of the Department's drilling rigs completed a borehole on contract to Mineral Holdings Limited who are actively continuing prospecting operations on their concession in the vicinity of Emlembe. Other boreholes, drilled by a private contractor, were also completed on behalf of the company. Progress on the adit started by the company in November 1967 has been maintained throughout the year at a steady rate. The adit is expected to intersect the ore-body early in 1969.

Barytes, Hhohho District

83. Underground development and prospecting continued at the property of Swaziland Barytes Limited under the technical guidance of the Department. A second winze linked by a drive to the winze sunk in 1967 was carried down dip for 126 feet by the end of the year. This winze lies in the true dip of the barytes vein.

84. The prospecting and development work has shown that flat-dipping faults lying very obliquely to the strike of the barytes veins have been the cause of many of the disappointing results obtained previously. Open stopes have been abandoned in the past because development has followed fault planes, along which some barytes has been preserved, rather than the true barytes horizon. It is now apparent that if development is properly directed the barytes vein behaves in a more consistent manner than was previously thought, with losses of ground occurring where there has been displacement of the vein by the flat faults. Borehole intersections led to the conclusion that lenses of barytes occurred in a broad zone, but underground

development has shown that the greater thicknesses of barytes result from drag on faults.

Coal, Lubombo District

85. Swaziland Collieries Limited began a drilling programme on Lukula Ranch seven miles south of their existing colliery. The drilling which began in November, is being carried out to obtain further information on the attitude of the coal seam in relation to known faults and dolerite intrusives.

Kaolin, Manzini District

86. Kaolin (S.D.) Limited sank a grid pattern of auger holes to test the continuity of the kaolin body known as No. 4. The auger holes were successful in delimiting the position of the kaolin body for a distance of 250 feet in a north-northwesterly direction. Beyond this point the kaolin is overlain by a considerable thickness of black turf clay which in the summer season is saturated with water and which effectively prevents the efficient use of augers. The lay-out of the prospecting grid was supervised by the Department to assist the company.

(c) WATER SUPPLY INVESTIGATIONS

87. Mr. J. K. Whittingham, Geologist/Geophysicist, selected seven sites for water boreholes as under:–

Lubombo District	
Siboteleni, Stegi	1 site
J. K. Manana's Farm, Sifutaneni	2 sites
Manzini District	
Luve Agricultural Experimental Station	1 site
J. D. Marvin's Farm, Manzini	1 site
Shiselweni District	
J. S. Murphy's Farm, Dwaleni	1 site
Hhohho District	
D. A. Beale and A. H. B. Childs' Farm, Ezulwini	1 site

88. The site at Siboteleni (L.387) near Stegi, was selected on a vlei overlying the boundary zone between basalts and rhyolites of the Stormberg Series. Along this boundary zone, the volcanic rocks appear to be weathered to a depth of about 70 feet.

89. Two sites on Mr. J. K. Manana's farm at Sifutaneni (L.397) and (L.402) were chosen about 200 yards apart in a fault zone following the strike of the Stormberg basalts.

90. The sites at Luve Agricultural Experimental station (M.133) and at Mr. J. D. Marvin's farm, Manzini (M.137) were marked at places where the granite-gneiss appears to be most deeply weathered. The depths of weathering are estimated at 110 feet at Luve and 90 feet at Mr. Marvin's farm. The site on Mr. Marvin's farm is close to the margin of a dolerite dyke.

91. At site S.247 marked on Mr. J. S. Murphy's farm at Dwaleni about 90 feet of soil and weathered rock are indicated below a near-surface layer of ferricrete. The granite-gneiss is expected to continue partly weathered to a depth of 150 feet.

92. Over most of the farm owned by Messrs D. A. Beale and A. H. B. Childs at Ezulwini, hard granite-gneiss crops out or is indicated at shallow depths. Site H.100 marked for drilling is on a fissure, which appears to be at least 50 feet deep, between the outcrops. Water may be located in this fissure at shallow depth.

93. Mr. J. G. Urie sited a water borehole for Ntongeni School, Hhohho District, at the request of the Department of Public Works. Mr. Urie visited two private properties in the Ezulwini valley, Hhohho District, and one at Kubuta, Shiselweni District, to advise the property owners on ground water supplies.

94. Three sites (L.370, L.376 and L.350) selected by Mr. Whittingham at the Ehlane Game Reserve were drilled by the Department's drilling rig, in order to assist the organizers with the development of the Reserve. One of the sites (L.376) was dry and a second site (L.350) encountered a dolerite dyke at a shallow depth. Mr. Urie sited two further holes which were successful.

95. Results of drilling received on water borehole sites chosen in 1967 and 1968 are as follows:–

District	*Locality*	*Site No.*	*Depth feet*	*Water struck feet*	*Static water level*	*Yield g.p.h.*
Manzini	Malkerns Police Post	M.110	154	105	23	112
Hhohho	Mr. Mhlotha's plot, Lobamba	H. 65	114	40 & 110	25	800
	Ntogeni School	—	194	70	—	600
	Siboteleni	L.387	200	140	182	24
	Ehlane	L.376	200	62	—	180
	Ehlane	L.370	220	—	—	Dry
	Ehlane	L.350	40	—	—	Dry
	Ehlane	Nr. L.350	112	80		140
	Ehlane	—	200	60	—	200
Shiselweni	C.D.C. near Goedgegun	S.231	186	110	—	700

(d) DRILLING OPERATIONS

96. Twenty boreholes were completed during the year with a total footage of 6,837 feet. Eight boreholes totalling 2,190 feet were drilled as part of the follow-up programme to the United Nations Development Programme Mineral Survey. One borehole was drilled on contract for Mineral Holdings Limited. Five boreholes

were drilled at Ehlane for water in order to assist with the development of the Game Reserve.

97. The footage drilled in 1968 exceeds that drilled in 1967 by 1,091 feet.

98. The revenue from drilling undertaken by the Department on behalf of private companies amounted to R3,693.50.

99. Revenue from the hire of a compressor to a private company amounted to R310.00.

(e) UNITED NATIONS DEVELOPMENT PROGRAMME MINERAL SURVEY—COUNTERPART CONTRIBUTION

100. The Department provides support for the United Nations Development Programme Mineral Survey by supplying the services of professional and technical staff for trenching and diamond drilling programme, draughting office facilities, laboratory services, transport and office accommodation. The total value of these services together with the statutory cash counterpart contribution amounted to R57,441.00 in 1968, an increase of R6,185.15 over the amount for 1967. In addition the Institute of Geological Sciences, London, provided the services of two geophysicists for two months together with the I.P. variable frequency unit. The cost of the passages of the geophysicists and the air freight on their equipment is not included in the above figures as these charges were not borne by the Swaziland Government.

101. Eight boreholes were completed during the year. Near Sipofaneni, a second borehole was completed in January, work on this borehole having started during December, 1967. Comparatively high conductivities had been measured during a ground geophysical follow-up survey, and it was thought that these were related to a mapped fault of post-Karroo age. The drilling proved that the fault as mapped is not a simple fault but a zone in which several major faults are arranged en echelon. It was concluded that the higher conductivities were caused by the presence of the more porous sandstones of the Karroo System containing more groundwater than the granitic gneisses against which sandstones are faulted.

102. Drilling south of the Usushwana River near the Maliwe stream was undertaken to investigate a well-marked electromagnetic anomaly which lies on or near the contact of serpentinite with amphibole gneiss. Drilling revealed the presence of an oxidised zone, which laboratory tests showed to be a moderately good conductor. It was concluded that the anomaly was due to this oxidised zone as the borehole core gave no indication of any mineralization.

103. Three boreholes were drilled to follow-up the I.P. survey carried out by Mr. Evans and Dr. Burley. Two of these boreholes were drilled into basic and ultrabasic rocks of the Usushwana Complex and the third intersected rocks of the Swaziland System on the eastern flank of Ngwenya Mountain. The electrical conductor in two of these holes was found to be graphite.

104. Three boreholes were drilled to assist in the interpretation of geochemical anomalies, where the depth of weathering was too deep for trenching or where quartzites of the Moodies Series cropped out preventing systematic sampling. Concentrations of arsenopyrite were noted in the fresh cores to account for the geochemical anomalies.

105. The two geophysicists, Mr. R. B. Evans and Dr. Burley, seconded to Swaziland by the Institute of Geological Sciences, London, for two months from the end of April to the end of June conducted surveys with the I.P. variable frequency unit. This secondment fulfilled Swaziland's obligation to provide four man-months of geophysicists time during 1968 as part of its counterpart contribution. The majority of the survey time was spent on the Usushwana Complex where the airborne electromagnetic survey completed in 1967 had indicated two major anomalies and where disseminated sulphide mineralization was known to occur from geological mapping.

106. Traverses with the I.P. equipment were also completed over the eastern flank of Ngwenya Mountain, where the airborne survey had reported an anomaly.

107. During the period the geophysicists were in Swaziland they completed 16.5 line miles of traversing. None of the technical assistants nor labourers attached to the field party had any previous experience of this type of work so that it was necessary to train the personnel.

108. Mr. J. K. Whittingham carried out an electro-magnetic and magnetometer survey over an area of three square miles at Makwane, Hhohho District. This involved 35 line mile of traversing. In addition to this work Mr. Whittingham assisted the United Nations geophysicist, Mr. W. Robinson, in his ground follow-up investigations of anomalies detected during the airborne electromagnetic survey. The four localities examined were Malolotsha (Hhohho District), Helo River (Manzini District), Ngcwane (Manzini District) and Ntambe Hill (Manzini District).

109. At these localities the Jalander flux-gate magnetometer, the E.M. gun and the Sharpe SP-RS equipment was used.

110. Geochemical prospecting was concerned with the selection of areas for detailed grid sampling based on the results of the stream sediment sampling programme completed in 1967. Soil sample grids were laid down over the selected areas to define more precisely the location of the geochemical anomaly, after which, trenches and/or boreholes were sited. The search for a definitive pathfinder element continued; preliminary results suggest that antimony may be significant.

111. Mr. J. G. Urie supervised trenching and bed rock sampling in an area immediately to the south of the dormant Art Union gold prospect. Trenches totalling 1,145 feet in length were dug and channel sampled.

112. Mr. R. P. Edwards supervised the grid sampling of eight areas north of Pigg's Peak between May and August. The samples were analysed for arsenic and antimony. On Mr. A. S. Dlamini's appointment, he assumed charge of the trenching programme at three of these localities in addition to supervising trenching and sampling in an area to the southeast of the dormant She gold mine. Trenches totalling 1,073 feet in length were dug at these localities.

113. Mr. A. S. Dlamini collected 213 soil profile samples from the trenches at the four locations for which he was responsible in addition to sampling the trenches for gold assay. At one location Mr. Dlamini collected an additional 33 soil samples at closer intervals than the original grid in an attempt to define more precisely a geochemical anomaly. Mr. Dlamini prepared geological descriptions of all the trenches and outcrop geological maps of the immediate vicinity of the trenches.

114. Three trenches totalling 91 feet in length were dug over a small discrete arsenic anomaly on the banks of the Black Mbuluzi River, south of Forbes Reef. The bed rock in the trenches was sampled, and subsequently a borehole was drilled beneath the surface anomaly.

115. The Departmental laboratory is used for all geochemical analytical work work in connexion with the Mineral Survey. A total of 34,891 determinations was made during the year, for the following elements:–

Arsenic	17,592
Antimony	7,187
Copper	7,165
Nickel	660
Cx Ni	1,193
Cx HM	1,094

116. Fire assays are carried out by the Assay Department of Barclay's Bank. Two hundred and eighty six samples were submitted for gold assay. The samples were either chip samples from trenches or borehole cores.

III. MINES DEPARTMENT

(a) MINERAL OWNERSHIP

117. Ownership of rights to minerals is now vested in the Nggwenyama with the exception of those areas covering 896.22 square miles which are still held by various concessionaires. These concessions are due to lapse at various times up to 1987.

118. The Nggwenyama has appointed a Minerals Committee to advise him on the granting of prospecting rights and mining leases. The Commissioner of Mines acts in an advisory capacity to this committee.

119. At the first meeting of the Minerals Committee it was agreed that all applications for mining leases or prospecting rights would be made in the first instance to the Commissioner of Mines who would be responsible for the transmission of these applications to the Minerals Committee, together with his recommendations.

120. At the end of the year, 20 applications were still under consideration.

(b) MINERAL STATISTICS AND EXPORTS

121. The mineral production figures for the year ending 31st December, 1968, are given in the table Appendix II) on page 32 of this report together with those for 1967 for comparison purposes.

122. The value of mineral production during the year rose once more to a new record figure with all minerals, with the exception of pyrophyllite, showing a gain. Value rose by R811,170 to R18,277,297.

123. Over half the increase was due to greater sales of iron ore, production of which rose by 338,292 short tons to 2,260,196 short tons valued at R11,828,372.

124. Asbestos also reached new record levels with the production of 42,946 short tons of fibre of all grades valued at R6,045,677, an increase of R187,649, the first time that this has topped the R6 million mark.

125. The coal industry has increased exports of coal considerably and more than maintained sales in the home market. Production has increased by 12,349 short tons to 106,692 short tons valued at R248,961.

126. The increase in building and construction work has resulted in a considerable increase in the production of quarry stone, which now comes fourth in the order of value of mineral production. A total of 48,577 cubic yards of stone was sold during the year valued at R116,399.

127. There have been steady sales of crude kaolin throughout the year which have brought about a modest increase in production. Sales of 2,364 short tons were valued at R23,356.

128. Production of barytes has also improved after a considerable amount of underground development. Sales improved by 356 short tons to 979 short tons valued at R11,482.

129. Production of pyrophyllite remained steady and showed a small drop of 20 short tons compared with the previous year. Sales of 640 short tons were valued at R3,050.

130. Once again no tinstone or gold was mined during the year.

(c) INSPECTIONS

131. The following visits were made by the Inspector of Mines to mines and quarries as well as to explosives and anti-hail rocket magazines in his capacity as Inspector of Explosives.

Purpose of visit	*No. of visits*
Routine inspection of mines and quarries	34
Inspection of explosives and rocket magazine	15
Miscellaneous	20
Accident enquiries (serious and fatal)	6

(d) LICENCES AND PERMITS

132. The following licences and permits were issued during the year:—

Type of licence or permit	*No. issued*
To purchase explosives locally	62
To import explosives	44
Blasting	15
Explosives or rocket magazines	Nil

(e) ACCIDENTS

133. Accidents in mines and quarries which cause an injured person to be absent from work for three or more days are reportable to the Inspector of Mines.

134. The following mining accidents (as distinct from machinery accidents on a mine) were reported during the year:—

Fatal	*Non-fatal*	*Non-casualty*	*Total*
6	172	—	178

135. The location of the various injuries received may be classified as follows:–

Location of injury	(*a*)	(*b*)	(*c*)
Arms, hands or fingers	2	—	79
Legs, feet or toes	1	—	53
Eyes	—	—	11
Body or head	—	—	32
Total	3	—	175

In this table:– (a) indicates loss of member
(b) indicates loss of use of member
(c) indicates injury to member

The above accidents may be further classified by cause as follows:–

Cause of accident	*No. of accidents*
Fall of ground	31
Fall of material	14
Transport of material	22
Travelling by ladderway	—
Falling and slipping	24
Splinters	5
Burning and scalding	1
Loading by hand	3
Explosives	4
Sundry and minor	74
Total	178

136. The total time, in shifts, lost as a result of accidents is given below, with similar statistics for 1967 for comparison purposes:–

Total No. of shifts lost		*Average shifts lost per accident*		*No. of accidents*	
1967	1968	1967	1968	1967	1968
1,848	3,284	13.7	18.45	135	178

137. The increase in fatal and other accidents gives rise for considerable concern, as does the increasing severity of each accident as shown by the rise in the average shifts lost per accident. It may be no more than coincidental that the increase comes during a year when localisation in the mining industry has been accelerated. The situation during the coming year will have to be watched very carefully. Additional safety training is obviously called for despite already great efforts made in this direction by some of the mining companies.

(e) LABOUR

138. A summary of the labour employed in the mining industry in Swaziland is given in the table (Appendix IV) on page 34 of this report. Total earnings in the mining industry increased by R164,359 during the year to a total of R2,063,200. Earnings have thus doubled in the five year period 1964 to 1968. The average monthly earnings of all employees in the mining industry increased from R51.9 in 1964 to R70.7 in 1968. The number of employees increased from 20,034 in 1964 to 29,147 in 1968.

IV. MACHINERY DEPARTMENT

(a) INSPECTIONS

139. Four working mines came under statutory inspection, on surface and underground at Havelock mine and Mpaka colliery, and on surface only at the Ngwenya and Swaziland Barytes Limited mines.

140. Forty-five premises used as factories or containing plant and machinery came under inspection. New installations falling under this head were a sweet factory, a grinding mill for producing cement, and a factory for making cardboard packaging; the latter two had not started production at the end of the year. All these installations are situated at the Matsapha industrial area.

141. Fifty working steam boilers were registered and in regular use at the end of the year, all having received the statutory examinations and tests.

142. A number of pressure vessels were also inspected with the result that some replacements and repairs were effected under supervision and certification.

143. New safety regulations dealing with the operation of machinery at works, mines and quarries await promulgation.

(b) ACCIDENTS

144. Accidents at mines (not mining) involving lost time of three days or more which were reported are shown in the following table. There were no fatal machinery accidents at mines.

Classification	*No.*	*Location of injury*	*No.*
Machinery	1	Arms, hands, fingers	6
Loading	2	Legs and feet	4
Burns	1	Head and body	1
Sundry	7		
Total	11	Total	11

145. The number of accidents involving machinery at mines decreased from 20 in 1967 to 11 in 1968. The number of shifts lost in 1968 totalled 156 as compared to 163 in 1967, with the result that the average number of shifts lost per accident increased from 8.15 in 1967 to 14.2 in 1968.

146. All accidents reported in factories or premises containing machinery were scrutinized for cases requiring further action or inquiry, and after classification were passed to the Labour Commissioner for his statistics and incorporation in his annual report.

147. Four fatal accidents occurred (as compared with one in 1967) in factories or at works and were duly investigated in terms of the Mines, Works and Machinery Proclamation and also for the purposes of the Inquests Proclamation.

148. The fatal accidents were the result of:–

(i) A painter falling off an overhead gantry while not wearing a safety belt issued to him;

(ii) A cleaner being trapped in a cane intercarrier which was started without the knowledge that he was working inside;

(iii) A labourer falling a short distance from a ladder which slipped onto an asbestos cement roofing sheet which fractured causing him to fall through to a cement floor forty feet below;

(iv) A linesman's labourer falling off a portable ladder which swayed out of the control of several men supporting it on the ground.

149. Recommendations were made to managements where improved safety precautions could have prevented accidents whether of a fatal or non-fatal nature.

V. HEADQUARTERS

(a) DRAWING OFFICE

150. The drawing office staff prepared two maps on a scale of 1:250,000 for colour printing on behalf of the Census Commissioner and a further 12 line drawings were completed for incorporation in the Census Report.

151. Work continued on the 1:25,000 series maps of the Swaziland System, the first sheet being completed in August. Comprising 10 colours and 32 tints, this sheet presented many difficulties and it was decided, after consultation with the lithographers, to invest in a set of scribing instruments in an endeavour to speed up the production of subsequent sheets. The second sheet which is already under way is being carried out by this method and the hoped for improvements are already noticeable.

152. During the year under review normal departmental drawings, including those for the United Nations Development Programme Mineral Survey, totalled 106 and a further 162 profiles showing geophysical data were prepared.

153. The printing machine was again extremely active and a total of 3,092 was produced. The filing space provided when the present building was erected is now almost full, and serious consideration will have to be given next year to alternative storage space.

(b) LABORATORY

154. In the geochemical laboratory, under Mr. M. Sobey, Geochemical Analyst, 34,891 determinations on samples were made for the following elements:–

Arsenic	17,592
Antimony	7,187
Copper	7,165
Nickel	660
Cx Ni	1,193
	34,891

In addition checks and statistical series determinations were made.

155. The laboratory is also equipped with an electro-magnetic separator and a Wifley table. The X-ray machine is now obsolete and is potentially dangerous to the operator. It has in consequence been boarded.

156. Several hundred thin sections of rocks are prepared each year by the technical assistant (Mr. R. Cindzi) who is also responsible for the storage of rock samples collected during field work. Adequate storage is becoming a serious problem.

157. Three hundred and three samples were assayed as follows:–

Gold	303
Nickel	6
Copper	1

All but 17 of these assays were carried out on samples collected during the course of trenching or drilling as part of the follow-up programme to the United Nations Development Programme, Mineral Survey geochemical survey. All assays are done by a commercial bank in Johannesburg.

(c) LIBRARY

158. The Departmental library has a satisfactory coverage of material dealing with geology, mining and machinery. The shortage of adequate storage room becomes a more serious problem each year as additional volumes, periodicals and reprints are received. Mr. J. G. Urie undertook a major re-organization of the library, assisted by Mrs. N. Dlamini who has been given some preliminary training in library duties.

159. In addition to the purchase of text-books the library receives publications and reprints on exchange from most of the Geological Survey and Mines Departments in Africa and also from many countries in North and South America, Western Europe and Australia.

160. The library receives by subscription some of the most important geological and mining journals published in Africa, Western Europe and America.

161. The necessity of maintaining an adequate reference library is an essential part of the efficient operation of the Department for it enables the professional officers to keep abreast of the latest developments in all branches of geology and mining.

(d) PUBLICATIONS

162. The following reports and maps published during the year:–

(i) Annual Report of the Geological Survey and Mines Department for the year ending 31st December, 1967.

(ii) Geological Map 1:25,000 Series, Sheet I, Hhohho.

(iii) Geological Map 1:50,000 Series, Sheets 2631 AD(12), 2631 BC(13), 2631 DA(19), 2631 CD(24) and 2771 BA(30).

(iv) Explanatory Notes for 1:50,000 Geological Maps Sheet 2631 DA(19).

165. A paper on the Usushwana Complex was prepared by Dr. D. R. Hunter at the request of the organizers of the Symposium on Layered Intrusives to be held in Pretoria during July, 1969.

166. A further paper by Dr. D. R. Hunter on the occurrence of an assumed glacial valley in southern Swaziland was accepted for publication by the Geological Society of South Africa.

D. R. HUNTER
Acting Director of Geological Survey and Commissioner of Mines.

Mbabane
April, 1969

APPENDIX I

STAFF LIST

AS AT 31ST DECEMBER, 1968

Establishment	*Designation*	
1	Director of Geological Survey/ Commissioner of Mines	D. R. Hunter, Ph.D., M.Sc., F.G.S., M.I.M.M. (acting).
1	Senior Geologist	J. G. Urie, M.Sc. (acting)
3	Geologists	D. H. Jones, B.Sc., F.G.S., A.M.I.M.M.
		R. P. Edwards, M.Sc.
		A. S. Dlamini, B.S.
1	Geologist/Geophysicist	Vacant
1	Inspector of Mines	D. A. C. Purser, M.B.E., A.C.S.M., A.M.I.M.M.
1	Inspector of Machinery	T. G. Blofeld, E.D., A.M.I.Mech.E., A.M.I.E.E.
1	Drilling Superintendent	D. Horn, M.B.E.
2	Drillers	R. A. M. Myburgh
		J. Motha
1	Supernumerary Driller	P. Gama
1	Senior Draughtsman	C. Matthews
2	Draughtsman/Draughtswoman	S. Dry
		Miss E. Macpherson
1	Geochemical Analyst	M. D. H. Sobey
1	Senior Accounts Officer	W. Mhlotha
1	Personal Secretary	Miss J. White
2	Typists	Miss A. Mpungose Mrs. N. Dlamini
4	Driver/Operators	4
21	Technical Assistants	17 Vacant (4)
3	Messengers	3

APPENDIX II

MINERAL PRODUCTION FOR 1968

MINERAL	*1967*		*1968*		*Increase*		*Decrease*	
	Short tons	*R*	*Short tons*	*R*	*Short tons*	*R*	*Short tons*	*R*
Iron ore	1,921,904	11,320,782	2,260,196	11,828,372	338,292	507,590	—	—
Chrysotile asbestos	40,154	5,858,028	42,946	6,045,677	2,792	187,649	—	—
Coal	85,938	184,223	106,692	248,961	20,754	64,738	—	—
Quarry stone	31,053*	75,071	48,577*	116,399	17,524*	41,328	—	—
Kaolin	2,050	18,695	2,364	23,356	314	4,661	—	—
Barytes	623	6,028	979	11,482	356	5,454	—	—
Pyrophyllite	660	3,300	640	3,050	—	—	20	250
Totals	—	17,466,127	—	18,277,297	—	811,420	—	250

*Cubic yards

APPENDIX III

MINERAL EXPORTS, 1968

Mineral	*Country to which Exported*	*Short Tons*	*Value R*
Chrysotile Asbestos	Belgium	4,250	640,900
	Denmark	600	70,320
	France	750	113,100
	Ireland	1,810	303,916
	Norway	600	70,320
	Republic of South Africa	4,904	515,985
	United Kingdom	29,872	4,320,464
	Zambia	160	10,672
Barytes	Republic of South Africa	979	11,482
Coal	Mocambique	Not available	44,364
	Kenya		50,362
Iron Ore	Japan	2,260,196	11,828,372
Kaolin	Republic of South Africa	2,364	23,356
Pyrophyllite	Republic of South Africa	640	3,050

APPENDIX IV

LABOUR STATISTICS

	SKILLED					UNSKILLED							TOTALS		
Month	*Below Surface*	*On Surface*	*Total*	*Earnings* R	c	*Below Surface*	*On Surface*	*Total*	*Earnings* R	c	*Value of food* R	c	*Total Labour*	*Total earnings and food* R	c
January	31	185	216	70,624	04	688	1,389	2,077	76,861	21	15,760	00	2,293	163,245	25
February	31	192	223	73,951	34	706	1,454	2,158	79,353	39	14,787	00	2,381	168,091	73
March	31	193	224	72,770	15	709	1,443	2,152	77,752	70	14,438	97	2,376	164,961	82
April	31	184	216	76,918	59	720	1,431	2,151	82,327	40	15,256	00	2,367	174,501	99
May	32	180	212	66,222	93	735	1,511	2,246	77,761	59	14,388	60	2,458	158,373	12
June	31	185	216	80,752	60	744	1,459	2,203	74,994	64	14,947	40	2,419	170,694	64
July	31	183	214	88,884	78	739	1,454	2,193	73,127	83	14,877	60	2,407	176,890	21
August	30	189	219	76,415	97	745	1,465	2,210	78,245	13	14,467	42	2,429	169,128	52
September	29	188	217	83,303	45	743	1,478	2,221	77,211	34	2,438	34	2,438	176,200	85
October	27	182	209	75,148	40	770	1,539	2,309	88,933	17	14,999	97	2,518	179,081	54
November	30	195	225	76,160	44	752	1,557	2,309	86,720	40	15,020	77	2,534	177,901	61
December	32	196	228	80,421	78	735	1,546	2,299	88,856	01	14,851	00	2,527	184,128	79
TOTALS	366	2,252	2,619	921,574	47	8,802	17,726	26,528	963,144	53	178,481	07	29,147	2,063,200	07

APPENDIX V

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDING DECEMBER, 1968

B.H. No.	*Depth feet*	*Formation*	*Locality*	*Remarks*
316	951	Chert, serpentinite, lavas	Mineral Concession 41M	Drilled on behalf of Mineral Holdings Limited
317	491	Sandstone and dolerite	Mineral Rights Swazi Nation	Geophysical anomaly
318	315	Amphibolite	S.N.L.10	Geophysical nomaly
319	531	Serpentinite, amphibolite and schist	Farm 21P	Makwanakop asbestos
320	232	Amphibolite	Farm 21P	Makwanakop asbestos
321	335	Pyroxenite	S.N.L.10	Geophysical anomaly
322	398	Amphibolite and serpentinite	Farm 21P	Makwanakop asbestos
323	154	Gabbro	S.N.L.10	Geophysical anomaly
324	363	Phyllite and chert	Farm A 17/P	Geophysical anomaly
325	802	Serpentinite and amphibolite	Farm A 17/P	Forbes Reef Gold Mine
326	536	Iron and shale	Farm A 2/5	Ngwenya Mountain
327	395	Serpentinite and amphibolite	Farm A 17/9	Forbes Reef gold
328	200	Sandstone	Farm 704	Water borehole Ehlane
329	220	Basalt	Farm 704	Water borehole Ehlane
330	110	Talc schist	Farm 3/5P	Geochemical anomaly
331	152	Quartzite	Farm 2/5P	Geochemical anomaly
332A	40	Dolerite	Farm 704	Water borehole Ehlane
332B	142	Basalt	Farm 704	Water borehole Ehlane
333	200	Sandstone	Farm 704	Water borehole Ehlane
334	270	Talc schist and quartzite	S.N.L.2	Geochemical anomaly
TOTAL	6,837			

APPENDIX VI

LIST OF UNPUBLISHED REPORTS
by the Professional Staff

DRH/1/68	Note on drilling results at Otandweni, Lubombo District.
DRH/2/68	An estimation of drilling costs to explore the Upper Coal Zone.
DRH/3/68	Review of progress of geological knowledge in Swaziland since 1960.
DRH/4/68	The Geological Survey and Mines Department (prepared for Principal Information Officer for inclusion in brochure on Swaziland).
DRH/5/68	Note on Swaziland mineral resources.
DRH/6/68	Note on further drilling programme at the asbestos prospect, Usushwana valley, Hhohho District.
JKW/1/68	Geological/geophysical survey for a water borehole site for Mlindazwe -Siboteleni area, Stegi, Lubombo District.
JKW/2/68	Geological/geophysical survey for a water borehole site on Tempest Estate, Dwaleni, near Goedgegun, Shiselweni District.
JKW/3/68	Geological/geophysical survey for a water borehole site on Messrs D. A. Beale and A. H. B. Child's farm, Ezulwini, Hhohho District.
JKW/4/68	Geological/geophysical survey for a water borehole site at Manzini Estates, Manzini District.
JKW/5/68	Geological/geophysical survey for water borehole sites on Mr. J. K. Manana's farm, Sifutaneni, Lubombo District.
JKW/6/68	Note on electro-magnetic and magnetic survey at Makwane, Hhohho District.
RPE/1/68	Report on the geology and geochemistry of Location 23 — Maliwe, Hhohho District.
RPE/2/68	Report on the results of geochemical reconnaissance sampling on sheet 2 (areas A and B), Hhohho District.
RPE/3/68	Report on the results of geochemical reconnaissance sampling on sheets 1 and 2 (areas C and B), Hhohho District.
RPE/4/68	Preliminary report on geochemical sampling Location 71. Hhohho District.
RPE/5/68	Preliminary Report on the results of geochemical sampling on Location 73, Hhohho District.

APPENDIX VII

LIST OF MAPS AND DIAGRAMS
prepared by the Draughting Office

No.	*Title*	*Scale*	*Author*
783	Diagram showing ownership of surface in respect of Mineral Concession No. 41	1:50,000	D.A.P.
784	Section through B.H.'s 315 and 317 with sketch geology, Otandweni	1:2,500 1:50,000	D.R.H.
786	Water borehole sites (Swaziland) (plotted on 1:50,000 topo. sheets)	1:50,000	J.K.W.
787	Location of Mines — Swaziland	1:50,000	D.R.H.
788	Magnetic Survey, Makwane area	1:4,800	J.K.W.
788A	Overlay Anomalies for Drawing 788	1:4,800	J.K.W.
789	Magnetic Survey, Makwane Area	1"—100 ft.	J.K.W.
790	Sampling of Trenches at Location 52	1:250	J.G.U.
791	Geology of Hhohho Area	1:25,000	D.H.J.
792	Density of Population (Census)	1:250,000	H.M.J.
793	Asbestos prospect, Usushwana Valley, Borehole Sections Projected Borehole Data	 1:500 1:1,000	 D.R.H.
794	Data Sheets, with yields of Water Boreholes (key to Sheet 795)	—	J.K.W.
795	Water Borehole Site Plans (Swaziland)	1:50,000	J.K.W.
796	Location 54 (Trench Plan)	1:100	D.R.H.
797	Key to Published Geological Sheets	1:500,000	C.G.M.
798	Swaziland Barytes Mine, Underground Workings Boreholes and surface Triangulation	1:200	D.A.C.P.
799	Geology of the Usushwana Complex (Mhlambanyati Area)	1:50,000	E.P.W.
800	Distribution of the Usushwana Complex in Swaziland	1:100,000	D.R.H.
801	Diagram to Accompany Above Plans		D.R.H.
803	Diagram showing Boundaries of Mineral Concession No. 29	1:50,000	D.A.C.P.
804	Departmental Organisation and Responsibilities	—	D.R.H.
805	Western Magnetic Horizon, Location 1, Mhlataan, Pigg's Peak	1:5,000	J.G.U.

APPENDIX VII Continued

LIST OF MAPS AND DIAGRAMS
prepared by the Draughting Office

No.	*Title*	*Scale*	*Author*
806	Western Magnetic Horizon, Location 1, Mhlataan, Borehole Section	1:2,500	J.G.U.
807	Explosives Magazine Design		D.A.C.P.
808	Distribution of Ancient Gneiss Complex	1:50,000	D.R.H.
809	Diagrams A, B, C, D and E (to Accompany Report on Ancient Gneiss Complex)	—	D.R.H.
810	Table III Mineral composition and Optical Properties, Ancient Gneiss Complex	—	D.R.H.
811	Table I Mineral Composition and Optical Properties, Ancient Gneiss Complex	—	D.R.H.
812	Table II Modal Analyses, Ancient Gneiss Complex	—	D.R.H.
813	Table IV Chemical Analyses, Cation Percentages, Norms and Niggli Values	—	D.R.H.

APPENDIX VIII

LIST OF PUBLICATIONS

SPECIAL REPORTS

1. The Haematite Deposits, Mineral Concession No. 41, Northwestern Swaziland, by A. T. M. Mehliss, 1946 (out of print).
2. Mineral Ownership as Effecting Mineral Development in Swaziland by H. J. R. Way, 1949 (price 75 cents).
3. The Bomvu Ridge Haematite Deposits, C. M. A. No. 7, Mbabane District, by D. N. Davies and J. G. Urie, 1955, (price R1.50).

BULLETINS

Bulletin No. 1 (1961, price R2.00) containing:–

(i) The Results of Eighteen years Organized Geological Work in Swaziland by H. J. R. Way.

(ii) The Zones of the Ecca Series, Karro System in Swaziland by D. N. Davies.

(iii) The Trend of Mineral Production in Swaziland from 1907 to 1960 by D. A. C. Purser.

(iv) The Geological Evolution of Swaziland during the Precambrian by D. R. Hunter.

(v) Notes on the Jamestown Complex, northwestern Swaziland by J. G. Urie.

(vi) The Geology of a Portion of the Country between Mankaiana and Hlatikulu, Mankaiana District by A. T. M. Mehliss.

(vii) The Geology of a Portion of the Country between the Komati and Usushwana Rivers, Northwestern Swaziland by D. A. Pretorius.

(viii) The Karroo System sediments of Eastern Swaziland by J. L. Scogings and C. J. Lenz.

(ix) Radiometric Survey as an Aid to the Geological Mapping of the Ancient System in Swaziland by H. J. R. Way.

(x) Major Strucures in Swaziland by H. J. R. Way.

Bulletin No. 2 (1962, out of print). The Mineral Resources of Swaziland.

Bulletin No. 3, (1963, price R3.00) containing:–

(i) The Mozaan Series in Swaziland by D. R. Hunter.

(ii) The Geology of the Malatotsha Valley by D. H. Jones.

(iii) The Geology of the Stormberg Volcanics by J. G. Urie and D. R. Hunter.

(iv) The Geology of the Gold Mines and Prospects at Horo, Pigg's Peak District by D. R. Hunter and D. H. Jones.

Bulletin No. 4, (1964, price R3.00) containing:–

(i) The Alumina, Pyrophyllite and Silica Deposits in the Insuzi Series, Mahlangatsha and Mkopelele Areas, Shiselweni and Manzini Districts by D. N. Davies, J. G. Urie, D. H. Jones and P. E. Winter.

(ii) Pyrophyllite occurring in the Mozaan Series by J. G. Urie.

(iii) Two Sillimanite-bearing Zones occurring on Lapsed Mineral Concession No. 50, Mahlangatsha Area, Manzini District by D. H. Jones.

(iv) The Kaolin Deposits, Mahlangatsha, Manzini District by D. R. Hunter and J. G. Urie.

(v) The Mhlosheni Fluorspar Prospect, Mineral Concession No. 31, Shiselweni District by J. G. Urie.

(vi) The Nickel and Tungsten Mineralization at Forbes Reef by D. N. Davies.

Bulletin No. 5, (1965, price R3.00). The Usushwana Igneous Complex by P. E. Winter.

Bulletin No. 6, (1966, price 75 cents) Analyses of Rocks, Minerals, Ores and Water.

SHORT REPORTS IN ANNUAL REPORTS

Part II of Annual Report for 1958 (price 30 cents).

(i) An Occurrence of Chrysotile Asbestos, Mineral Concession No. 25, Mbabane District by D. R. Hunter.

(ii) Recent Coal Investigations on Crown Mineral Area No. 27, Stegi District by D. R. Hunter.

(iii) Some Recent Investigations on Stormberg Volcanics by D. R. Hunter and J. G. Urie.

(iv) The Ngwavuma Gravels, Maloma Area, Hlatikulu District by J. G. Urie.

(v) Cinnabar Prospect, Mineral Concession No. 41, Pigg's Peak District by J. G. Urie.

Part II of Annual Report for 1959 (out of print)

(i) The Geology of the Wyldsdale Ridge Gold Mine, Mineral Concession No. 51, Pigg's Peak District by D. R. Hunter.

(ii) The beryl-cassiterite-bearing Pegmatites of the Sinceni Area, Hlatikulu District by J. G. Urie.

(iii) Mhlosheni Fluorspar Deposit, Mineral Concession No. 31, Hlatikulu District by J. G. Urie.

Part II of Annual Report for 1960 (price 35 cents).

(i) Copper-Nickel Mineralization in the Usushwana Complex by D. R. Hunter and P. E. Winter.

(ii) Notes on the Swaziland System and Jamestown Igneous Complex with Particular Reference to the Area between the Komati River and Havelock and Pigg's Peak Mines by J. G. Urie.

ANNUAL REPORTS

(i) Government Geologist for 1942 and 1943 (both out of print).

(ii) Geological Survey Department for years 1944 (out of print), 1947 (out of print), 1948 (price 15 cents), 1949 (price 20 cents), 1950 (price 30 cents), (1951 (price 30 cents), 1952 (price 25 cents), 1953 (price 30 cents), 1954 (price 30 cents), 1955 (price 30 cents), 1956 (price 30 cents), 1957 (price 30 cents).

(iii) Progress Report of the year 1945 and 1946 (price 50 cents).

(iv) Geological Survey and Mines Department for the years 1958 (30 cents), 1959 (out of print), 1960 (price 35 cents), 1961 (price 35 cents), 1962 (price 50 cents), 1963 (price 50 cents), 1964 (price 50 cents), 1965 (price 50 cents), 1966 (price 50 cents), 1967 (price 50 cents).

MAPS

(i) Geological Map of Swaziland Scale 1:125,000 1959 (price R6.30). Explanation of above Map entitled The Geology of Swaziland, 1960 (price R2.00).

(ii) Geological Map of Swaziland Scale 1:250,000, 1966 (price R1.00).

(iii) 1:50,000 Geological Maps with Explanatory Notes (price 35 cents each).

Sheet 2531 CD (2) 1966
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(iv) 1:25,000 Geological Map Series (price R1.50 each), (No Explanatory Notes).
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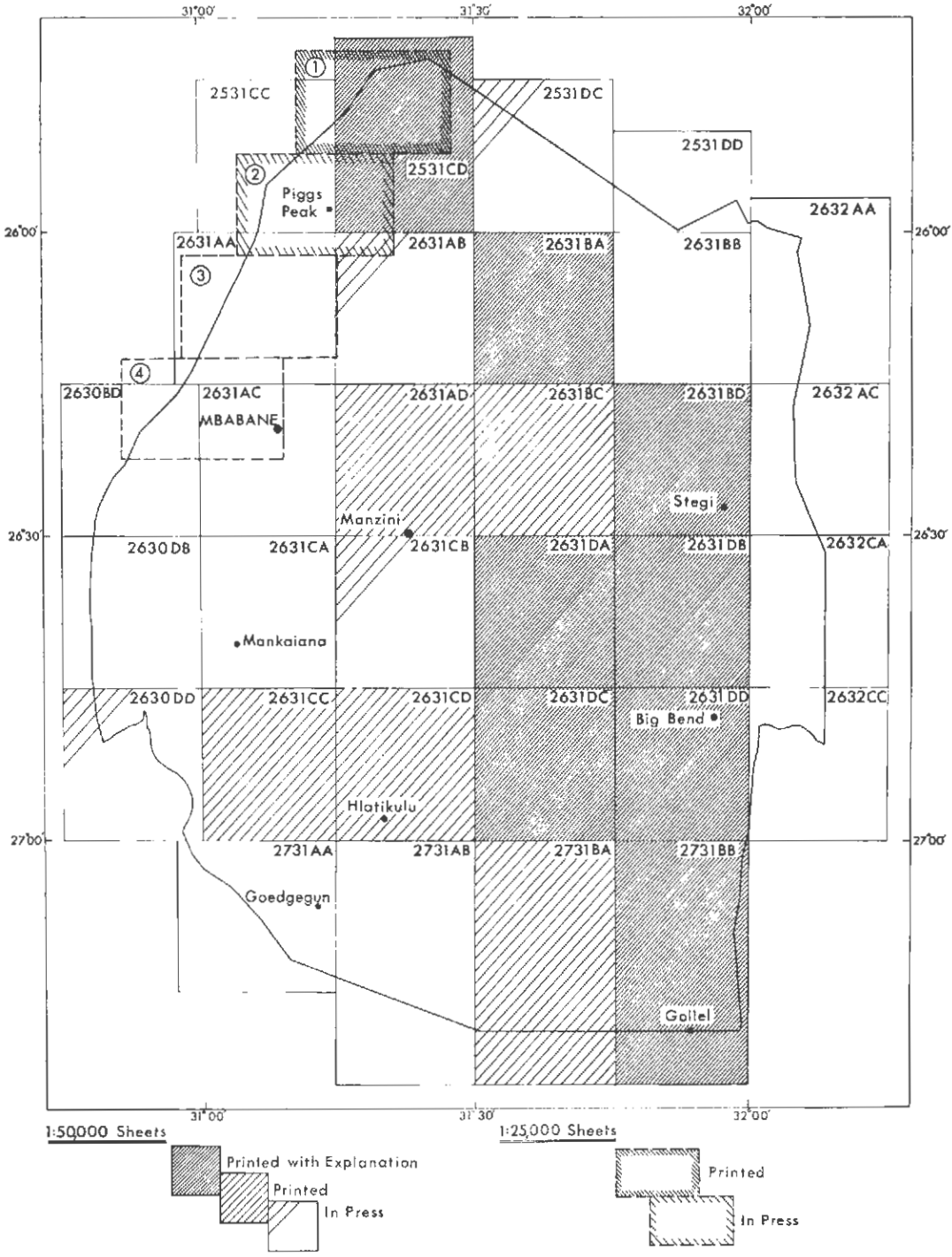

SWAZILAND

ANNUAL REPORT

of the

GEOLOGICAL SURVEY AND MINES DEPARTMENT

FOR THE YEAR ENDED
31ST DECEMBER 1966

PRICE — 50c (5/–)

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Senior Geologist	D. R. HUNTER, M.Sc., (Lond.), F.G.S., M.G.S., (S.A.).
Geologist	J. G. URIE, M.Sc., (Rand.) B.Sc., (Hons.), (Rhodes), M.G.S., (S.A.).
Geologist	D. H. JONES, B.Sc., (Hons.), (Wales), F.G.S., (Lond.), M.G.S., (S.A.).
Geologist	R. P. EDWARDS, M.Sc., (Leeds), B.Sc., (Hons.), (Leeds).
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Inspector of Machinery	T. G. BLOFELD, E.D., A.M.E. Mech.E., A.M.I.E.E.
Drilling Superintendent	D. HORN, M.B.E.
Diamond Driller	R.A.M. MYBURGH.
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Draughtswoman	MISS E. M. MACPHERSON.
Personal Assistant	MISS J. WHITE.
Accounts Assistant	MRS. B. M. BAIN.
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Typist	MISS A. MPUNGOSE.

II. INTRODUCTION

During the course of the visit of Mr. Stonehouse, M.P., Parliamentary Under Secretary of State, the Director accompanied Mr. Stonehouse and Her Majesty's Commissioner, Sir Francis Loyd, K.B.E., O.B.E., on a tour of the Ngwenya iron ore mine.

2. In April, Mr. D. R. Hunter, Senior Geologist, represented the Territory at the congress of the African Geological Survey Association in Tunis.

3. Mr. Beggs, geologist, resigned in February. This post was filled by the appointment of Mr. R. P. Edwards who arrived in the Territory in November. Following the resignation of Miss S. Harvey, stenographer, Mrs. M. Richards was appointed to the post.

4. The learner draughtsman, Mr. A. Vilakazi proceeded on a two year scholarship to Canada in early October.

5. Mr. R. B. Evans, geophysicist, arrived in September on secondment from the Overseas Division of the Institute of Geological Sciences to assist with the ground follow-up geophysical operations following the completion of the airborne magnetometer and scintillometer flying programme.

6. Mr. A. Hatton, Project Manager, of the United Nations Special Fund Project arrived in the Territory in March. In November, Mr. M. Baker, geochemist to the United Nations project, was appointed.

7. In February and August, the Director visited the Geological Survey of the Republic of South Africa for discussions on matters of mutual interest.

8. The Director also paid a visit to Bechuanaland in April in connexion with the investigation of water supplies in Swaziland. Basutoland also was visited to advise on the establishment of a mining section. The Director and Mr. Hunter attended a geophysical seminar in Johannesburg in October.

9. As in previous years Dr. Snelling of the Age Determination Unit, Oxford, Professor Nicolaysen and Dr. Allsopp of the Bernard Price Institute, Johannesburg assisted most materially with age determinations. This assistance is sincerely acknowledged.

10. At the request of His Excellency, Sir Francis Loyd, K.C.M.G., O.B.E., a visit was paid in November to underground workings of the dormant Pigg's Peak gold mine in the company of the Inspector of Mines, Mr. Purser, the District Commissioner, Mr. Simkin and the District Officer, Mr. Sibanyoni.

11. Mr. R. Davies, a research student at the Bernard Price Institute was awarded a one-year fellowship by the Government of Swaziland for work on the geochronology of gneisses and granites of Swaziland. The initial results of this work are discussed elsewhere in the report.

III. GEOLOGICAL SURVEY

Regional Survey

12. An area of 28 square miles was mapped on a scale of 1:10,000 by Mr. D. H. Jones in the rugged terrain of northwestern Swaziland.

13. Mr. Urie mapped 15 square miles to the south of the Ngwenya mine on a scale of 1:10,000. A sequence of hornblendic schists derived from mafic lavas, siliceous meta-sediments, and tremolitic, chloritic and talcose schists underlie much of the terrain. One extensive and numbers of small bodies of serpentinite are present. The above-mentioned rocks are invaded by a late-orogenic granite represented by a sodic phase and a later potassic phase.

[A] BY D. R. HUNTER — SENIOR GEOLOGIST

14. The writer was on duty from January to the end of October.

Asbestos

15. The presence has been known for many years of chrysotile asbestos in serpentinite outcropping on the watershed between the Usushwana and Motshane Rivers. In 1949 and 1950, surface prospecting was carried out with disappointing results and a borehole was drilled which provided little additional information as core recovery was poor. In 1949, the area was mapped and it was suggested that such asbestos as may be present was likely to be found in a zone of dislocation striking nearly parallel to the foliation of the serpentinite. Four boreholes were sited along 800 feet of strike with the intention of intersecting this zone at depths of about 150 feet below surface. All four boreholes intersected a fibre-bearing zone which varied in true width from 15 to 45 feet. The start of the fibre bearing zone was marked by two or three veinlets of cross-fibre, each up to $\frac{1}{2}$ inch wide and followed by a complex stockwork of fibre seams usually not exceeding $\frac{1}{8}$ inch in length. Core recovery in the fibre-bearing serpentinite varied between 75 to 80 per cent, the best recovery being obtained in borehole No. 279. Through the co-operation of the management of Havelock mine, tests were conducted on the core from this borehole to evaluate the content and quality of the fibre. Their results showed that the content of fibre amounted to 1.2 per cent. The results of the Quebec box test were as follows:—

OZ on 1st screen	OZ on 2nd screen	OZ on 3rd screen	OZ in bottom box	— 50% mesh
Nil	trace	9.2	6.8	2

16. Visual examination of the cores indicated that this result can be taken as representative of the fibre-bearing zone. The results show that the quantity of fibre is not sufficient to warrant exploitation.

Barytes

17. At the request of the owners of Swaziland Barytes Limited, seven boreholes were drilled in the waterfall area of their property. In addition one inclined and two vertical boreholes were drilled, without charge, to assist in the assessment of the economic potential of the deposit.

18. Boreholes have been drilled at this property in the past but these were all sited to intersect the barytes zone at considerable depths. The present programme was designed to explore the barytes at depths of up to 200 feet down dip. The waterfall area was selected because deeper holes drilled in this area indicated the presence of thicker blows of barytes.

19. Barytes veinlets are located in a silicified shear zone which dips conformably with the foliation of the overlying quartz-biotite gneisses and the underlying quartz-amphibole gneisses. The zone of silicification is variable but has not been fully examined. Previous boreholes drilled through the zone indicate widths up to 60 feet. However, the best development of barytes veins is confined to the top 30 feet. A distinct lineation directed N 70° (magnetic) can be observed on the foliation planes in the shear zone. A general sequence in the topmost portion of the shear zone was established as follows:—

(i) Highly lenticular but pure barytes vein.

(ii) Intermediate zone with irregular lenses of barytes.

(iii) Lower zone in which the barytes veins are more continuous and in which upper and lower veins are developed. Usually only one of these veins is developed.

20. It was concluded from the drilling results that there is a possibility that the economically exploitable blows of barytes are developed in shoots aligned parallel to the lineation on the foliation planes. This hypothesis requires testing.

21. Ore reserves were calculated on this assumption, and the barytes in the top and intermediate zones ignored because of their extremely erratic nature. Thus the total reserves of barytes in the waterfall area in the lower zone comprising the upper and lower lenses is as follows:—

Semi-proven	6,800 tons
Probable	9,000 tons
	15,800 tons

22. Soon after this work was completed a large blow was exposed at the southern end of the property. Two boreholes were drilled to intersect the barytes zone at 100 to 200 feet down dip respectively. Both boreholes were unsatisfactory in that core recovery, due to the weathered nature of the gneisses, was poor. Barytes of good quality was intersected in both cases. Surface exploration revealed that the economically exploitable barytes has a strike length of 70 feet, which is approximately half the width of the waterfall shoot. Again a lower zone of more consistent barytes was recognized with irregularly developed lenses of barytes above it. The lower zone has an average width of 68 inches in which the minimum percentage of barytes intersected in the boreholes is 55½. Reserves have been calculated for this shoot as follows:—

Semi-proven	6160 tons
Probable (a further 125 feet down dip)	3080
	9240

Coal

23. When the coal-bearing strata were being explored ten years ago a line of boreholes was drilled across the strike. If the main seam was not intersected within 500 feet drilling was stopped. However, a borehole on the Mtendekwa River penetrated the main seam at a depth of over 1,000 feet. Analysis showed that the main seam became a true anthracite at this depth. It was decided to deepen borehole Nos. 83 and 84 in an endeavour to locate anthracitic coal east of and adjacent to the Swaziland Railway line. A third borehole was drilled one mile to the northwest of borehole No. 83. In all three boreholes the position of the main seam was occupied by a dolerite sheet at least 100 feet thick. In boreholes Nos. 83 and 84 the upper marker seam was intersected, but analyses show that it has a high ash content and is, therefore not of sufficiently high quality to warrant exploitation at these depths. In borehole No. 283 the upper marker seam horizon is occupied by dolerite. This drilling indicates that a large area south of the old road from Manzini to Stegi contains no coal of commercial value. It is not known how far to the south the dolerite sheet occupies the position of the main seam. The analyses of the upper marker seam are as follows:—

B.H.	Depths	Float Yield at 1.58	Cal. Val. lbs/lb.	H_2O %	Ash %	Vol. Mat. %	Fixed C%	A.F.T. °C
83	789′ 9″ 794′ 11″	86.0	12.64	1.0	18.8	8.2	72.0	1,300
84	1026′ 9″ 1031′ 9″	86.6	12.67	1.3	17.7	7.2	73.8	1,260

24. The owners of mineral concession No. 37 (portion 3) decided to examine the potential of the coal reserves on their concession immediately south of the Usutu River. Much of the concession is covered by a large dolerite sheet but it is possible that coal-bearing strata lies beneath this sheet. Drilling commenced in October.

Usushwana Valley

25. Geophysical investigations in the area around the asbestos prospect on the Motshane-Usushwana watershed revealed the presence of large magnetic anomalies, aligned parallel to the strike of the rocks. Outcrops are generally poor and weathered. The area had been mapped in 1949 and the rocks classed as ferruginous, banded quartzites. However, an inclined hole drilled across strike showed that in reality these rocks are highly silicified amphibole-chlorite gneisses containing, in certain bands, a high percentage of magnetite. Even in 1949 the rocks outcropping in this area were recognized as being lithologically distinct from typical members of the Figtree Series and were therefore distinguished as Lower Figtree. It seems probable that they are, in fact, members of the Onverwacht Series.

Granite Contact, Forbes Reef

26. North of Forbes Reef the granite contact with the basic and ultrabasic schists is complex. Pegmatites, always highly weathered, are extensive. In order to locate the contact and also to determine whether the pegmatites contained minerals of economic importance two boreholes were drilled. The first borehole drilled at an angle of 45° cored pegmatite from 90 feet, where coring began, to the final depth of 241 feet 6 inches. The pegmatite contained small books of white mica and occasional pin-head sized garnets set in a coarse quartz-feldspar mass. A sample of the kaolinized pegmatite has been submitted for testing. If the flakes of mica can be removed, it is possible that the kaolinised pegmatite could be a source of china clay. If the tests are satisfactory more detailed prospecting by means of augers will be undertaken.

27. The second borehole showed that near the granite, the country rocks are intruded by a complex stockwork of pegmatites barren, however, of economic mineralization. Near the contact with the granite small garnets occur in the amphibole gneiss which forms the country rocks.

Geological Research

28. A research student from the University of Natal is mapping a portion of the Mkondo Valley for a higher degree. His mapping is under the supervision of the writer on behalf of the University authorities. During January visits were made to this area to discuss problems which had arisen during the course of the mapping.

29. A research student from the University of Cape Town visited Swaziland with the object of studying the methods of mapping and the classification of the granites adopted in Swaziland, in order to assist him with his research on similar rocks in South-West Africa. Several days were spent in the field.

30. Following the award by Government of a research studentship in geochronology, Professor Nicolaysen and Dr. Allsopp of the Bernard Price Institute visited Swaziland for field trips with Mr. Davies, who has been awarded the research studentship. Visits were paid to several localities to determine which area was likely to provide the best field of research. Preliminary results suggest that an area southeast of Mankaiana may be the most suitable.

31. Samples of granodioritic gneiss were collected and sent to Professor Engel of the University of California who is undertaking geochronological studies on ancient gneisses.

United Nations Special Fund Project

32. The collection of a representative suite of rock types was organized to obtain data on their magnetic susceptibility. In all 336 samples were collected, measured and documented. The data will be used to assist in the interpretation of the magnetic data obtained during the aerial survey flown in May and June.

33. Visits were paid to northwest Swaziland and the Usushwana Complex with the United Nations consultant on geochemistry when he made his preliminary visit to Swaziland to advise on the best method of tackling the geochemical survey.

Water Supply and Dam Sites

34. Evidence, both oral and written, was given with the Director, to the Water Affairs Commission which is charged with recommending suitable legislation for the use and control of surface and underground water.

35. A visit was paid to Stegi to discuss the water supply there in the light of projected developments.

36. Visits were paid to proposed dam sites on the Lomati and Poponyane Rivers with officials of the Departments of Public Works and Agriculture. Further visits were made with the same officials and the Adviser to the Secretary of State on Water Affairs to proposed dam sites on the Usushwana and Usutu Rivers.

Geological Mapping

37. Mapping along the contact of the granite pluton north and south of Mbabane was completed. In the course of this work a major fault was located and followed to Forbes Reef. It could not be traced into the rocks of the Swaziland System. Visits were made to the Motshane valley, mapped in 1949 by the writer, which is now being re-mapped on a scale of 1:10,000 by Mr. J. G. Urie.

Miscellaneous

38. The draft of the new 1:250,000 geological map of Swaziland was completed. After visits to various printers a tender was accepted for the printing in colour of this map, work on which is now well advanced.

39. Drafts of six 1:50,000 sheets were sent to the Directorate of Overseas Surveys at Tolworth, England, who have undertaken to print this series in colour. The proof of the sheet covering the northwestern corner of Swaziland was received. The draft of an explanatory note on the geology to accompany this sheet was prepared.

40. Bulletin No. 6 was compiled during the year and the first proof was corrected. It will list all chemical analyses of rocks, minerals, ores and water.

41. Visits by consulting geologists, engineers and others interested in mineral development in the Territory involved visits to the kaolin mine, Usushwana Complex, Pigg's Peak, Daisy and She mines, the molybdenum occurrences on the Komati river, nickel at Forbes Reef and the water boreholes supplying the Mpaka Colliery.

42. Samples alleged to contain gold were examined on behalf of the Swaziland Police at Bunya.

43. Samples of dolerite were collected on behalf of persons interested in establishing a quarry for the export of building stone. Unfortunately none of the samples came up to specification.

44. In April the meeting in Tunis of the Association of African Geological Surveys was attended. A report on the activities of the Swaziland Geological Survey was presented arousing interest among many of the delegates who were, in general, poorly informed on the contribution being made by the Swaziland and United Kingdom Governments. In the field of training local candidates for careers in geology Swaziland is well in advance of many of the larger and more wealthy countries in Africa. The conference was poorly attended by the English-speaking countries in Africa, Zambia being the only other such country to be represented.

45. After the conference a tour of the mines in Tunisia was organized. Visits were paid to the phosphate mines near Gafsa, the iron ore mine at Djerrissa and the lead-zinc mine at Djebel Hallouf. Numerous other prospects were visited.

[B] By J. G. Urie — Geologist

46. The writer was on duty throughout the year with the exception of a short period of leave during May. From mid-July to mid-August the writer acted as Inspector of Mines during the absence on sick-leave of Mr. D.A.C. Purser and in November and December as Senior Geologist during the absence on overseas leave of Mr. D. R. Hunter.

47. Prospecting for kaolin in the Mahlangatsha Mountains, Manzini District, was continued in the early part of the year. Frequent visits were made to the cinnabar prospect near Pigg's Peak to supervise the adit being driven below the original surface workings. Nickeliferous laterites occurring to the south of Ngwenya iron mine were pitted and sampled. Regular visits were made to Nqcampalala area, Ubombo District, to supervise a coal drilling programme undertaken by the Department on behalf of the concessionares, to the Umhlataan area, Pigg's Peak, to supervise the drilling and prepare a geological map, of a magnetiferous horizon located in the area and to the Havelock mine area to log borehole cores on behalf of the concessionaires.

48. During September and October regional mapping on a scale of 1:10,000 was undertaken in the Motshane valley, northwestern Swaziland.

49. Headquarters work included the examination of rock slides, the identification of specimens submitted by the Police Department and private persons, the logging and splitting of drill cores and the preparation and testing, by geochemical methods, of loam samples.

Motshane Valley — Hhohho District

50. In the Motshane valley an area of 15 square miles was mapped on a scale of 1:10,000.

51. A sequence of hornblendic schists derived from mafic lavas, siliceous meta-sediments, and tremolite-chlorite and talcose schists underlies much of the terrain. One extensive and numbers of small bodies of serpentinite are present.

52. A late-orogenic granite represented by a sodic phase and a later potassic phase invades the country rock.

53. Intrusives, of post granite age, abound. Major gabbroic intrusions and one micro-granodioritic intrusion of Usushwana Complex age occur in the south of the mapped area. Dykes, usually diabasic, but of variable composition, invade the terrain and are particularly abundant in the granite country. At least three ages of basic dykes are present; early dykes which trend in a northwesterly direction and which are followed by dyking in north-northeasterly and west-northwesterly directions. Dykes of granitic composition which are post-Usushwana Complex in age are present particularly in the southern portion of the map area.

Cinnabar, Hhohho District

54. In mid-1965, and in collaboration with the concessionaires, it was decided that subsurface investigation of the cinnabar occurrence at Cinnabar Ridge was warranted. Accordingly, an existing adit was driven eastwards to intersect the anticipated zone of mineralization at a depth of some 100 feet below the level of the old quarry. The adit was driven 60 feet beyond the target area and the entire width of the zone in which mineralization was anticipated was channel sampled. Sampling results were poor and operations in the area ceased in July.

Kaolin, Manzini District

55. Prospecting for kaolin was continued in the Mahlangatsha Mountains in the country surrounding the known kaolin deposits. Sixteen trenches totalling some 2,000 feet in length were dug. The presence of minor partially kaolinized bodies was revealed but to date only one occurrence of significance has been located. Here, cream-white to cream kaolin, patchily stained by iron oxide, occurs in a lensoid body having a strike length of 330 feet and a maximum surface width of 36 feet. It appears that the body dips eastwards at a relatively low angle of between 40° and 50°: reserves of mineable kaolin are, therefore, limited. If a quarrying depth of 30 feet be assumed, then some 10,000 tons of kaolin are available.

Magnetite Horizon, Umhlataan, Pigg's Peak

56. A banded taconite horizon traceable over a strike length of some 15,000 feet was located in the Umhlataan area, Pigg's Peak, during the aerial magnetometric survey of the territory. A follow-up geophysical ground survey has been undertaken by Mr. R. B. Evans of the Overseas Division of the Institute of Geological Sciences and at present diamond drilling of the horizon and the preparation of a geological map of the area are in progress.

Nickeliferous Laterites, Motshane Valley, Hhohho District

57. To the south of the Ngwenya iron ore mine the country is underlain by essentially talcose schists of ultrabasic origin and serpentinite bodies. In the relatively low lying Motshane valley laterite develops quite extensively on the weathered schists. Sampling elsewehere has shown that the ultrabasic schists invariably carry small amounts of nickel, averaging about 0.1%. It was decided to test pit and sample the laterite in order to establish if any concentration of nickel occurred in them.

58. Eight pits were dug and the samples from these assayed for both gold and nickel. Content of both metals was extremely low, ranging in the case of gold from nil to 0.67 dwts/ton and in the case of nickel from nil to 0.74 per cent.

[C] Report by D. H. Jones—Geologist

59. The writer was on duty throughout the year except for three weeks annual leave taken in November. The early part of the year was spent at headquarters examining 385 thin sections of rocks, plotting data from the work of the previous field season and preparing geological plans.

60. From mid-April detailed mapping was undertaken in the Komati-Havelock area of the Hhohho District in northwestern Swaziland. Aerial photographs enlarged to a scale of 1:10,000 were used for this work. The area, occupying 28 square miles, is bounded to the northeast by the boundaries of Swaziland Plantation Limited, Peak Timbers Limited and Havelock mine. To the south it is demarcated by the Komati River. The northwestern and southeastern boundaries are constituted by the Transvaal-Swaziland border and the contact of intrusive granites respectively. The terrain is extremely mountainous, making access difficult, and horses were used for much of the field season. The area is underlain by highly contorted sedimentary and extrusive rocks of the Swaziland System and by intrusions of ultrabasic and basic material. Constituting an intrinsic part of the Barberton Mountain Land gold belt, the area was prospected for gold as well as iron and asbestos. A total of 169 rock samples were collected of which 83 were fire assayed and 86 panned.

61. The field season ended late in October and from that time to the end of the year, the writer has been plotting data, examining thin sections and preparing plans at headquarters.

The Havelock — Komati Survey, Hhohho District

62. The surveyed area is dominated along its northwestern boundary by the Makonjwa Range, with the Diepgezet Mountain, elevation 5,097 feet, forming its highest point. In the northwestern extremity Nottingham Peak is a prominent landmark rising to 4,200 feet above sea level. The area is drained by such rivers as the Umkomozaan and Ruby Creek flowing southwestwards to join the Komati River. Generally following the structural grain, the rivers have carved out deep valleys and narrow gorges.

Stratigraphy

63. Detailed mapping reveals that three distinct lithological units constitute the Swaziland System. The uppermost of these, the Moodies Series, consisting essentially of massively bedded quartzites and conglomerates, lies unconformably on the lower members of the system. Beneath occurs a succession of rhythmically banded argillaceous and fine-grained arenaceous rocks which traced downwards contain an increasing proportion of basic and ultrabasic intercalations. The succession of preponderantly sedimentary rocks is placed in the Figtree Series and that with an increased proportion of basic and ultrabasic material in the

Onverwacht Series. The relationship between the two is conformable and transitional so that their correlation as Figtree and Onverwacht Series is, at this stage, purely tentative. A number of ultrabasic intrusions occur throughout the area which appear to post-date the Swaziland System in age and are considered to represent the Jamestown Complex. Granites were intruded into the Archaean rocks along the southeastern limit of the area. Igneous activity concluded with the intrusion of basic dykes into both the granite and the rocks of the Swaziland System.

64. The Moodies Series, the youngest member of the Swaziland System, consists of massively bedded quartzites and conglomerates. It is responsible for building the heights of the Makonjwa Range along the northwest boundary of the area. Slivers of Moodies Series are also found in the cores of synclines and localities which have been complexly faulted. Thus, the series is found two miles south-southeast of Diepgezet Mountain and again on the southeastern flank of Nottingham Peak. A compact conglomerate lying unconformably on the underlying Figtree Series delimits the base of the series. Its absence at any locality can usually be attributed to faulting. Along the Makonjwa Range the basal conglomerate contains a high percentage of jasper and banded ironstone pebbles, obviously derived from the beds of the Figtree Series.

65. The Figtree Series is represented by shales, slates, banded ironstones, cherts, quartzites and conglomerates occurring in rapid alternations. A number of lava flows, ranging in composition from acid to basic occur as narrow and impersistent intercalations within the sedimentary succession. At their contact with the sedimentary rocks, the lavas are frequently amygdaloidal, being concordant with such beds even when they have a highly folded disposition. The acid lavas are commonly altered to quartz sericite schists, much of the latter mineral being derived from the original feldspar content of the rock. More basic lavas are represented by amphibolites and talc-amphibole schists. The bulk of the Figtree Series comprises shales and slates with narrow bands of chert, quartzite and conglomerate. Towards the base of the series there is a marked increase in the incidence of ferruginous shales, jasperitic beds and banded ironstones. Such rocks are well developed at Nottingham Peak extending southeastwards in the core of a complexly faulted anticlinal overfold, at Iron Hill and again three-quarters of a mile northwest of Diepgezet Mountain.

66. The Onverwacht Series comprises a succession of argillaceous quartzites, shales and cherts with inter-layered lavas ranging from basic to acid in composition. Such rocks are well exposed in the cores of the arcuate, anticlinal folds in the Havelock area and along the banks of the lower reaches of the Umkomozaan River. In both cases they underlie banded ironstones and ferruginous shales considered to be basal beds of the Figtree Series. The interlayered relationship between the acid lavas and the sedimentary rocks is usually well preserved especially in the area immediately south of Havelock mine. Here the uppermost occurrence of acid lavas is taken as the top of the Onverwacht Series. Significant field relationship between sedimentary and basic units are, however, obscure. The last mentioned are invariably altered to amphibolites and magnesia-rich schists which in some cases are concordant with the sedimentary rock suggesting they are of extrusive origin. Rocks of the Onverwacht Series lying adjacent to the granite have undergone considerable metamorphism. Sedimentary rocks are converted to amphibolites, quartz-mica schists, quartz-sericite-andalusite schists and metaquartzites. The basic rocks are represented by amphibolites together with talc-amphibolite, talc-chlorite-carbonate and talc-carbonate-bearing rocks.

67. A number of ultra-basic intrusions, varying considerably in size, occur throughout the area. Converted by metamorphism to serpentinite, amphibolites and talcose schists they are invariably concentrated in areas affected by major faulting. Many of the smaller bodies can be regarded as tectonic intrusions due to the re-mobilization of pre-existing ultrabasic material under stress. They are invariably lens-shaped with their axes aligned parallel with the major northeast striking faults, and are unfoliated and uncleaved. The more substantial intrusions, also occupying major fault zones, are not of tectonic type and are classified as Jamestown Complex. The largest of these occur at the Havelock mine, along the northwestern banks of the lower reaches of the Umkomozaan River and in the deep valley below Diepgezet Mountain. The Havelock body, consisting of apple-green and blue-black serpentinites, has a total length of three miles along its north-easterly strike and a maximum width of 1,300 feet. The contact between the serpentinites and adjacent talcose schists and sedimentary rocks is abrupt. It is debatable as to whether this contact is an intrusive or a faulted one. There is, however, field evidence that banded ironstones of the Figtree Series have been engulfed by serpentinites. The intrusion occurring along the flank of the Umkomozaan River consists almost entirely of serpentinite. It becomes progressively steatized when traced northeastwards along its length of three miles. The intrusion occupying the valley below Diepgezet Mountain is essentially a talc-carbonate rock. Serpentinite bodies occur within it on the banks of the Komati River and again 2¼ miles east-northeast of Diepgezet Mountain. Like the previously described intrusion, it has a strike length of three miles and a maximum width of 1,600 feet. All three mentioned intrusions are relatively uncleaved indicating that their emplacement occurred late in the tectonic history of the area.

68. Granites demarcate the southeastern limit of the area; consequently only their contacts were examined. Two varieties of granite are apparent. The first is a medium-grained biotite granite which may be either foliated or unfoliated, the former usually occurring near the contact with the country rocks. At the present time this biotite is considered to represent a late-orogenic type intruded at a time when the tectonic stresses in the area were waning.

69. The second variety is a coarse-grained, porphyritic granite occurring as small bosses within the main mass or insinuating itself along cleavage planes in the country rocks. The granite is regarded either as a later phase of the late orogenic granite or an early expression of post-orogenic igneous activity.

70. Post-granite basic intrusions occur in the form of dykes throughout the area. Two varieties are known; firstly diabase dykes, often deuteritically altered and, secondly, dolerite dykes which may be either olivine-or enstatite-bearing. The former are considered to be pre-Karroo System and the latter post-Karroo System in age. The dykes show a preferential alignment either along a northeasterly or a northwesterly direction and a tendency to be concentrated near the granite contact.

Metamorphism

71. The rocks of the area have undergone both dynamic and contact metamorphism. The effects of dynamic metamorphism are prominent and pervade uniformly throughout the whole area. The imposition of slaty and fracture cleavage, re-orientation of clastic particles, re-silicification, mylonitization, sericitization and chloritization are the most prominent features.

72. Contact metamorphism is confined to localities immediately adjacent to the granite. Argillaceous rocks are converted to pyroxene granulites, amphibole gneisses and quartz-sericite andalusite schists dependent upon their original composition. The magnesia-rich rocks in turn are represented by amphibolites and a variety of talcose schists. The mineralogy of these rocks is complex due to variations in their composition and varying influences of metamorphism. A gradational metamorphic zoning is apparent. In the immediate vicinity of the contact, amphibolitization has occurred but, at increasing distances from the granite, amphibole disappears and talc-chlorite, talc-chlorite-carbonate and talc-carbonate schists represent the magnesia-rich rocks. Further manifestations of the granitic metamorphic influence include steatization and local carbonatization.

Structure

73. Two phases of folding have been responsible for the structural pattern of the area; a pattern so intricate that the establishing of a stratigraphical succession and the deciphering of structural relationships is well nigh impossible.

74. The first and main phase caused the initial tilting of the Onverwacht and Figtree Series resulting in their partial erosion prior to the deposition of the Moodies Series. Following this deposition stresses operating in a northwesterly direction compressed the pile into a series of northeast aligned overfolds. The intensity of this phase is expressed by the folding, by the well developed slaty and fracture cleavage, re-orientation of clastic grains so that they attain parallelism within the cleavage planes and by faulting. The faults are invariably high-angle thrusts which are nearly concordant with the dip and strike of the axial planes of overfolds. It would seem, therefore, that folding and faulting were closely related; the thrust affording relief of compressive forces. The faults are of sufficient magnitude to eliminate anticlinal folds and throw syncline against syncline.

75. The second phase of folding was less severe and was instigated by stress along a northeasterly direction. Thus, cross-folding occurred along northwest axes causing the warping of main-phase structures. Buckling of pre-existing fold keels and fault planes is particularly evident between Havelock mine and Diepgezet Mountain where acute arcuation has occurred. Related to the second phase of folding was the re-activation of earlier thrust-faults so that a slip-wrench action was imparted. With re-activation, many such faults have behaved as detachment planes with intense deformation occurring usually on their northwestern sides.

Economic Geology

76. Despite extensive prospecting no new occurrences of gold were discovered during the survey. Old trenches sunk on auriferous banded ironstones in the Imgudugudu Valley were sampled along a strike length of 390 feet. The auriferous zone, which has a width of 48 inches, carries an average value of 0.73 pennyweight. In addition underground workings of the derelict New England mine were examined. In every instance the adits have collapsed at short distances from their portals and no gold values were located.

77. All serpentinites were examined for asbestos but only one positive occurrence was located on the banks of the Komati River near the Transvaal border. Here chrysotile is to be found in 1/16 inch thick veinlets lacing the rock. A paucity of outcrops makes impossible the assessment of the economic value of the occurrence.

78. The banded ironstones, jasperlitic beds and ferruginous shales at Nottingham Peak and between Iron Hill and Diepgezet Mountain were grab sampled. An approximate estimate is that their iron content averages 31 per cent but a true assessment of their economic potential can only be made from extensive trenching.

[D] Report by R. P. Edwards — Geologist

79. The writer arrived in Swaziland on the 9th November, 1966. One week was spent in Mbabane reading the bulletins of the Geological Survey and preparing for field work.

80. During the remainder of November and the whole of December the writer was working in the Hhohho area as counterpart geologist to the United Nations Mineral Survey Programme. Nine hundred and twenty eight stream sediment samples were collected at intervals of a quarter mile and at stream intersections. The samples were sent to the geochemical laboratory in Mbabane for analysis.

[E] Report by J. K. Whittingham — Geologist/Geophysicist

81. The writer was on duty throughout the year, apart from a few days casual leave.

82. The equivalent of six months was spent on ground water survey and five months on geophysical survey for mineral occurrences in the Hhohho District and near Hlatikulu.

83. For two weeks in May, the writer assisted with the supervision of census enumeration in the Manzini District.

Water Supply

84. During the year, several boreholes were drilled for water on sites selected by geophysical survey in 1965, with the following results:—

District	Locality		paragraph Annual Report 1965	Site No.	Depth of Borehole ft.	Water Struck ft.	Stat. Water level ft.	Yield in g.p.h.	Quality	Formation
Shiselweni	Gollel Vet. Holding Ground	Camp 5		S.105	169	90	89	1500	v.sl. brack	Basalt and tuff wthd to 80 feet
		Mhlofunga Valley	122	S.100	253	140	86	90	slightly brack	Basalt and tuff wthd to 63 feet
		Camp 4	122	S.132	292	140	126	270	v.sl. brack	Basalt and tuff wthd to 22 feet
		Camp 1	122	S.110	202	194	97	840	v.sl. brack	Basalt and tuff wthd to 22 feet
		Camp 3	122	S.113	292	150	59	1500	slightly brack	Basalt and tuff wthd to 274 feet
		Camp 9	122	S.123	238	120	78	270	Fresh	Basalt and tuff wthd to 173 feet
		Camp 6 (Msuzwane)	122	S.104	200	100	74	1600	Fresh	Basalt overlain by 53 ft. superficial material
		Camp 11	122	S. 59	250	108	88	60	Brack	Basalt wthd to 80 feet
		Sikalisebodwe SNA. 31	116	S. 5	111	101	45	1170	v.sl. brack	Sandstone & shale
		Progress Ranch (Hillary's)	118	S.124	150	—	—	Nil	—	Dolerite
Lubombo	Mpaka		113	L.156	250	110	59	1260	Fresh	Sandstone and shale
Hhohho	Nkambeni School		128	H. 25	155	—	—	Nil	—	Granite

85. Full details are now available for some borehole sites selected by Jennings (Geological Survey of Bechuanaland) and the writer in 1965 and are as follows:—

District	Locality	paragraph Annual Report 1965	Site No.	Depth of borehole ft.	Water Struck ft.	Stat. Water level ft.	Yield in g.p.h.	Quality	Formation
Shiselweni	Gollel Vet. Holding Ground Resettlement Area		J.50	136	120	85	540	Fresh	Basalt and tuff
			J.41	181	—	—	370	Fresh	Basalt and tuff
			J.54	275	250	76	180	Brack	Basalt and tuff
	Camp 2	121	J.53	220	205	83	1500	Slightly brack	Basalt and tuff soft to 210 feet
	Camp 12		J.43	84	65	65	1400	Brack	Basalt and tuff
			S.70	350	265	260	180	V. brack	Basalt and tuff wthd to 95 feet.
	Matanjeni S. SNA. 31		S.52	87	50	41	1500	V. slightly brack	wthd dolerite, sandstone and shale

86. Results of drilling of water boreholes during 1966 on sites selected by this Department during 1965 and 1966, can be summarized as follows:—

	over 1000 g.p.h.	600 — 1000 g.p.h.	300 — 600 g.p.h.	Under 300 g.p.h.	Dry
Lubombo District Nazarene Mission, Stegi				1	
Swaziland Colliery, Mpaka	2				
Lismore Estate			1		
Shiselweni District SA 31	2		1		
Gollel Vet. Holding Ground	5	1	2	4	
Progress Ranch					1
Manzini District St. Julian's R.C. Mission					1
TOTALS	9	1	4	5	2

87. During 1966, thirty six borehole sites were chosen.

Localities are as follows:—

Lubombo District

Swaziland Collieries, Mpaka	9 sites
Esigcaweni	2 sites
Red Tiger Ranch	2 sites
Mkaya Ranch	1 site
Guquka	2 sites
Sitobela	1 site
Popanyane	1 site
Maloma	2 sites
Lismore Estate	2 sites

Shiselweni District

Sufumisa	1 site
Hlushwane	2 sites
W. C. Henwood's Estate	1 site
Progress Ranch	1 site
Gollel Veterinary Holding Ground	6 sites
Vermaak's Estate	1 site
Mooihoek (Mhlolo's Estate)	1 site

Hhohho District

Bulandeni	1 site

Lubombo District

88. During the early part of the year, the geophysical survey to locate water supplies along the Karroo-Precambrian boundary was continued in this district from Mbahaan Ranch (Corbett's) to Maloma. Sites were chosen at about 4 miles intervals. Between Mbahaan Ranch and Sitobela, the north-south zone, which forms the western boundary of the Karroo System in Mpaka area, swings west of south and Precambrian rocks occur on both sides of the fault. The Karroo strata dipping gently to the east overlie the Precambrian unconformably. The boreholes, therefore, were sited some distance east of the unconformable boundary in order that they may strike water on the unconformity and in the watershed granite below. Two sites were selected on Red Tiger Ranch, one on Mkaya Ranch and one in the Guquka area south of the Usutu River.

89. South of Sitobela, the Karroo-Precambrian boundary is again a north-south fault zone, although Karroo outliers do occur over the Precambrian in places on the west (upthrow) side of the fault zone. One site was chosen at Sitobela, one near Poponyane dip and one at Maloma.

90. Later in the year, at the request of Rand Mines Limited, five further sites were selected to augment the water supplies of Mpaka Colliery. Two of these were drilled together with one site chosen in 1965. Although the three sites drilled were placed within a short distance of the most easterly Precambrian outcrop, only one of these boreholes struck granite. One near to the Manzini-Stegi road (L.191) passed through 300 feet of sandstone and shale although Precambrian amphibolite outcrops occur only 30 feet to the west. This shows that the fault plane is very steep or even vertical in places and that it has an upthrow to the west of at least 300 feet.

91. At the end of the year, two sites were chosen on the Karroo-Precambrian boundary 1 to 1½ mile north of the Manzini-Stegi road to supply water for a proposed U.K.A.E.A. Tracking Station near Mpaka Station.

92. One water borehole site was chosen on Lismore Estate (Rabe's) south of the Ngwavuma River and one at Ngcina (SA 27) for an Agricultural Development Scheme. In each case, a zone of deep weathering in basalt was located for drilling. The former site was drilled.

93. The table shows results of drilling in Lubombo District on sites selected this year:—

Locality	Site No.	Depth ft.	Water Struck ft.	Stat. Water level ft.	Yield g.p.h.	Quality	Formation
Lismore Estate	L.212	305	150 and 210	141	400	Slightly brack	Basalt/ash wthd/174 feet
Mpaka	L.196	250	90	54	1600	Fresh	Sandstone and shale Granite
Mpaka	L.191	300	250	114	190	Fresh	Sandstone and shale

Shiselweni District

94. Following the drilling of several boreholes in the Veterinary Holding Ground during 1965 and the early part of 1966, it became clear that some of the best supplies of water were obtainable from the Msuswane and Mhlofunga valleys which, it may be inferred, follow cross-fracture zones in the Stormberg basalt. It was decided therefore by the Department of Agriculture to build the headquarters and main handling centre at Camp 5 north of the Mhlofunga stream, where good water supplies are proved rather than at the foot of the Lubombo escarpment, where drilling for water had proved unsuccessful.

95. In order to augment the supply of water in Camp 5 and to choose new sites in the northern part of the holding ground six sites were selected in the light of information gained from drilling. Four sites were marked in the east-west fracture zone of the Mhlofuna valley; one of these has already been successfully drilled.

96. One new site was placed in the Zibe valley at the point where it appeared another east-west fracture zone crosses the valley, on the border of Camps 4 and 10. This was also drilled successfully. Another attempt was made at finding a good water borehole site at the foot of the Lubombo escarpment (Camp 11) where drilling had shown disappointing results, apparently due to the fact that thick beds of tuff gave low-resistivity anomalies but contained very little water. The new site was drilled but, although more successful than those previously drilled at the foot of the escarpment, yielded only 450 g.p.h.

97. One water borehole site was chosen north of the Holding Ground on Vermaak's estate, in a zone where geophysical results indicate that the basalt is deeply fractured or weathered.

98. Drilling on Progress Ranch, where a site had been chosen in 1965, showed that what had appeared to be a contact between Karroo sedimentary rocks and a dolerite was in fact a "step" of a large transgressing dolerite sill. A new site was chosen, this time in the Sitilo valley where thick superficial deposits overlay weathered sandstone and dolerites. Drilling at the new site was successful.

99. One borehole site was marked at Mahlobo's estate at Mooihoek. This site is in Mozaan phyllites.

100. Results of drilling on sites selected this year in the Shiselweni District are as follows:—

Locality	Site No.	Depth ft.	Water Struck ft.	Stat. Water level ft.	Yield g.p.h.	Quality	Formation
Gollel (Camp 5)	S.196	239	80	55	1500	Almost fresh	Basalt and tuff soft to 214 ft.
Vet. (Camp 4/10)	S.202	251	82	78	1500	Almost fresh	Basalt and tuff
Holding Ground (Camp 11)	S.206	250	167	124	450	Slightly brackish	Basaltic and tuff
Progress Ranch	S.224	151	30	15	780	Fresh	Sandstone and shale.

Hhohho District

101. One borehole site was marked for Bulandi village, close to the Nazarene School. This site is located on a low watershed between two valleys running north and south. It is thought that the north-south valleys follow joints or shatter zones in the granite.

102. The site chosen in 1965 at Nkambeni School, near Balegane was drilled and, although low-resistivity anomalies showed promising indications of water supply, the borehole was dry to 150 feet. A new site was chosen about ½ a mile distance from the school.

Manzini District

103. At Mliba, ¼ mile south of the Police Post, a borehole site was marked in a valley where there is evidence of deep weathering or fracturing of the granite.

104. Several existing borehole sites in the Malkerns-Manzini area were visited and details of depth of water and borehole yield were obtained. Some resistivity depth probes were made near some of the more successful boreholes. In general, it was found that the most successful boreholes were those which had been drilled right through the superficial deposits into weathered granite and about 10 to 20 feet into solid granite underneath.

Economic Geology

105. Electro-magnetic traverses were made with the E.M. gun near to an old asbestos prospect on the Watershed between the Motshane and Usushwana Rivers with a view to delimiting the extent of serpentinite under valley superficial deposits, (see also para. 25). Strong E.M. anomalies were obtained (maximum 50% in-phase and 35% quadrature on high frequency). Accordingly the E.M. survey was followed up with magnetic traverses using a Hilger-Watts magnetometer. These showed anomalies which appeared to correspond with the E.M. anomaly. Drilling on the anomaly peaks failed to reveal any deposit which would give rise to such anomalies. This survey was followed by laying out a 50 foot grid over the area and resurveying with a Jalander flux-gate magnetometer. The magnetic survey showed positive and negative anomalies up to the order of 40,000 gammas which clearly corresponded with bands of ferruginous, siliceous schists. The large E.M. anomaly is still not satisfactorily explained.

106. Several E.M. traverses were made in an east-west direction across the strike of the Moodies quartzites and Figtree schists between the She mine and the Mbabane-Oshoek road. The most prominent anomalies (20% in-phase and 10% to 15% quadrature) were on the margin of dolerite dykes. Another prominent anomaly was found over a bed of greenish, banded quartzite about 100 yards north of the Ngwenya mine office.

107. Two months were spent in Pigg's Peak area with Mr. R. B. Evans of the Overseas Geological Surveys. A strong magnetic anomaly west of Pigg's Peak revealed by the aero-magnetic survey flown earlier in the year, was followed up by ground magnetic and electro-magnetic survey.

108. E.M. traverses were made across Ntonga ridge, east of the Ngwavuma valley, near Hlatikulu, to see if any anomaly could be obtained over a quartz reef carrying galena. A distinct anomaly was obtained over a dolerite dyke following the same ridge but there was no anomaly which could be attributed to the quartz reef.

[F] Special Investigations

(i) *Engineering Geology*

109. Visits were paid to proposed dam sites on the Lomati and Poponyane Rivers with officials of the Departments of Public Works and Agriculture. Further visits were made with the same officers and the Adviser to the Secretary of State on Water Affairs to proposed dam sites on the Usushwana and Usutu Rivers.

(ii) *Gravimetric Survey*

110. The results of the gravimetric survey were made available to the Department during the year. The results are incorporated on Bouger and isostatic anomaly maps which will be published together with an interpretation of the anomalies in the Departmental Bulletin which is in the course of preparation.

(iii) *Geochronology*

111. Dr. J. N. Snelling of the Age Determination Unit of the Institute of Geological Sciences at the Department of Geology and Mineralogy at Oxford University, undertook the following age determinations on behalf of the Department on rocks from the Lebombo range in eastern Swaziland.

No.	Locality	Rocks	Method	Age (m.y.)
1.	W. of Lubuli, Lebombo District	Dolerite		159 ± 10 m.y.
2.	Nkalishane Valley, Lebombo District	Augite diorite		152 ± 10 m.y.
3.	Nkalishane Valley Lebombo District	Dolerite	Whole rock K/Ar	182 ± 12 m.y.
4.	Stegi road	Porphyritic basalt		149 ± 10 m.y.

112. Dr. Snelling comments as follows on the above age determinations:— "The above are in general similar to those reported by McDougal. I should stress, however, that in all cases the ages are only minima. The most significant result is undoubtedly No. 3. Since this dolerite cuts the augite diorite No. 2, there can be no doubt that the diorite has suffered argon loss. That the result on No. 2 should be too low is in no way surprising, its high content of K suggests, in the absence of biotite, the presence of K-feldspar and this can easily be seen in graphic intergrowth with quartz in thin section. That K-feldspar can suffer appreciable argon loss is a well established geochronological fact. There is no reason to suspect the age of No. 1 which is well within the age range of Karroo dolerites, nor the basalt No. 4 which, although fine-grained, is fresh and holocrystalline. If, however, No. 4 is a sample of Stormberg basalt underlying the rhyodacite ignimbrite succession cut by dolerite No. 3 then argon loss must be inferred on geological ground".

113. Mr. R. D. Davies, Research Fellow of the Bernard Price Institute of Geophysical Research, Johannesburg, carried out Rb/Sr dating on a total of seventeen rocks from the Basement granites and gneisses. Five age determinations were on the Mliba granite and six each on the ancient gneisses and so-called G3 granite located south of Mankaiana. The provisional ages are given below:—

Age of Mliba granite (tentative)	:	3.15 b.y.
Age of Ancient gneiss complex	:	3.14 b.y.
Age of G3 granite (S. of Mankaiana)	:	3.14 b.y.

114. Mr. Davies's comments, inter alia, as follows on the above data:—

"Mliba Granite: Of the five rocks analysed (with the help of Mr. W. Manton of Dallas, U.S.A.) four gave points on a Rb87/Sr 87 versus Sr 87/Sr 86 plot approximating to a straight line. This is the 3.15 b.y. isochron. The fifth plot lies well off this line and far outside experimental error. As yet, no logical explanation can be given for this discordance. Hence, the labelling of this 3.15 b.y. age as tentative.

Ancient gneisses and G3 granite: The two isochrons drawn through the plotted points of these respective rocks, both show ages close to 3.14 b.y. Alignment of these points on the respective isochrons is fairly good. In the case of the G3 granite, one of the points lies wide of the isochron fitting the remaining five points.".

[G] Diamond Drilling

115. The total footage drilled during the year amounted to 8,939 feet, comparing favourably with that in the preceding year. See appendix III for details of diamond drilling.

116. Mr. P. J. van der Walt resigned in January, 1966, and it was decided to fill this vacancy with a learner driller, Mr. J. Motha.

117. Revenue from drilling undertaken by the Department under contract during the past year amounted to R4,441.

IV. UNITED NATIONS SPECIAL FUND PROJECT

MINERAL SURVEY OF SWAZILAND

118. The Plan of Operation for the mineral survey was signed on 15th April, 1966. The plan envisages aerial geophysics carried out during two flying seasons together with ground follow-up incorporating geophysics, geochemistry and, if required, detailed geological studies.

119. Mr. A. Hatton, the Project Manager, arrived in Swaziland in March. The Director of the Geological Survey and Mines Department was appointed Project Co-ordinator by the Swaziland Government.

120. The first phase was the flying of the airborne geophysical survey, the magnetometer and scintillation counter survey, was completed by mid-year. The final reports and maps were received in December.

121. The counterpart geophysicist, Mr. R. B. Evans, seconded from the Institute of Geological Sciences, (Overseas Division) London, arrived in September for a four months stay during which period he investigated eight localities where magnetic anomalies had been located during the airborne survey.

122. Dr. J. N. Tooms, geochemical consultant to the Project, visited the Territory in June. Mr. M. D. Baker, geochemist, arrived in November and systematic stream sediment sampling was initiated immediately.

123. The airborne magnetometer and scintillation counter survey totalling 13,986 line miles was a complete coverage of the Territory at a half mile spacing.

124. In addition three hundred and thirty six core and outcrop samples were collected by officers of the Department and their magnetic susceptibilities determined.

125. The geophysicist, Mr. Evans, accomplished the following during the four months:—

	Line Miles
Lines cleared	74
Magnetometer traverses	68
E. M. traverses	6½
S.P. traverses	¾
Gravity traverses	¼

126. Plans of the surveyed areas have been prepared on the appropriate scales of all magnetic and E.M. profiles have been drawn. In selected areas contour maps have been prepared and drawn.

127. Areas for coverage by an airborne E.M. survey to be flown early in the winter of 1967 have been selected.

V. MINERAL DEVELOPMENT

128. Four boreholes were drilled on an asbestos prospect on the watershed between the Usushwana and Motshane Rivers. All boreholes intersected a fibre-bearing zone which varied in true width from 15 to 45 feet. The core was tested for fibre content through the co-operation of the management of the Havelock mine. The results showed a fibre content of 1.2 per cent which is too low to warrant exploitation.

129. At the request of the owners of Swaziland Barytes Limited, seven boreholes were drilled on their property in the area at the waterfall. In this block of ground ore reserves amount to 6,800 tons semi-proven and 9,000 tons probable.

130. Drilling in the coal measures in the Mtendekwa River area several years ago showed that the main seam in depth became a true anthracite. It was decided to deepen boreholes Nos. 83 and 84 in an endeavour to locate anthracitic coal east of and adjacent to the Swaziland railway line.

131. The drilling indicated that a large area south of the old road from Manzini to Stegi contains no coal of commercial value due mainly, to the intrusion of dolerite sheets.

132. At the request of the owners of mineral concession No. 37 (portion 3) the Department is presently engaged on a coal drilling programme immediately south of the Usutu River.

133. Investigation of the cinnabar occurrence in the Hhohho District was completed in July. The sampling of the adit revealed only trace amounts of cinnabar and gold.

134. Early in the year prospecting was continued in the Mahlangatsha Mountains in the country surrounding the known kaolin deposits. Sixteen trenches totalling some 2,000 feet were excavated. The presence of a number of minor partially kaolinized bodies was revealed but only one occurrence of significance was located. Here the kaolin occurs in a lensoid body with strike length of 350 feet, and a width on surface of 36 feet.

135. Further investigation was initiated by Mineral Holdings Limited, on the western extension of the Havelock mine serpentinite, adjacent to the Transvaal-Swaziland border. Steps will be taken to dewater the prospect winze and a further diamond drilling programme has been laid out for the coming year.

136. Barytes production showed a considerable increase during the year. All the ore was won from surface quarrying operations.

137. Mining at Mpaka colliery owned by the Swaziland Collieries Limited was continued in a most satisfactory manner and production showed a marked increase as shown in the statistics. It is hoped that production will increase materially in the coming year.

138. It is disappointing to have to record the closure of two small gold mines in the Forbes Reef area. However, it is hoped that the geochemical prospecting programme in progress at present, and which will be actively pursued over the area underlain by rocks of the Swaziland System, will indicate the possibility of discovering new economic occurrences of gold.

139. The mining of iron ore at the Ngwenya mine owned by the Swaziland Iron Ore Development Company was continued most actively during the year resulting in an increased output. The stripping of overburden from the opencast pit proceeded apace.

140. Two firm markets were established for the sale of kaolin. Beneficiation tests, with particular reference to upgrading the reflectivity of the clay to meet the specifications of the paper industry, in particular, were being undertaken on bulk samples at the year end. It is known that the requisite micron size as required by the rubber industry, can be produced. In the rubber industry, colour is of very little consequence.

VI. MINES DEPARTMENT

[A] Mineral Statistics and Exports

141. The mineral production figures for the year ending 31st December, 1966, are given in the table (Appendix I) on page 37 of this report, together with those of 1965 for comparison purposes.

142. There has been an increase of R2,598,482 in the value of mineral production for the year. This is attributable largely to an increase in the sale of iron ore coupled with a more realistic means of valuing the ore sold as compared with the previous year. Actual tonnage of iron ore sold rose only by 629,712 short tons to 1,754,022 short tons, which does not entirely account for the rise in value of R3,373,081.

143. Sales of coal rose steadily during the year and totalled 73,589 short tons valued at R128,105, double that for the previous year.

144. With the closure during the year of the Territory's two small gold mines in the Forbes Reef area production fell considerably by 1,312 fine ozs to a total 308 fine ozs valued at R7,667.

145. Barytes production rose again during the year but still remains small. Sales of 1,150 short tons were valued at R9,910. The industry is, however, showing some signs of recovery.

146. Production of both pyrophyllite and kaolin decreased. Sales of diaspore were again nil. Pyrophyllite production fell by 534 short tons to 480 short tons valued at R2,400. Sales of kaolin dropped to 647 short tons valued at R5,652.

147. Tin mining virtually ceased and the recorded production of ½ ton of metallic tin was merely derived from prospecting activities.

[B] Inspections

148. The following visits were made by the Inspector of Mines to mines and quarries, as well as to explosives and rocket magazines in his capacity as Inspector of Explosives.

Purpose of visit	No. of inspections
Routine inspections of mines and quarries	31
Inspection of explosives and rocket magazines	29
Miscellaneous	22
Accident enquiries (serious or fatal)	4

[C] Licences and Permits

149. The following licences and permits were issued during the year:—

Type of licence or permit	No. issued
To purchase explosives locally	34
To import explosives	21
Blasting	39
Explosives or rocket magazines	6

[D] Accidents

150. Accidents in mines and quarries which cause an injured person to be absent from work for three days or more are reportable to the Inspector of Mines.

151. The following mining accidents (as distinct from machinery accidents on a mine) were reported during the year:—

Fatal	Non-fatal	Non-casualty	Total
0	144	0	144

152. The location of the various injuries incurred from the above accidents are classified as follows:—

Location of injury	(a)	(b)	(c)
Arms, hands or fingers	2	67	—
Legs, feet or toes	—	47	—
Eyes	—	14	—
Body or head	—	14	—

In this table,— (a) indicates loss of member
(b) indicates injury to member
(c) indicates loss of use of member.

153. These accidents. may be further classified as follows:—

Cause of accident	No. of accidents
Fall of ground	23
Fall of material, tools etc.	16
Transport of material	15
Loading by hand or machinery	1
Miscellaneous — Sundry	63
Splinters	10
Falling or slipping	13
Burning or scalding	3

154. The total time, in shifts, lost as a result of accidents is given below:—

No. of accidents	Total No. of Shifts lost	Average Shifts lost per accident
144	2,138	14.85

[E] LABOUR

155. A summary of the labour employed in the mining industry in Swaziland is given in the table (Appendix III) on page 39 of this report.

VII. MACHINERY DEPARTMENT

156. Mr. T. G. Blofeld, Inspector of Machinery has been on duty throughout the year.

Industry

157. Difficulty continues to be experienced in filling vacancies for qualified engineers in charge of plant and machinery, and maintenance of the requisite standard has only been met by resorting to recruitment from overseas, in certain cases.

158. In order to tide over these periods, temporary exemptions have been applied for and have been conditionally granted to enable Users to carry on.

Inspections

159. The following Mines and Works came under inspection:—

(a) Mines: Surface and underground 3
(b) Works: Including factories, mills and workshops . . . 55
(c) Pressure Plant (a) and (b): Certification up to date.

Mines and Quarries

160. Development at Mpaka Colliery has necessitated extensions underground including further certified flame proof apparatus and the use of higher voltages.

161. Arrangements have been made to take supply from the Electricity Board in 1967.

Legislation

162. Circumstances have found it necessary to amend both the proposed new Mines and Quarries (Machinery) Regulations and the proposed new Factory Law and Machinery Regulations where these are common to both, before the existing Mines, Works and Machinery Regulations can be repealed.

163. The proposed draft has been circulated to Users during the latter part of the year with the result that a number of suggestions have been carefully considered and incorporated.

Industry and Accidents

164. This section is to be published in the Labour Department Annual Report for 1966, pursuant to the formation of the proposed Factory Department.

165 Accidents (as distinct from mining accidents) involving lost time of three days or more were reported as follows:—

1966	Fatal	Lost time
Mines and Quarries	1	15

Classification	Mines and Quarries	Fatal
Machinery	1	1
Loading	3	—
Vehicles	—	—
Sundry	11	—
TOTAL	15	1

Arms, hands and fingers	Legs and feet	Head and Body	Eyes
7	6	1	1

Mines and Quarries	No. of shifts lost	Average shifts lost per accident
—	146	9.73

166. The above fatal accident occurred underground when a person was run over due to the accidental starting of a battery operated locomotive.

VIII. HEADQUARTERS

[A] Administration

167. In the Territorial Estimates a sum of R87,488 was provided for the normal running cost of the Department. The above figure was supplemented by finance, provided under three Colonial Development and Welfare Schemes, of a further R64,268. These were C.D. and W. Schemes D.5926 "Location of Underground Water Supplies", Scheme D.6548 "Territorial Counterpart Contribution to the United Nations Special Fund Project" and Scheme D.6202 "Office Accommodation for Geologists".

168. In addition to maintaining a close liaison with the mining houses the Department advises other Government Departments and members of the public on a variety of geological matters.

169. In spite of the erection of a new block of offices for geologists and a draughting office, the accommodation situation has reached saturation point. The situation now obtains where it would not be possible to accommodate any additional staff, professional, technical or clerical.

170. It give me great pleasure to record my sincerest appreciation to all members of the staff of the Department for their loyalty and efficiency throughout the year.

[B] Drawing Office

171. During the year under review the staff consisted of a draughtsman, a draughtswoman and a learner draughtsman. The last mentioned officer, Mr. A. Vilakazi, was awarded a scholarship and left for Canada on the 4th October. It is expected that his course will last from between two to three years.

172. The main item of work produced during the year was the new 1:250,000 geological map of Swaziland in twelve colours. This map took many man hours to complete and was in part responsible for the decrease in the number of fair drawings this office turned out in comparison to the previous year, the total number of drawings being forty five.

173. In addition to the above this office was made responsible for the complete mapping programme for the 1966 Swaziland Population Census. This work took up a considerable amount of time and casual labour was engaged to keep the schedule set by the Census Department. Further maps were produced for outside agencies and these included a constituency boundary map for the House of Assembly elections.

174. The office acquired, during the year, two sets of aerial photographs of Swaziland. One set will be used in the office and the other for field work. Considerable use is being made of these photographs by the United Nations Mineral Survey. It should be noted that many plans have been drawn for this survey which have not been listed in the plans produced during the year.

175. The dye-line machine has given an unusual amount of trouble this last year, but notwithstanding this, a total of 2,077 prints were prepared for distribution.

[C] Library

176. The Department maintains a well stocked library to which additions in the form of the latest, up-to-date technical publications are continually being made. The library receives current geological and mining periodicals and allied scientific magazines.

177. The Department's publications, including bulletins, reports and maps, are distributed on a reciprocal basis to other Surveys, and universities throughout the world.

178. Mrs. B. M. Bain, the accounts assistant, also acts as librarian and is responsible for the filing, indexing, etc., of all publications and information received.

[D] Laboratory

179. With the arrival late in the year of Mr. M. Baker, geochemist, of the United Nations Special Fund Project, Mineral Survey of Swaziland, the laboratory was completely re-organized and re-equipped essentially as a laboratory to cope with geochemical analyses.

180. Much new equipment of glassware was purchased. Most of this had arrived and was in use at the year end.

181. Samples totalling 255 in number were sent for assay and analysis during the year. In addition several hundred samples were crushed and panned in the course of routine investigations.

182. The samples were assayed for the following constituents:—

Alumina	17
Arsenic	1
Calcium	11
Carbon dioxide	11
Chromium	1
Coal analyses	2
Gold	75
Iron	38
Manganese	2
Nickel	41
Phosphorous	1
Platinum	7
Potassium	10
Silica	28
Sulphur	1
Titanium	5
Vanadium	4
	255

[E] Publications

183. The following reports and bulletins were published during the year.

1. Annual Report of the Geological Survey and Mines for the year ended 31st December, 1965.

2. Bulletin No. 6 of the Geological Survey and Mines Department.

3. The origin of kaolin deposits, Mahlangatsha Mountains, by D. R. Hunter and J. G. Urie, Published in Economic Geology, Vol. 61.

184. A list of unpublished Departmental and other written reports by the professional staff is contained in Appendix V. A list of maps and plans produced in the draughting office during the year is given in Appendix IV. Except for those of a confidential nature, all are available to the public on request.

[F] Visitors

185. As usual a very considerable portion of the professional and technical staff's time was taken up in discussions, both of an academic and economic nature, with members of the geological and mining fraternity. In many instances, these discussions were followed by field visits to interesting areas.

[G] Acknowledgements

186. The Department acknowledges its indebtedness and thanks to the following for their co-operation and assistance in a variety of ways:—

The staff of the Secretariat, Mbabane.
The Director and staff of the Overseas Geological Surveys.
The Director and staff of the Overseas Surveys.
The Director and staff of the Geological Surveys of the Republic of South Africa.
The Director and staff of the Geological Survey of Mocambique.
The Director and staff of the Bernard Price Institute, Johannesburg.
District Commissioners and Police Force of the Territory.
The Manager and staff of the Havelock Mine.
The Manager and staff of Peak Timbers Limited.
The Manager and staff of Usutu Pulp Company, Limited.
The Manager and staff of the Ubombo Ranches Limited, Swaziland.
The Manager and staff of the Mhlume (Swaziland) Sugar Company.
The many members of mining companies operating in the Territory for their assistance and freely-given hospitality.
To members of the public for their co-operation with the Department.

D. N. DAVIES
Director of Geological Survey and Commissioner of Mines.

Mbabane
19th June, 1967.

APPENDIX I.

MINERAL PRODUCTION FOR 1966

	1965		1966		Increase		Decrease	
MINERAL	Short tons	R	Short tons	R	Short tons	R	Short tons	R
Chrysotile asbestos	40,883.56	5,793,501	36,142.44	4,986,804	—	—	4,741.12	806,697
Iron ore	1,124,310.00	4,426,735	1,754,022.00	7,798,816	629,712.00	3,372,081	—	—
Coal	33,032.40	66,388	73,589.00	128,105	40,557.00	61,717	—	—
Pyrophyllite	1,014.00	4,056	480.00	2,400	—	—	534.00	1,656
Barytes	540.85	3,322	1,150.00	9,910	609.15	6,588	—	—
Kaolin	829.50	3,222	646.82	5,652	—	2,430	182.68	—
Metallic tin	1.72	4,224	0.54	1,175	—	—	1.18	3,049
	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R
Gold	1,619.11	40,507	307.58	7,667	—	—	1,311.53	32,840
Silver	130.14	116	28.28	24	—	—	101.86	92
TOTALS		10,342,071		12,940,553		3,442,816		844,334

APPENDIX II.

MINERAL EXPORTS, 1966

MINERAL	COUNTRY TO WHICH EXPORTED	SHORT TONS	VALUE R
	Argentina	1,000	110,000
	Belgium	200	26,000
	Denmark	560	59,360
	Eire	600	88,800
	Finland	550	62,480
Chrysotile	France	800	104,000
	India	97	14,356
Asbestos	Nigeria	965	112,440
	Norway	560	59,360
	Republic of South Africa	8,027	981,445
	Spain	4,100	528,800
	Sweden	560	59,360
	United Kingdom	18,123	2,780,382
	West Germany	Sample	21
Barytes	Republic of South Africa	1,150	9,910
Coal	Mocambique	Not available	29,788
	Kenya		7,899
Iron Ore	Japan	1,754,022	7,798,816
Kaolin	Republic of South Africa	647	5,652
Pyrophyllite	Republic of South Africa	480	2,400
Tin concentrates	Republic of South Africa	¾	1,175
		Fine ozs.	Value R
Gold	Republic of South Africa	308	7,667
Silver	Republic of South Africa	28	24

APPENDIX III

LABOUR STATISTICS

Month	SKILLED					UNSKILLED							TOTALS		
	Below Surface	On Surface	Total	Earnings R	Earnings c	Below Surface	On Surface	Total	Earnings R	Earnings c	Value of food R	Value of food c	Total Labour	Total earnings and food R	Total earnings and food c
January	41	166	207	60,505	18	678	1,221	1,899	53,241	61	13,471	21	2,106	127,218	00
February	39	169	208	61,153	52	680	1,266	1,946	59,173	30	12,459	14	2,154	132,785	96
March	41	169	210	59,024	86	680	1,269	1,949	58,967	69	11,241	80	2,159	129,234	35
April	37	175	212	58,290	03	683	1,273	1,956	58,957	52	11,475	26	2,168	128,722	81
May	34	175	209	59,770	97	680	1,283	1,963	61,774	91	12,733	31	2,172	134,279	19
June	34	181	215	58,731	07	676	1,296	1,972	62,709	61	13,116	47	2,187	134,557	15
July	30	180	210	61,351	84	702	1,304	2,006	63,177	71	15,195	00	2,216	139,724	55
August	28	179	207	60,725	07	700	1,317	2,017	70,461	65	14,472	42	2,224	145,659	14
September	30	180	210	62,428	35	700	1,355	2,055	69,961	89	14,363	15	2,265	146,753	39
October	30	176	206	61,755	32	705	1,324	2,029	69,555	09	13,523	82	2,235	144,834	23
November	27	183	210	64,715	10	688	1,296	1,984	65,502	60	13,856	25	2,194	144,073	95
December	26	185	211	66,682	69	682	1,292	1,974	68,370	93	13,391	75	2,185	148,445	37
Totals	397	2,118	2,515	735,134	00	8,254	15,496	23,750	761,854	51	159,299	58	26,265	1,656,288	09

APPENDIX IV.

SUMMARY OF DIAMOND DRILLING FOR THE YEAR ENDING 31ST DECEMBER, 1966

B.H. No.	Depth ft.	Formation	Locality	Remarks
275	127	Quartzite	Farm 5P	Siderite Deposit, Forbes Reef
276	254	Serpentinite	Farm 21P	Asbestos Deposit, Mankaiana
277	251	"	" "	" " "
278	334	"	" "	" " "
279	250	"	" "	" " "
280	1141	Sandstone and Dolerite	Lapsed Min. Conc. 19	Coal Prospect, Mpaka.
281	907	Sandstone and Dolerite	" " " "	" " "
282	155	Banded Ironstone	Farm 21P	Aerial Geophysical Survey
283	900	Sandstone and Dolerite	Lapsed Min. Conc. 19	Coal Prospect, Mpaka.
284	155	Metamorphic Rock	Farm 210	Swaziland Barytes Mine
285	120	" "	" "	" " "
286	103	" "	" "	" " "
287	113	" "	" "	" " "
288	135	" "	" "	" " "
289	155	" "	" "	" " "
290	108	" "	" "	" " "
291	100	" "	" "	" " "
292	305	Dolerite and Lava	Farm A/23P	Antimony at She Mine
293	241	Granite and Schist	Farm E/17P	Kaolin, Forbes Reef

CONTINUED ON NEXT PAGE

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDING 31ST DECEMBER, 1966 CONTINUED FROM Page 40

B.H. No.	Depth ft.	Formation	Locality	Remarks
294	115	Metamorphic Rock	Farm 210	Swaziland Barytes Mine
295	457	Granite and Schist	Farm E/17P	Kaolin, Forbes Reef
296	152	Metamorphic Rock	Farm 210	Swaziland Barytes Mine
297	188	Dolerite	Swazi Nation Land 28	E.T.C. Mines Coal Prospect Ngqamphalala
298	374	Sandstone, Shale and Dolerite	Swazi Nation Land 28	E.T.C. Mines Coal Prospect Ngqamphalala
299	151	Schist	Farm 5	Forbes Reef Gold Mine
300	252	Amphibolitic ironstone	Farm 3	Aerial Geophysical Survey
301	392	Sandstone and Dolerite	Swazi Nation Land 28	E.T.C. Mines Coal, Ngqamphalala
302	544	Amphibolitic ironstone	Farm 3	Aerial Geophysical Survey
303	460	Sandstone and Dolerite	Swazi Nation Land 28	E.T.C. Mines Coal Prospect Ngqamphalala
TOTAL	8939			

APPENDIX V.

Reports by Professional Staff

BY D. N. DAVIES — DIRECTOR

1. Overseas Geological Survey report for the period 1st January 1966 to 31st December 1966.
2. Monthly reports to Her Majesty's Commissioner and the Honourable Member for Natural Resources.

BY D. R. HUNTER — SENIOR GEOLOGIST

1. Report on visit to Gongolweni Dam, Stegi, Lubombo District.
2. Note on underground water supplies and foundations in the Swaziland lowveld.
3. Note on boreholes drilled at the siderite deposit, Rashale, Forbes Reef.
4. Report on drilling of an asbestos prospect, Usushwana Valley, Hhohho District.
5. Report on drilling programme, Swaziland Barytes Limited, Oshoek, Hhohho District.
6. An estimation of drilling costs at proposed dam sites.
7. Report on coal drilling southeast of Mpaka dam.
8. Supplementary note on drilling operations at Swaziland Barytes Limited, Oshoek, Hhohho District.

to be published

1. Bulletin No. 6 Analyses of Rocks, Minerals, Ores and Water.
2. Explanatory notes to accompany sheet 2531 CD (with D.H. Jones).

BY J. G. URIE — GEOLOGIST

1. Note on the examination of an occurrence of copper-bearing float in the Sinceni area, Lubombo District, Swaziland.
2. Note on prospecting for Kaolin in the Mahlangatsha Mountains, Manzini District.
3. Note on the examination of nickelferous laterite in the Motshane Valley, Forbes Reef Area, northwestern Swaziland.

BY D. H. JONES — GEOLOGIST

1. Explanatory notes to accompany sheet 2531 CD (with D. R. Hunter).

APPENDIX VI.

Maps and Diagrams Produced in 1966.

No.	*Title*	*Scale*	*Author*	*Date*
704	Sections through the 4th Body (Kaolin)	1:1000	D.R.H.	4/1/66.
705	Sections through the Main Body (Kaolin)	1:1000	D.R.H.	4/1/66.
706	Kaolin occurrences in the Mahlangatsha Mountains	1:1000	D.R.H.	6/1/66.
707	Locality Map of Kaolin Deposit	1:50,000	D.R.H.	6/1/66.
708	Plan of Mpaka Colliery Area. (water borehole sites)	Various scales	J.W.	7/1/66.
709	Location of Boreholes in Karoo/ Precambrian boundary	1:500,000	J.W.	7/1/66.
710	Ngomane Area (water borehole sites)		J.W.	7/1/66
711	Mpaka Area (water borehole sites)		J.W.	14/1/66.
712	Mpaka Area (water borehole sites)		J.W.	14/1/66.
713	Ranches North of Sipofaneni (water borehole sites)		J.W.	14/1/66.
714	Guguka, Sitobela and Poponyane (water borehole sites)		J.W.	14/1/66.
715	Maloma, Lafumisa Area (water borehole sites)	1:50,000	J.W.	14/1/66.
716	Hlushwane Area (water borehole sites)	1:50,000	J.W.	24/1/66.
717	Plan of Mliba Area (water borehole sites)		J.W.	24/1/66.
718	Geology of the Sicunusa-Mankaiana Area. Southwestern Swaziland	1:25,000	C.J.B.	28/2/66.
719	Geology of Pigg's Peak, Havelock Area	1:25,000	D.H.J.	18/3/66.
720	Geological Section Pigg's Peak — Havelock Area.	1:25,000	D.H.J.	18/3/66.
721	New Borehole Sites near Mpaka Colliery	1:5,000	J.W.	9/6/66.
722	Plan of Upper Hot Spring, Ezulwini	Not to scale	D.N.D.	0/6/66.
723	Stream profiles of Dwalile — Litchfield Area	1:25,000	C.J.B.	0/6/66
724	Overlay from Air Photo. No. 156	1:30,000	J.W.	0/0/66.
725	E. M. Gun Traverses Upper Usushwana Valley	Graph.	J.W.	0/0/66.
726	Traverses with Hilger-Watts Vertical Force Magnetic Variometer	Graph.	J.W.	0/0/66.
727	Sections to accompany Geological Map Dwaleli-Litchfield Area	1:25,000	C.J.B.	29/3/66.

No.	*Title*	*Scale*	*Author*	*Date*
728	Swaziland Mineral Survey (time-table)	—	J.H.	20/4/66.
729	Geological map and Sections of Siderite deposits. Rashale.	1:1,000	D.R.H.	14/7/66.
730	Geological Sketch Plan Asbestos Prospect. Usushwana Valley.	1:10,000	D.R.H.	18/7/66.
731	Base Maps of Swaziland	1:250,000 1:500,000		27/7/66. 28/7/66.
732	Bulandeni Area (water borehole sites)	1:25,000	J.W.	2/8/66.
733	Geology of the Granodioritic Gneisses Northwest of Manzini.	1:50,000	D.R.H.	5/8/66.
734	Borehole Sections, Swaziland Barytes Ltd.	1:50	D.R.H.	8/8/66.
735	Mololotsha Drainage Area, Geochemical Reconnaissance	1:10,000	J.H.	8/8/66.
736	Location of Boreholes, Swaziland Barytes-Waterfall Area	1:1,000	D.R.H.	29/8/66.
737	Borehole Sections. Swaziland Barytes.	1:500	D.R.H.	5/9/66.
738	Representation of Schematic Occurrence of Barytes.	Not to scale	D.R.H.	6/9/66.
739	Lismore Estate (water borehole sites)	1:12,500	J.W.	8/9/66.
740	Vermaak's Estate (water borehole sites)	1:12,500	J.W.	8/9/66.
741	Plan and Section of Boreholes, Mpaka Area, Lubombo District	1:1,000	D.R.H.	6/10/66.
742	Location of boreholes, Waterfall and Southern Areas, Swaziland Barytes.	1:1,000	D.R.H.	12/10/66.
743	Geology of Gneisses, North of Malinda	1:50,000	D.R.H.	13/10/66.
744	Generalized Geology of the area in which copper-bearing float was located	1:50,000	J.G.U.	12/12/66.
745	Map of Neina Area, Lubombo District	1:25,000	J.W.	19/12/66.
746	Geology of the Swaziland Granites.	1:100,000	D.R.H.	/66.
747	Area proposed for Airborne E.M. flying	1:50,000	J.H.	/66.

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SWAZILAND

ANNUAL REPORT

of the

GEOLOGICAL SURVEY AND MINES DEPARTMENT

FOR THE YEAR ENDED
31ST DECEMBER 1965

Price – 50c (5/-)

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FOR THE YEAR ENDED
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PRINTED BY SWAZILAND PRINTING AND PUBLISHING COMPANY LIMITED MBABANE, SWAZILAND.

CONTENTS

I. STAFF OF THE GEOLOGICAL SURVEY AND MINES DEPARTMENT

Director of Geological Survey and Commissioner of Mines	D. N. DAVIES, O.B.E., M.Sc., (Rand.), B.Sc., (Stell.), M.G.S., (S.A.).
Geologist	D. R. HUNTER, M.Sc., (Lond.), F.G.S., M.G.S., (S.A.).
Geologist	J. G. URIE, M.Sc., (Rand.), B.Sc., (Hons.) (Rhodes), M.G.S. (S.A.).
Geologist	D. H. JONES, B.Sc., (Hons.) (Wales), F.G.S., (Lond.), M.G.S. (S.A.).
Geologist	C. J. BEGGS, B.A. (Mod.) (Dublin).
Geologist/Geophysicist	J. K. WHITTINGHAM, B.Sc., (Lond.).
Inspector of Mines.	D. A. C. PURSER, A.C.S.M., A.M.I.M.M.
Inspector of Machinery	T. G. BLOFELD, E.D., A.M.I. Mech.E., A.M.I.E.E.
Drilling Superintendent	D. HORN, M.B.E.
Diamond Driller	R. A. M. MYBURGH.
Diamond Driller	J. S. MCCALL (retired on expiration of contract.)
Diamond Driller	P. J. VAN DER WALT.
Draughtsman	C. G. MATTHEWS.
Draughtswoman	MISS E. M. MACPHERSON.
Personal Assistant	MISS J. WHITE.
Accounts Assistant	MRS. B. M. BAIN.
Stenographer	MISS S. F. HARVEY.
Clerk	MRS. C. THABEDE.

II. INTRODUCTION

The year 1965 saw the first full year of production for the Ngwenya iron ore mine and the colliery at Mpaka. The resultant considerable increase in value of minerals produced is reflected in the annual figures in Appendix I.

2. Dr. S. H. Shaw, C.M.G., O.B.E., Director of Overseas Geological Surveys visited the Department for four days in June for technical discussions with His Excellency, Sir Francis Loyd, K.C.M.G., O.B.E., and the Director and staff of the Department and also other Senior Government officials.

3. The Director accompanied Mrs Eirene White, M.P., Parliamentary Under-Secretary of State, on a tour of the Havelock asbestos mine. The Under-Secretary of State, Colonial Office, J. E. Marnham, Esq., C.M.G., M.C., T.D., visited the Ngwenya iron ore mine in the company of the Director and Acting Manager, Mr. R. Stephenson.

4. With the arrival of Mr. J. K. Whittingham, geologist/geophysicist the C.D. & W. Scheme for the location of underground water supplies was set in motion. Miss M. E. Macpherson was appointed to the post of assistant draughtswoman and Miss S. F. Harvey to the post of stenographer in the place of Miss V. M. Slatem who resigned to get married. Mr. J. S. McCall, Driller, retired on the expiration of his contract. Mr. P. J. Van der Walt was appointed to this post. Mrs. Thabede was appointed to the post of clerk and Mr. Vilakazi to the newly created post of Trainee Draughtsman and Messrs P. Gama and J. Motha were appointed Trainee Drillers. During the absence of Mr. D. A. C. Purser on overseas leave, Mr. Urie, acted as Inspector of Mines. I regret to report that Mr. T. G. Blofeld, Inspector of Machinery, was taken ill in the last quarter of the year and is still on sick leave at the year end.

5. During the year the application made to the United Nations Special Fund for financial and technical assistance for an aerial geophysical survey of the Territory was approved. It is anticipated that the Project Manager will assume duty early in 1966, and that the flying operations will commence in the second quarter of the year.

6. Prior to the arrival of Mr. Whittingham the opportunity was taken to visit the Bechuanaland Geological Survey whose advice on the problems of underground water supplies and geophysical equipment was greatly appreciated.

7. The Geological Society of South Africa held its Eighth Annual Congress in Johannesburg in July. This was attended by the Director, who was on the congress organization committee, and Messrs Hunter and Urie. Papers were presented at the annual congress by Messrs Hunter, Urie and Jones. On the seven day post-Congress excursion to the Barberton Mountain Land the Director was one of the organizers of the Swaziland excursion and Messrs Hunter and Urie acted as guides.

8. Close liaison has been maintained with Dr. Snelling of the Age Determination Unit, Oxford, of the Overseas Geological Survey and also with Dr. Allsopp, of the Bernard Price Institute, Johannesburg in connexion with the geochronology of a variety of Swaziland rock types. The most helpful assistance provided by both these organization is gratefully acknowledged.

9. Samples for age determination also were collected for submission to Professor Engel of the University of California. Specimens of ultrabasic rocks were prepared for the Economic Geology Research Unit of the University of the Witwatersrand in connexion with their contribution to the International Upper Mantle Project.

10. The secondment to the Territory of Dr. Masson-Smith and Mr. Evans, of the Geophysical section of the Overseas Geological Surveys, London, who undertook the first detailed gravity survey of Swaziland, was greatly appreciated. The preliminary results of their work expected early in 1966 are eagerly awaited.

11. Due to very severe drought conditions particularly in the Lowveld area which were only alleviated by rains very late in the year, coupled with a serious outbreak of foot and mouth disease in February, considerable attention, as an emergency measure, had to be given to the siting and drilling of water boreholes in selected areas. This crash programme naturally interferred with the planned routine work of the Department. Nevertheless the strategically sited water boreholes should be of lasting benefit to community development.

III. GEOLOGICAL SURVEY

12. Mr. D. H. Jones continued the detailed mapping of the Swaziland System rocks and the Jamestown Igneous Complex ultramafics in northwestern Swaziland. An area of 57 square miles was mapped using aerial photographs on a scale of 1:10,000 and topographical forestry maps of 1:12,000 scale.

In the Lichfield — Dwaleli area of southwest Swaziland Mr. C. J. Beggs mapped 56 square miles on a scale of 1:10,000. The area is underlain by granites, gneisses, pyroxenites, amphibolites and serpentinites. During the early part of the year Mr. J. G. Urie undertook a detailed study of the metamorphism of sedimentary and ultramafic units of the Motjaan valley, Forbes Reef area, in northwest Swaziland and continued a reconnaissance structural investigation of the same area. This structural work, it would seem, has a considerable bearing on the mineralization of certain areas in this part of the country.

13. Mr. Hunter remapped a portion of the contact of the post-orogenic granite pluton southeast of Mbabane. Minor structures and lineations in the hornblende granodioritic gneiss southeast of Mankaiana were also mapped.

[A] BY D. R. HUNTER — GEOLOGIST.

14. The writer was on duty throughout the year except for a brief period of leave taken in September.

Coal

15. The drilling programme undertaken under contract with the Johannesburg Consolidated Investment Company Limited at the Maloma anthracite prospect was completed in January. The rigs were then moved to the area north of the Maloma-Nsoko road where the possibility was tested that intact blocks of coal remained. However, the boreholes drilled there indicated that there is considerable faulting which displaces the main seam to depths in excess of 1,000 feet below surface. In view of the unsatisfactory results work was abandoned.

Gold

16. Between April and September further boreholes were drilled at the dormant Daisy mine on behalf of Rand Mines Limited who had obtained a prospecting licence over the area. The results of this work are confidential.

Rashale Prospect

17. Towards the end of the year drilling began at the Rashale prospect at Forbes Reef. The area had been drilled some years ago during prospecting operations for radioactive minerals. This drilling encountered a hitherto unsuspected occurrence of siderite, prospecting rights to which were subsequently granted to the Swaziland Iron Ore Development Company Limited. The presence of metallic sulphides was noted in the original boreholes and it was decided to investigate the area again in the hopes of locating sulphide and auriferous deposits. At the year's end the boreholes were not completed.

Miscellaneous Drilling

18. A borehole was drilled on farm F55 in the Manzini District near the Transvaal border where an occurrence of chrysotile asbestos had been prospected some years ago. In one of the old boreholes a narrow nickeliferous sulphide segregation was intersected. This borehole was sited in an attempt to achieve a second intersection of this segregation but the borehole passed through only serpentinite and pyroxenite, the latter containing small patches of finely disseminated sulphides.

19. Boreholes were drilled for Swaziland Collieries Limited to help determine the displacements on faults in their mining area at Mpaka.

20. A borehole was drilled at the sillimanite occurrence in the Mahlangatsha Mountains. This drilling felt under J. G. Urie's control.

Geological Mapping

21. The contact of the Mbabane granite pluton with the gneisses was mapped north and south of Mbabane. A major fault in the pluton was traced from the Black Mbuluzi River northwards towards Forbes Reef where it crosses into the late-orogenic biotite granite.

22. Lineations and minor structures in the hornblende granodiorite gneiss were recorded in the area south and southwest of Mankaiana. The lineations plunge to the east at low angles. Insufficient work has been completed to interpret the significance of these lineations.

23. The work of a student from the University of Natal mapping an area of gneisses south of Hlatikulu was supervised.

Geological Research

24. The Bernard Price Institute of Geophysical Research, Johannesburg, continued to undertake age determinations on various granites. In connexion with this work samples of granite were collected from the Mliba area, the Ngwempisi pluton and the Hlatikulu area. Sixteen samples were collected and prepared.

25. As a result of the visit of Professor Engel of the University of California (San Diego) a large sample of gneiss was collected from the Mkondo valley north of Hlatikulu and prepared for submission to Professor Engel, who proposes to separate the zircon content for age determination.

26. Samples of basalt, dolerite and rhyolite were collected from Big Bend, Ngwavuma Gorge and Lubuli for age determination at Oxford University.

27. A suite of specimens of ultrabasic rocks was collected at the request of the Economic Geology Research Unit, University of the Witwatersrand. Thirty samples of kaolin were collected at the kaolin prospect in the Mahlangatsha Mountains to determine the distribution of TiO_2 in the clay.

Miscellaneous

28. The Annual Congress of the Geological Society of South Africa met in Johannesburg in July. The theme of the Congress was the geology of the Barberton

Mountain Land. A paper on the granites of Swaziland was prepared and read at the Congress. After the Congress a party of some thirty geologists spent three days in Swaziland, for whom itineraries and descriptive matter were prepared.

29. Evidence was given in court at Manzini in one case involving the fraudulent possession of unwrought gold.

30. Lectures on the organization, methods and objects of the Geological Survey and Mines Department were given to recruits to the Special Branch, Swaziland Police. A further lecture on geology was given to the pupils of St. Michaels' School, Manzini.

31. Various visiting mining engineers and geologists were shown mineral occurrences in which their companies were interested.

32. A short article on the early history of mining and prospecting in Swaziland was written for publication in the Swaziland Teachers Journal.

33. The editing of the Department's Bulletin No. 5 was completed and the first proofs from the printers corrected.

[B] By J. G. Urie — Geologist

34. During the early part of the year a structural investigation of the Forbes Reef — Ngwenya Iron Mine — Motjaan valley area was continued and a study was made of the metamorphic zones occurring along the periphery of the fold belt in this area.

35. In May an examination and survey of clay fields in the vicinity of Maseru, Basutoland was undertaken. During July the writer attended the 8th Annual Congress of the Geological Society of South Africa and post-congress excursion through Northwestern Swaziland and the Barberton Mountain Land. Two papers entitled "Metamorphic Zones and the Archaean Fold Belt in Northwestern Swaziland" by J. G. Urie and D. H. Jones and "A Reconnaissance Structural Investigation in the Forbes Reef Area, Swaziland" by J. G. Urie were read at the congress.

36. In September and part of October the post of Inspector of Mines was held during the absence on overseas leave of Mr. D. A. C. Purser. During the remainder of the year investigation of mineral occurrences in various parts of the territory was carried out.

37. Work at headquarters included the preparation of reports, the examination of numerous rock slides and the identification of specimens submitted by private persons and the Police Department.

Forbes Reef — Ngwenya Iron Mine Area — Hhohho District

38. Within this area Archaean sediments of the Swaziland System and schists of the Jamestown Igneous Complex are the primary rock types encountered. These geosynclinal sediments and associated schists have been strongly folded and invaded by a late orogenic granite.

39. A study was made, in particular, of the formations occurring within the metamorphic aureole of the granite. Within the aureole gneissic, hornfelsic and serpentinous rocks and amphibolitic, chloritic and talcose schist occur. On a mineralogical basis the rocks lying within this peripheral metamorphic zone have been divided into meta-sedimentary and magnesia-rich groups. The former includes derivatives of sedimentary material and possibly also volcanic material. In the field a transition from quartz-chlorite-carbonate schist to pyroxene-bearing hornfelses can be traced across the metamorphic aureole. The magnesia-rich group includes serpentinous, amphibolitic and talcose rocks which are largely, if not entirely, derived from ultramafites. A transition from antigorite-chlorite-amphibole rocks, occasionally containing olivine, to talc-chlorite-carbonate schists can be traced outwards from the granite contact.

40. Investigation of small scale structures in the area was continued. Despite the structural complexity of the area, studies to date indicate that deformation can be related to only two main folding episodes:— (i) An early and intense phase of folding about northerly to northeasterly trending axes. This folding episode is attributed to a complex stress system operating in an east-west to west-northwesterly direction. (ii) A later and less intense phase of folding about northwest trending axes. This folding phase deformed the earlier structures and led to the imprinting of new structures.

41. Studies of structural phenomena along the granite contact suggest the following. The onset of granite emplacement was broadly synchronous with the early period of deformation. Emplacement of the granite in its final position was not simultaneous along the length of the fold-belt. The position which the near-structureless granite in the Forbes Reef area occupies was attained only in the waning phases of the early period of deformation. The position which the marginally foliated granite of the Motjaan valley occupies was possibly attained at an earlier stage. The relationship of granite emplacement to the second phase of deformation has not been established. It would appear, however, that folding occurred either after emplacement of the granite but prior to complete consolidation of the magma or possibly during some late phase of granite emplacement.

Cinnabar — Hhohho District

42. A prospecting gang operating in the Pigg's Peak area found traces of cinnabar mineralization to the north of the known occurrence at Cinnabar Ridge. Trenching of the area did not reveal the presence of the mineral in any quantity.

43. Interest in the area was, however, re-awakened and, in collaboration with the concessionaires, it was decided that subsurface investigation of the occurrence at Cinnabar Ridge was warranted. Accordingly an existing adit is now being driven eastwards to intersect the mineralized zone at a depth of approximately 100 feet below the level of the old quarry. Operations commenced in June. As only hammer boys are being used, progress in the fractured but hard cherts and mylonites has been extremely slow and the anticipated zone of mineralization is only now being penetrated. Other than trace amounts of cinnabar in panned samples no mineralization has been observed.

Sillimanite — Manzini District

44. The existence of sillimanite-bearing horizons along the eastern flank of the Mahlangatsha mountains and towards the base of the Mozaan Scries has been

known for some years. The alumina content of these horizons is, in general, rather low and a further search in the area was thus undertaken.

45. A minor occurrence of sillimanite-bearing rock was located on Farm No. 588 and to the east of the known horizons. With the exception of the upper portion of the horizon the rock has a coarsely felted texture. Acicular laths of sillimanite and intergrown quartz are the essential constituents. Muscovite, iron oxides, zircon and other accessories are present. Results of partial analyses of random specimens are given below:—

Sample	SiO_2	Al_2O_3	TiO_2	FeO
1	49.92	46.19	1.16	1.00
2	52.54	42.28	0.63	0.30
3	64.09	31.28	0.97	1.29

46. The analyses indicate that the sillimanite content is appreciable. The horizon is as much as 20 feet in thickness but its strike length is extremely limited. To the north it pinches amid the granulitic country rock while to the south it is terminated by the granite so that the strike length does not exceed 700 feet. A borehole drilled to the south of the most southerly outcrop and so sited as to intersect the horizon at an anticipated depth of 200 feet penetrated only granulitic country rock and a series of granite tongues. The horizon occurs at the foot of, and dips westwards at an angle of 30° into the mountain scarp. Mining would necessitate the stripping of large tonnages of overburden and it is unlikely that the occurrence could be successfully exploited.

Lithium — Shiselweni District

47. Lithium-bearing pegmatites in the Kubuta area were originally reported and briefly described by G. N. Hamiliton in 1938.

48. These pegmatites are situated along the crest and southern flank of a rounded hill lying approximately one mile west-northwest of the Kubuta homestead.

49. A medium-grained leucocratic rock of granitic composition builds the crest and northern flank of the hill. Along the southern and eastern flanks granodiorite and rafts of amphibolite occur.

50. The lithium bearing pegmatites are present as two fairly large, and a number of smaller bodies. They are irregular in form and appear to be subhorizontal masses.

51. Alkali feldspar, microcline, orthoclase and albite, along with quartz, form the principle constituent minerals of the pegmatites. Lithium bearing minerals are represented by rubellite and lepidolite. The former is seen as pink coloured, acicular prisms. Lepidolite occurs as small plates but more commonly is seen as massed aggregates of small shreds which in hand specimen form scattered, interstitial, mauve coloured patches and clusters. In places mauve coloured quartz is seen. The microscope reveals that the colour is imparted by clusters of minute lepidolite shreds.

52. Results of analyses of 21 samples indicate that the lithium oxide content of the pegmatite varies from trace amounts to 0.66%. A sample of mineralized grani-

tic country rock returned a value of 1.53%. In view of the low lithia content and the small size of the pegmatite bodies successful exploitation of the occurrence would not be possible.

Clay — Maseru Basutoland

53. During October 1964, and at the request of the Basutoland Government a reconnaissance of the Maseru area was undertaken in order to ascertain if clays suitable for brickmaking are present in the vicinity of the township. Six fields were located and sampled. Preliminary kiln tests indicated that suitable material is present in four of the fields. During May of this year pitting, re-sampling and a survey of these four fields was undertaken. A detailed report has been submitted to the Basutoland Government.

[C] Report by D. H. Jones — Geologist

54. Apart from two weeks annual leave in January and four weeks overseas at the end of September, the writer was on duty throughout the year. The period from the end of January to the beginning of April was spend in headquarters interpreting data collected during the 1964 field season, examining 225 rocks slides and preparing geological maps and sections. In addition average heights were calculated in a kilometric grid on 1:50,000 scale topographical maps of Swaziland for use in the forthcoming geophysical survey of the Territory. At this time also a paper entitled "Metamorphic Zones of the Archaean Fold Belt in Northwest Swaziland" was written in conjunction with Mr. Urie of the Department for publication by the Geological Society of South Africa.

55. Detailed mapping of Pigg's Peak — Havelock area in the Hhohho District in northwestern Swaziland was undertaken from the beginning of April to the end of September. A tract of country covering 57 square miles was mapped in detail using 1:12,000 scale topographical forestry maps and aerial photographs enlarged to a scale of 1:10,000. The surveyed area is bounded to the west and northwest by the Transvaal border and to the southeast by the granite contact. It includes Emlembe Mountain to the north and is demarcated to the south by the southernmost boundaries of Swaziland Plantations Limited., Peak Timbers Limited and Havelock mine. The area is underlain by highly contorted rocks of the Swaziland System and Jamestown Complex into which have been intruded granite and post-granite dykes of basic composition. Constituting the southernmost extension of the Barberton Mountain Land auriferous belt, the area was extensively prospected for gold as well as asbestos, iron and cinnabar. All quartz veins, occurrences of sulphide-bearing rock and serpentinites were examined and all streams and rivers panned for gold. A total of 398 rock samples were collected of which 282 were panned and the remainder fire assayed. The old workings of the Emlembe and Pigg's Peak gold mines were investigated during the survey.

56. From October to the end of the year, the writer returned to headquarters duties and has been engaged on interpreting and plotting data derived from the 1964 field season.

The Pigg's Peak — Havelock Survey, Hhohho District

TOPOGRAPHY

57. The surveyed area of 57 square miles is of a very dissected nature and extremely complicated geologically. It is dominated along its western and northwestern margins by the Makonjwa Range with Emlembe Mountain forming the highest point with an elevation of 6,109 feet. In the centre of the area Nottingham Peak is a prominent landmark with its crest 4,200 feet above sea level. The road between Havelock and Pigg's Peak follows the watershed between the Lomati and Komati rivers. North of the road such tributaries as the Poponyane, Mgudugudu and Black Diamond Creek flow northeastwards to join the Lomati. South of the road such tributaries as the Umkomazaan and Ruby Creek deeply dissect the terrain on their way to join the Komati River.

STRATIGRAPHY

58. Stratigraphically the rocks of the area conform with the concept that the strata of the Barberton Mountain Land were deposited in a geosynclinal environment. The area constitutes, therefore, part of the relic of a classic Archaean geosyncline; the Swaziland System representing the depositional phase, the Jamestown Complex an initial magmatic phase and the granite to the southeast a late-orogenic phase.

The Swaziland System

The Figtree Series

59. The Figtree Series is the lowest represented member of the Swaziland System in the area and comprises a considerable thickness of mainly argillaceous sediments. It may be taken to represent a flysch facies in the foredeep of the geosyncline. Shales and phyllites form the greater part of the series with narrow intercalations of quartzites, grit, arkose and chert. Ferruginous shales and banded ironstones are prominent in the succession at Havelock and 1½ miles to the southwest at Iron Hill. The argillaceous sediments are generally soft and easily eroded whereas the more siliceous members form ridges of high ground.

The Moodies Series

60. The Moodies Series represents the molasse facies of the geosyncline consisting of psammitic and psephitic sediments. A well developed conglomerate marks the base of the series and is consistently present throughout the area, its absence at any locality being attributable to faulting. Comprising ill-sorted pebbles and boulders of chert, grit, shale, banded ironstone and, occasionally, jasper, the basal conglomerate lies disconformably on the underlying Figtree Series. Succeeding the conglomerate are uneven-grained gritty quartzites with scattered angular and sub-angular pebbles of grit and chert, and numerous loosely packed pebble and boulder conglomerates. Felspathic and calcareous grit bands occur intermittently throughout the quartzites. Due to the hardness of its sediments the Moodies Series occupies high lying ground and builds the prominent Emlembe Mountain. At this last mentioned locality the basal conglomerate is particularly well developed to a thickness in excess of 250 feet. Inversion of strata results in the conglomerate being exposed on the whole dip slope of the mountain and the succeeding quartzites

being observed in deep gorges only. Moodies Series sediments also occur in a faulted synclinal trough lying between Nottingham Peak and Pigg's Peak mine.

THE JAMESTOWN COMPLEX

61. Metamorphosed ultra-basic rocks of the Jamestown Complex occur in intimate association with Figtree Series sediments. Besides talc-tremolite schist, talc-chlorite schist, talc-carbonate schist and amphibolite, lenticular shaped bodies of serpentinite are prevelant throughout the area. Light apple green and dark green coloured varieties occur. The contact between the serpentinite bodies and the associated schists may either be gradational or, as is more commonly the case, sharply defined due to faulting. At Havelock mine the chrysotile-bearing, apple green serpentinite occurs in a core of dark green coloured serpentinite. The contact between the serpentinite and adjacent schists and sediments is nearly always faulted, though one surface outcrop clearly show banded ironstones of the Figtree Series to have been engulfed by serpentinite. Due to its inherent softness, the rocks of the Jamestown Complex form low lying ground. It is haphazardly associated with argillaceous sediments or with major fault zones.

INTRUSIVE ROCKS

The Granite

62. The late-orogenic granite demarcates the southeastern boundary of the surveyed area and in consequence only its contact has been surveyed. Its emplacement has had profound structural and metamorphic effects upon the pre-existing rocks. Essentially a medium-grained biotite granite, observed variations in the field would indicate its intrusion to have occurred in more than one phase. Both foliated and unfoliated varieties occur adjacent to the country rocks and furthermore the aureole of contact metamorphism may vary considerably in intensity. On the property of Swaziland Plantations two miles southwest of Pigg's Peak, tongues of almost pegmatitic granite extend from the granite mass. They insinuate along foliation planes in the country rock with a cross-cutting relationship where the tongues join the main body of the granite. Portions of the granite become porphyritic in character in the southeastern extremity of the surveyed area.

The Dykes

63. Two types of dykes occur in the area; firstly, diabase dykes commonly deuterically altered, and, secondly, dolerite dykes which may be olivine or enstatite bearing. The former are considered to be pre-Karroo System and the latter post Karroo System in age. Their alignment is either in a northwest, east or north direction.

METAMORPHISM

64. The area has been subjected to a complicated history of metamorphism. Regional, thermal, contact, retrogressive and dynamic metamorphism in overlapping and repetitive phases have had a profound influence on the country rocks.

65. Metamorphism is most intense immediately adjacent to the granite contact. Jamestown Complex rocks in such an environment have invariably undergone

amphibolitization. Traced away from the contact the amphibolite zone grades into talc-amphibole, talc-chlorite and finally talc-carbonate schists, though considerably overlapping occurs between each zone.

66. Sediments in the immediate influence of the granite show metamorphic variations dependent upon their original composition. Argillaceous sediments containing chloritic minerals have invariably suffered amphibolitization. Amphibole gneisses are common in the southeastern extremity of the area and grits with an amphibole-rich matrix have also been observed. Aluminous sediments are converted to sericite or sericite-andalusite schists. Dolomitic phyllites in close proximity to the granite pass into pyroxene granulites. More arenaceous sediments have undergone re-silicification.

67. The presence of carbonate in Swaziland System and Jamestown Complex rocks and also steatization of the latter may be attributed to the effects of retrogressive metamorphism.

68. In by far the greater part of the area, regional and dynamic metamorphism have played the dominant role. The main features of such metamorphism are re-silification, mylonitization, sericitization and chloritization. Re-silicification, and mylonitization of some grits and quartzites may be so intense that they ultimately resemble primary chert, whereas many shales are converted to siliceous slates.

69. Sericitization of argillaceous sediments results in sericitic schists and phyllites. The introduction of interstitial chlorite and the formation of green chlorite schists is a feature of dynamic metamorphism.

STRUCTURE

70. Two orogenic phases have influenced the structural pattern of the area. The first and major phase initiated the tilting of the Figtree Series resulting in their erosion prior to the deposition of the Moodies Series. The Figtree Series may thus be regarded as pre-orogenic sediments and the Moodies Series as synorogenic having derived, in part, its material from the uplifted Figtree Series. The phase continued with increasing compression from the southeast resulting in the piling of the geosynclinal strata into a series of northeast aligned overfolds. Relief of the compressive forces was achieved by thrust faulting near parallel to the axial planes of the folds.

71. The second orogenic phase was less intense and with a stress direction originating from the southwest. Cross folding thus occurred on axes generally aligned northwestwards resulting in the buckling and warping of pre-existing fold keels. Such buckling is particularly evident in the Havelock mine area. At Iron Hill, 1½ miles southwest of Havelock, the stress from the southwest has been responsible for the arcuation of a pre-existing northeast aligned fold. This arcuation is only evident on the northwest side of a northeast striking wrench-thrust fault suggesting that the fault acted as a detachment plane. Re-activation along pre-existing thrust planes causing slip action can be attributed to the stress of this orogenic phase.

72. Orogenic activity culminated with a period of relaxation during which time tension faults and planes developed with either a northwest, east or north trend.

The basic dykes of the area are almost invariably intruded into these lines of structural weakness.

MINERALIZATION

73. The localization of mineral deposits is greatly influenced by structural controls in the area. Almost invariably mineralization is concentrated where a cross-folding or arcuation has occurred. Thus, in the Havelock—Pigg's Peak area, where such a stress has considerably influenced the structural pattern, gold, asbestos, iron and mercury minerals are present.

Gold

74. No new occurrences of gold were located during the survey. The old Emlembe and Pigg's Peak mines were, however, examined. In the former mine the ore body, a brecciated re-silicified rock in talc-schists, was sampled but only low gold values were obtained. Gold mineralization in the Pigg's Peak mine is associated with fractures in a re-silicified fine-grained, banded quartzite. Two main ore-shoots occur on surface but converge before reaching 4 level elevation. These shoots have been extensively mined but numerous pillars remain intact. Sampling of one such pillar gave a value of 12.84 pennyweights over a width of 10 feet. Extraction of these pillars could well be an economic proposition. In the country rock intervening between the main ore-bodies, gold mineralization is generally low grade, sporadic and confined to sympathetic fractures. Selective mining, however, could yield profitable results.

Asbestos

75. Two known occurrences of asbestos occur in the area, one at Havelock mine and the other ¼ mile to the west-southwest near the Transvaal border. The former is being mined and the latter has been extensively examined by the Department and Mineral Holdings Limited. During the present survey, a mile long body of dark green serpentinite was located in the Umkomazaan valley on the northwestern flank of Nottingham Hill. The serpentinite body, which is aligned in a north-easterly direction, and has an average width of 450 feet, carries pseudo-fibre at many localities. Numerous other small bodies of both dark green and apple-green coloured serpentinites with pseudo-fibre occur haphazardly throughout the surveyed area.

Iron

76. The iron deposit at Iron Hill has been previously examined by the Department and no further comments can be added. The ore consists of haematite and specularite of which there is a calculated tonnage of 15,045,000 tons at a mean grade of 48.66 per cent iron and 22.28 per cent silica.

Mercury

77. A known occurrence of cinnabar occurs on a prominent ridge threequarters of a mile southeast of the old Nottingham Hill mine. The cinnabar, which is finely disseminated in a sheared and chloritized, siliceous zone, is being investigated by the Department at the time of submitting this report. The writer found traces

of cinnabar in similar siliceous zones 1¼ miles south of the Nottingham Hill and also in the auriferous zone of the Nottingham Hill mine itself.

[D] REPORT BY C. J. BEGGS — GEOLOGIST

78. The writer was on duty throughout the year except for two weeks in October and one week in December when leave was taken.

79. The period from January to the beginning of April was spent at Headquarters completing a report on the geology of the Sicunusa-Mankaiana area from data obtained during the 1964 field season. The writer was also engaged during this period in compiling elevation maps for a gravity survey of the Territory.

80. From the beginning of April to the end of September the writer continued field mapping north of the Ngwempisi River in the Dwaleli — Lichfield area of southwestern Swaziland. Fifty six square miles of country were mapped on a scale of 1:10,000 using enlarged aerial photographs. During the course of mapping all streams in the area were panned.

81. From October to the end of the year the writer has been at Headquarters plotting the data and examining thin sections of samples collected during the field season.

The Dwaleli — Lichfield Survey (Manzini District)

82. The country mapped in the Dwaleli-Lichfield area is bounded on the north by the Bunya-Amsterdam road and on the south by the Ngwempisi River. To the east it is bounded by the Mponono River and on the west by the Transvaal border. It consists of hilly country with large areas of open veld dissected by deep valleys. The elevation ranges from 3,150 feet at the Ngwempisi River to 4,950 feet at Lichfield. Stream patterns in the area follow the dominant northwest to southeast joint direction.

Areal Geology

83. The greater part of the area is underlain by a suite of granite and granodioritic rocks. Caught up in these are many xenoliths of ultra-basic rocks. Just south of Dwaleli village a large body, 4½ square miles in extent, of amphibolites, pyroxenites and serpentinites occurs. Within this body is a wide band of quartzites, and meta-sediments, in the form of garnetiferous quartz-mica schists and recrystallised quartzites, appears on the southern flank of this body.

84. The granites in the area were originally classified collectively as G4 granite. The writer has subdivided the granites into various types. Chemical analyses and age determinations on these granitic rock types are required before a final classification can be given.

85. The granites range from the highly potassic pluton of coarse-grained Lichfield type through the potassic fine-grained Mabonye and Dwaleli types which occur in a sheet-like form to the sodic coarse-grained granodiorite of the Ngwempisi type.

86. Medium and coarse-grained veined gneisses representing the Ancient Gneiss Complex occur in the upper part of the Mponono River.

87. A large body of hypersthene gabbro occurs in the vicinity of Dwaleli Mountain and its contact with the surrounding country rock is marked in places by a very coarse intrusion breccia.

88. Pegmatization is very extensive in the south of the area but is less common in the Mabanye and Dwaleli granites and is completely absent in the Lichfield granite.

89. Dolerite dykes are very widespread throughout the area. Coarse-grained diabase dykes show an extensive development in the central part of the area and have a marked northwest to southeast trend and influence the stream pattern to a great extent.

90. Xenoliths of amphibolite and talc-tremolite-actinolite schists occur throughout the area, with the exception of that portion underlain by Lichfield granite. They tend to follow the general pattern of an aureole of amphibolitic schists with a core of talc-tremolite-actinolite schist.

Structure

91. Fold structures are only seen in the quartzite contained with the ultrabasic body south of Dwaleli village. The quartzite forms a broad syncline plunging southwest.

92. Lineations in the veined gneisses of the Mponono stream show a marked uniformity in a N 110 direction.

93. Major faulting is not seen within the area, with the exception of a large east to west fault which displaces the Mozaan quartzites to the west of the area in the Transvaal and which displaces the southern portion of Dwaleli ultrabasic body some 400 feet to the east on its southern side. Minor shearing associated with the intrusion of the Lichfield granite is seen in the Mponono River.

Economic Geology

(a) TALC

94. Six small bodies of talc schist were discovered on the gabbro-pyroxenite contact east of Dwaleli Mountain. The average strike length of these bodies is approximately 50 feet with an average width of 30 feet. Sampling of these bodies analysed as follows:—

Sample	*Silica %*	*Ferric Oxide %*	*Magnesium Oxide %*
B1266	55.53	1.63	27.73
B1268	53.74	3.97	24.28
B1270	54.90	4.31	25.26
B1271	59.02	0.75	27.88
B1272	58.49	1.25	27.38
B1273	57.36	1.50	25.66
B1274	52.10	1.72	26.01

[E] Water Supplies

95. With the arrival of Mr. J. K. Whittingham geologist/geophysicist the Department for the first time was able to undertake underground water investigations using geophysical instruments specifically designed for the purpose. In this connexion the thanks of the Department are due to the Director and Staff of the Bechuanaland Geological Survey for the loan of the Van Staden resistivity apparatus and for instruction in the use of this and other geophysical instruments under practical field conditions. The Department has a similar instrument on order in addition to the Tellohm and an EM Gun which was delivered late in the year.

(a) Report by J. K. Whittingham — Geologist/Geophysicist

Water Supplies

96. The writer arrived in Swaziland on appointment as Geologist/Geophysicist at the beginning of May.

97. In May — early June, three weeks were spent with the Geological Survey of Bechuanaland in Lobatsi, becoming acquainted with geophysical instruments and methods used there. The intruments used included Van Staden's resistivity apparatus, the Enslin-Slack electromagnetic apparatus, torsion balance, Jalander magnetometer and Hunting's S.F. 2 seisomgraph.

98. Shortly after return to headquarters in Mbabane, field work was commenced and the remainder of the year was spent on field work, chiefly in the Lowveld area. Electrical resistivity methods were used almost exclusively throughout.

Lubombo District

Nomahasha Area

99. Surveys were carried out in the Nkalishane valley in the Lebombo Mountains, and near to the Police/Customs post and school.

100. In the first instance, two sites were marked in the Nkalishane valley, one, it was thought, near to the margin of a basic dyke, the other in pediment with boulders overlying rhyolite. The latter site was considered unsuitable for a rotary drill so drilling was done at the former site. Drilling at this site was unsuccessful, passing through intrusive igneous rock to final depth of 250 feet. Subsequent geological investigation suggested that the "basic dyke" was in fact a sill of dioritic rock dipping gently eastwards. It is now considered that the chances of striking ground water in the Nkalishane valley above this sill are remote.

101. Three sites were marked on top of the Lebombo escarpment two immediately west of the school and a third about 1 mile west-northwest of the Police/Custom post. These are located in a zone of weathered rhyolite which runs from north to south immediately east of the scarp crest. Springs occur in small valleys below the crest of the escarpment. This would suggest that ground water does accumulate at the top of the escarpment and the spring water may be derived from ground water storage in the zone of weathered rhyolite.

Stegi Area

102. Four boreholes sites were located on top of the Lebombo escarpment in the vicinity of Stegi. Sites were selected at Ganspan close to the Swaziland/Mocambique boundary, at Magwanyana near the foot of the Lebombo escarpment and on Magomba Ranch.

103. At Stegi, one borehole site was selected, with two alternative sites, for the Nazarene Mission. These sites were selected in a zone of weathered rhyolite. The site marked for first drilling was drilled to a depth of 120 feet and gave a yield of 130 gallons per hour.

104. Three sites were also marked on Mabuda Estate at the request of the Honourable C. F. Todd. These were also marked in places where the resistivity survey indicated weathering to a depth of 70/90 feet. A borehole drilled on Mrs. Badenhorst's property adjoining Mabuda Estate, situated in the same zone of weathering as two of the sites marked, gave a yield of 450 gallons per hour drilled to a depth of 130 feet. This would suggest that the zone of weathered rhyolite crossing Mabuda Estate would be a promising source of ground water. (Two boreholes drilled on Mabuda Estate previously, situated away from the zone of weathering, were dry.)

105. At Ganspan Veterinary Field Station, one borehole site was chosen in a zone of rhyolite breccia. Such sites have proved successful in the Lebombo range both in the Republic of South Africa and in Swaziland near Mhlumeni.

106. One site was selected at Magwanyana close to the bed of the Nyetane stream near a site which previously proved unsuccessful. This site is in Stormberg basalt terrain and the Nyetane stream, flowing from north to south follows the strike of closely spaced dolerite dykes. The resistivity survey showed a narrow zone of low resistivity representing a zone of basalt between two dykes.

107. On Magomba Ranch (D.R. Koch's), one site was chosen by the stream channel immediately south of the house. The site was marked in sandstone and shale of the Ecca Series, close to the margin of a north to south vertically dipping dolerite dyke.

Nsoko Area

108. A survey was carried out at the Metropolitan Mission, Sipofaneni, in an attempt to locate a site for obtaining ground water. One spot was marked close to the margin of a dolerite dyke cutting basalt, but in view of the hardness of the rock in that area, chances of obtaining a good yield of water are considered to be remote.

The Karroo — Precambrian Boundary

109. A group of five two and half inch boreholes, drilled along the boundary between Karroo sandstone and Precambrian granites west of Mpaka Colliery in 1964, showed that plentiful ground water (between 500 and 800 gallons per hour) can be recovered from an aquifer at the base of the Karroo System and in weathered granite immediately below. South of Mpaka, the boundary is a normal fault, running west of north and dipping to the east. The fault plane is also considered to be a possible source of ground water.

110. In December, a survey was commenced, to locate borehole sites at approximately four mile intervals along the Karroo/Precambrian boundary. By the end of the year, the survey was complete as far south as Mbahaan Ranch (Corbett's).

111. Between Mbahaan Ranch and Bordergate, the Karroo/Precambrian boundary can be located approximately by examination of stream sections, but the boundary itself is not exposed at any of the localities visited. In some places, notably at Tshaneni, the boundary is complicated as a result of emplacement of dolerite sills.

112. Some assistance in accurate location of the Karroo/Precambrian boundary, especially where it is faulted, may be obtained from a series of resistivity depth probes aligned parallel to the boundary. The resistivity of the Karroo strata (sandstone and shale) is distinctly lower than that of the granite except where the latter is deeply weathered. Accordingly, the position of the boundary was estimated at the places where a depth probe, showing characteristic low resistivity, was located closest to the granite outcrops.

113. In this way, nine borehole sites were selected along the boundary between Mbahaan Ranch and the Black Mbuluzi river. (One site at Ngomane between the Black Mbuluzi and White Mbuluzi rivers, the remainder at approximately four mile intervals south of the White Mbuluzi). In addition, two new sites were selected on the Karroo/Precambrian boundary for use by Mpaka Colliery.

114. Immediately east of Mpaka Colliery, four possible drilling sites were marked about 200 feet northeast of a dolerite dyke which strikes northwest to southeast at 30° north. Previous exploratory drilling for coal in this area had shown that water occurs immediately above this dyke at about 90 feet in depth and a yield of over 300 gallons per hour was obtained. The four new sites were selected with regard to the possibility of striking water at comparable depth along the strike of the dyke.

SHISELWENI DISTRICT

Gollel-Hluti Area

115. Six borehole sites were chosen in the Sikalasebodwe, Matanjeni and Nkutshini divisions of Swazi Nation Land No. 31. On Skermerskraal Ranch (Hiestermann's), 2 sites were marked and on Progress Ranch (Hillary's) 3 sites were selected. All these sites mentioned above with the exception of those on Skermerskraal Ranch (which lie in Stormberg basalt terrain) are located in the terrain of the Ecca sandstone/shale formation. In this part of Swaziland, sediments of the Ecca Series and basalts of the Stormberg Series occur alternately, being repeated by a series of north-south faults, downthrowing to the west.

116. Details of the sites selected in Swazi Nation Land No. 31 are as follows:—

Site No. 1—Sikalasebodwe (near village). In sandstone/shale formation on eastern side of a dolerite dyke which runs north-south and dips steeply to the west. The site is near a stream which runs due east where the dolerite dyke appears to be displaced to the west by a east-west fault.

Site No. 2 — Matanjeni (south of Gollel — Hluti road). Above a weathered dolerite dyke cutting sandstone/shale and striking north-south. This site has been drilled — water was struck at 50 feet and a yield of 1500 gallons per hour obtained.

Site No. 3 — Matanjeni (near village). In sandstone/shale formation on margin of a dolerite dyke which runs north-south and dips vertically.

Site No. 4 — Nkutshini (upper Matanjeni valley). Above a weathered dolerite dyke cutting north-south across a sandstone/shale formation. This site was drilled, striking water at a depth of 195 feet and yielding 490 gallons per hour.

Site No. 5 — Nkutshini (Mhumba valley). In a broad valley floored by black cotton soil, lacustrine type limestone and calcrete, underlain by weathered sandstone, shale and dolerite.

Site No. 6 — Sikalasebodwe (near boundary of Vimy Ridge Ranch.) In broad valley (Msuzwane) floored by dark soils with dolerite and sandstone boulders, and underlain by sandstone/shale close to the line of a north-south striking dolerite dyke exposed north of the valley.

117. The sites selected on Skermerskraal Ranch are situated close to a north-south flowing stream close to the eastern boundary fence. Along this stream, a zone of soft sheared light green rock, probably derived from basalt, runs for a considerable distance, dipping about 85° to the west. It is considered that the soft rock, if intersected, at depth may yield ground water.

118. On Progress Ranch, two sites were marked on the eastern margin of a north-south dolerite dyke in sandstone/shale formation, east of the Sitilo stream. A third site was found in the upper Nkutshini valley in the northeast corner of the property; this site is located in weathered sandstone/shale close to a north-south dolerite dyke.

Veterinary Holding Ground, Gollel

119. Two and a half months were spent in the Holding Ground at Gollel to locate sites for drilling in the fourteen camps planned by the Agricultural Department. As far as possible two sites were marked in each camp, and one for the export camps close to Gollel Township.

120. The Veterinary Holding Ground covers an area about 11 miles north to south by 5 miles west to east on undulating plain country at the foot of the Lebombo Range. Along the eastern edge of the area, a chain of foothills of the Lebombo Range runs from north to south. The whole area west of these foothills is in Stormberg basalt terrain but the foothills and the pediment slope of the main Lebombo escarpment are formed by upper Stormberg rhyolites.

121. At the time of commencement of the survey, two boreholes had been drilled successfully in the Msuzwane valley, floored by black cotton soil overlying weathered basaltic rocks. One of these gave a yield of 1800 gallons per hour from a depth of 105 feet, another 360 gallons per hour from a depth of 170 feet. Two boreholes have been drilled in Camp 2 west of the Gollel-Big Bend road (sited by Jennings of Geological Survey, Bechuanaland). One of these, near the Mhlofunga stream yielded over 1000 gallons per hour, the other, a mile to the southwest, 180 gallons per hour.

122. The survey was concentrated along the main linear features crossing the Holding Ground area, namely the north-south depressions (Zibe valley, upper

Mhlofunga valley, and the valley filled with pediment east of the Lebombo foothills) also the valleys running west-northwest to east-northeast across the area (Msuzwane and Mhlofunga valleys). Altogether, 24 sites were marked for drilling. The first two to be drilled, in the area designated for the headquarters proved disappointing, one on the pediment slope behind the foothills yielded 180 gallons per hour of brackish water from 270 feet in depth, the other in the Zibe stream gave a very small yield after drilling to 250 feet.

123. At the former site, the borehole passed through a considerable thickness of rhyolitic ash which would very likely give a low resistivity anomaly resembling that indicating water-bearing strata. At the latter site anomalous geophysical results may be due to a 50 feet thickness of black cotton soil with boulders.

124. Comparing geophysical results obtained on the survey with results of drilling so far, it may be suggested that the west-northwest to east-southeast valleys, the Mhlofunga and Msuzwane, follow cross-cutting structural features which are more reliable aquifers than those in the valleys which follow the regional north-south strike.

Gollel Township

125. Plans have been made for expansion of Gollel township on the Swaziland side of the border and it is anticipated that present water supplies, obtained mainly from the tank installations of South African Railways, will be inadequate. Some brackish water was obtained from a borehole half a mile west of Gollel township. This borehole was stated to yield 1500 gallons per hour from a depth of 74 feet on testing.

126. A large north-south dolerite dyke runs through the eastern side of Gollel township and the possibilities of obtaining water from the flanks of this dyke was investigated. Geophysical depth probes suggested that the western flank of the dyke would be more favourable and six sites were marked at intervals along the flank of the dyke in the township area and Holding Ground Export Camp. Past experience has shown, however, that the margin of dolerite dykes cutting Stormberg basalts are often not good aquifers unless the dyke was emplaced at a later stage. In this case, one or two trial boreholes would be necessary to investigate the possibilities of obtaining water from this source.

127. Providing for the event of failure of boreholes on the dyke margin to yield adequate water supplies, two sites were selected in a north-south valley two miles west of Gollel. These are situated in Stormberg basalt terrain where topographical features show evidence for a north-south fault. Resistivity curves indicate that the basalt may be weathered or shattered to a considerable depth.

HHOHHO DISTRICT

128. Nine boreholes sites were selected in the Balegane area of Hhohho District, in granite terrain, in areas where geophysical investigations indicated that the granite is weathered to a considerable depth or shattered. Sites were marked at Masinde, Mbulu, Nkambeni, Shumehill, Nomngqai, Mangela, Nyakato (2) and Nkambeni School. Possibilities for ground water supply are considered good. One site was marked on Woodley Estate (Brigadier Worthington's) near Mbabane. At this site, a fissure or shatter zone crosses a mass of granite. Possibilities of obtaining a good water supply here remains doubtful.

MANZINI DISTRICT

129. Four boreholes sites were marked on Mafuteni Estate (Howe's). One site, near the farmhouse, was chosen where granite is cut by pegmatite and dolerite dykes, and where there are indications of weathering to considerable depth. Another was chosen one mile west of the farm where the north-south shatter zone occurs in the granite. Two others marked on the eastern side of the estate where geophysical depth probes indicate that granite is weathered to a considerable depth.

130. One site was selected for St. Joseph's Mission in a valley west of the Mission where granite appears to be weathered at depth. Another site was marked for St. Juliana's Mission on a ridge where granite is weathered to 130 feet in depth. Drilling to 200 feet at this latter site proved the prediction of the geophysical survey that granite is weathered to about 130 feet in depth but no water was struck.

Miscellaneous

131. Traverses were made near Mpaka Colliery and Gollel township with a Hilger-Watts Magnetometer across dolerite dykes, and, at the former locality, across the Karroo/Precambrian boundary.

132. An E. M. Gun purchased by the department was tested in Mbabane and the instrument was used in traverses at Gollel township. Results at Gollel were inconclusive owing to strong interference by barbed wire fences and other installations at the township.

[b] BY D. R. HUNTER

133. Two sites selected in the Malkerns valley on behalf of the Agricultural Department in 1964 were drilled during the year. One borehole yielded 750 gallons per hour and the other in excess of 2,200 gallons per hour.

134. Sites were selected and drilled at Nyetane dip (350 gallons per hour), Magomba (300 gallons per hour), Magwanyane (dry) and Koch's Ranch (350 gallons per hour). Sites were also selected on the Msuzwane stream near Gollel, and on farms belonging to Messrs Marvin and King. No results of these holes are available. Advice was also given to Mr. Howe and Swaziland Canners Limited on underground water.

135. The drilling of sites selected by Mr. J. K. Whittingham in the Nkalishane valley was supervised.

136. A visit was paid to the Bechuanaland Geological Survey at Lobatsi with the Director in connexion with the organisation of the underground water programme in Swaziland.

[F] SPECIAL INVESTIGATIONS

(i) *Engineering Geology*

137. Severe pollution of the Motjaan and Usushwana Rivers from the slimes dams at the Ngwenya iron ore mine followed heavy rains in the area. Schemes were worked out in conjunction with the mine management to prevent any future pollution.

138. Advice was given to the Swaziland Spa Development Company, who are building a luxury hotel and casino, in regard to the development of the thermal springs on their property. The flows from the springs and the temperature were measured and the company advised on the most suitable form of tapping the spring in relation to the geological environment in which they occur.

(ii) *Gravimetric Survey*

139. Dr. Masson Smith and Mr. Evans, geophysicists seconded from the Overseas Geological Surveys, London, carried out a gravimetric survey of the Territory during a two months stay during which period a total of 2,117 stations, generally at one mile intervals, were read. The preliminary results of the survey are expected to be available early in 1966.

(iii) *Geochronology*

140. A total of 27 specimens including granites, gneisses, diorites, rhyolites, felsites and dolerites were despatched to the two institutions mentioned previously for age determinations. The age determinations listed on page 24 on Swaziland rocks were received during the year.

141. In all cases the determinations were made by the Age Determination Unit, Oxford of the Overseas Geological Surveys. Dr. N. J. S. Snelling is in charge of the Unit. Mrs. A. D. Richards was responsible for most of the analytical work.

142. Dr. Snelling comments as follows on rock number 4. "The determinations sets a good younger limit to this rock. The error is low (about a third of the strontium is radiogenic) and the age as calculated is quite insensitive to uncertainties in the initial $^{87}Sr/^{88}Sr$ ratio." He also, comments on rocks numbered 5 and 6 as follows "The determination sets a reliable younger limit to the age of this rock and because of the high degree of enrichment in radiogenic Sr is not affected by uncertainties in the initial $^{87}/Sr^{88}Sr$ ratio. In contrast the age one calculates for the total rock is very dependant on the initial $^{87}Sr/^{88}Sr$ that one assumes. Taking 0.705 as the initial $^{87}Sr/^{88}Sr$ ratio the total rock gives an age of 3040 ± 400 m.y. However bearing in mind the error (reflecting the large amount of common Sr in the total rock) the agreement is quite good. If we were to assume an initial $^{87}Sr/^{88}Sr$ ratio of 0.708 for both the biotite and total rock we would get a concordant age of 2810 m.y. for both. The problem is to know what is the correct initial $^{87}Sr/^{88}Sr$ ratio and for this reason I have only claimed that the ages set reliable younger limits".

[G] Diamond Drilling

143. The total footage drilled during the year amounted to 9,000 feet, a drop of 2,131 feet over the preceding year.

144. Mr. J. S. McCall retired on the completion of his contract in July. Mr. Van der Walt was appointed in October to fill Mr. McCall's post.

145. Following the policy of localization two trainee drillers were appointed in June. These trainees, who were selected from the drilling crews, have had many years experience on the Departmental rigs as drilling assistants.

No.	Locality	Rock	Mineral	Method	Age (m.y.)	Remarks
1.	Stegi	Granophyre	K Felspar	Rb : Sr	160 ± 50 m.y.	
2.	Stegi	Granophyre	Hornblende	K : Ar	190 ± 10 m.y.	Same rock as No. 1
3.	Mananga	Granophyre	Hornblende	K : Ar	175 ± 15 m.y.	
4.	The Rocks	G3 granite	Biotite	Rb : Sr	2235 ± 70 m.y.	See comments
5.	Confluence Tawela & Ngwempisi Rivers	G1 granodiorite gneiss	Biotite	Rb : Sr	2810 ± 80 m.y.	
6.	Ditto	Ditto	Biotite	Whole rock	3040 ± 400 m.y.	Same rock as 5 — See comments
7.	Mozaan Valley	Insuzi felsite	Biotite	Whole rock	2970 ± 150 m.y.	

146. During the year eleven water boreholes were drilled for drought relief. This was an emergency programme as the drought in the Lowveld areas was aggravated by an outbreak of foot and mouth disease which prohibited the movement of cattle in the cordoned areas.

147. Revenue from drilling contracts undertaken by the Department amounted to R9,389.

IV. MINERAL DEVELOPMENT

148. Asbestos is being mined on an increasing scale at the Havelock asbestos mine. A drilling programme on an occurrence of chrysotile of the short fibre variety is planned for early 1966.

149. The production of barytes has increased slightly during the year. Although production is not very high it is nevertheless being maintained at a satisfactorily rate.

150. At the request of the Basutoland Government, the clay deposits in the vicinity of Maseru were investigated in some detail to determine their value for the manufacture of stock bricks. A comprehensive report in the deposits has been submitted to the Government.

151. At Mpaka colliery of Swaziland Collieries Limited, production is rising steadily. A washing plant with a capacity of 75 tons per hour was installed. This plant, using magnetite as the heavy media, is the first of this type to be installed in Southern Africa. The coal is supplied to the Swaziland Railways, the two sugar mills in the Territory and to concerns in Lourenco Marques. Now that a sized, washed production is available the export market is being actively investigated. Considerable difficulty was experienced in obtaining an adequate truck allocation for coal from the Swaziland Railway with the result that the supply to the railways was below the contractual agreement. Likewise consumers in Lourenco Marques suffered from the insufficiency of railway trucks. In view of the potential export market for coal it is hoped that these difficulties will be resolved early in 1966. Three boreholes were drilled on the property by the Department to assist in the mining layout. The drilling at the Johannesburg Consolidated Investment Company's anthracite prospect at Maloma was completed. The economic potential of the prospect is under investigation.

152. Drilling operations were undertaken at the dormant Daisy gold mine on behalf of Rand Mines Limited who however, on the completion of the drilling programme, allowed their prospecting licence to lapse. Interest is being shown by other parties in the prospection of the mine.

153. The two gold mines in the Forbes Reef area, the She and Waterfall mines maintained a steady rate of production during the year. Recently new auriferous reefs were discovered on both these mines and are being actively prospected.

154. Prospecting also took place at the Pigg's Peak gold mine which has been dormant since 1950. The comprehensive survey, geological mapping and sampling programme which was undertaken indicated a reasonable possibility that the mine could be made productive again.

155. The Ngwenya iron mine has had its first year of full production, all the ore being shipped to Japan. A further series of boreholes were drilled by the mining company to test the attitude and grade of the orebody at depth.

156. There was very little production at the kaolin mine during the year but bulk samples were sent to the Republic of South Africa and Japan for comprehensive tests. Another large deposit, in the near vicinity of the deposit at present being exploited, has been discovered. This is being systematically explored at the

moment. Several important large scale consumers, following satisfactory tests, have made enquiries in regard to the tonnages the property is in a position to supply.

157. In conjunction with the mineral concessionaires, a mercury prospect is being examined by means of an adit which is being driven by the Departmental prospecting team. The total cost of this exploratory work is being borne by the concessionaires.

158. Following an enquiry about muscovite mica schists, an area in the Mahlangatsha mountains was examined. Large quantities of mica-bearing schist were discovered. The mica schists will be treated to give a ground mica minus 400 mesh. This product is in considerable demand as an insulant filler in the paint industry.

159. A lithium pegmatite and a sillimanite deposit were also investigated during the year. The details concerning these investigations have been given in Mr. Urie's report.

160. The siderite deposit situated in the Forbes Reef area adjacent to the Ngwenya iron ore mine is being re-investigated by diamond drilling. This work is in progress. Preliminary results indicate that very substantial quantities of siderite exist in the area.

V. MINES DEPARTMENT

[A] Mineral Statistics and Exports

161. The mineral production figures for the year ending 31st December, 1965, are given in the table (Appendix I) on page of this report, together with those for 1964 for comparison purposes.

162. The total value of sales of minerals for the year has benefitted from an increase both in production and price of asbestos fibre and from a full year's production from the Ngwenya iron ore mine and the colliery at Mpaka. This has resulted in an overall increase in value of R4,724,235 to bring the total to R10,342,071, an increase of 84 per cent and a new record for Swaziland.

163. Sales of asbestos fibre increased during the year and, together with an increase in the average price per ton, brought the total to 40,884 short tons valued at R5,793,501.

164. Exports of iron ore, despite some initial difficulties, were well maintained totalling 1,124,310 short tons valued at R4,426,735.

165. Sales of coal have been lessened to some extent by a lack of railway trucks and a considerable tonnage has had to be dumped. The tonnage sold has nevertheless risen month by month, the total for the year being 33,032 short tons valued at R66,388.

166. Gold production has fallen by 459 fine ounces, largely due to the virtual closure of the Waterfall mine which, during the last few years, has been the country's richest producer. Production from this mine is now derived solely from reworking the slimes dumps. Total production from all sources was 1,619 fine ounces valued at R40,507.

167. Pyrophyllite production was halved and sales of diaspore for the year were nil. Pyrophyllite was obtained mainly from the section of the deposit which contained little diaspore. The same company also worked a similar deposit of pyrophyllite in the Transvaal which is nearer to the railhead and thus reduced the scale of its operations in Swaziland. Sales of pyrophyllite amounted to 1,014 short tons valued at R4,056.

168. Barytes production recovered somewhat after a virtual standstill in 1964. An experiment was carried out by railing the barytes in crude lump form to Johannesburg via Lourenco Marques from the Ka Dake railhead of the Swaziland railway. Such is the tariff differential between road haulage and rail freight that, despite the considerably longer haul involved, the transport cost was little changed. Sales of 541 short tons of barytes were valued at R3,322.

169. Sales of raw kaolin increased during the year for the first time since production started at the mine. Production is however still low. Sales of kaolin amounted to 830 short tons valued at R3,222.

170. Tin mining again had a bad year and production was further reduced despite the increased price of the metal. Production dwindled to 1.72 short tons valued at R4,224.

[B] Inspections

171. The Inspector of Mines was overseas on leave for the period 28th August to 1st October, 1965.

172. The following visits were made by the Inspector of Mines to mines and quarries, as well as to explosives and rocket magazines as Inspector of Explosives. From the time of his return from leave until the end of the year the Inspector acted also as an Inspector of Machinery during the absence of Mr. T. G. Blofeld on sick leave.

Purpose of visit	No. of inspections
Routine inspection of mines and quarries	23
Inspections of explosives and anti-hail rocket magazines	38
Miscellaneous	27
Accident enquiries (serious or fatal)	6

[C] Licences and Permits

173. The following licences and permits were issued during the year:—

Type of licence or permit	No issued
To purchase explosives locally	80
To import explosives	36
Blasting	33
Explosives and rocket magazines	10

[D] Accidents

174. Accidents in mines and quarries causing an injured person to be absent from work for three days or more are reportable to an Inspector of Mines.

175. The following mining accidents (as distinct from machinery accidents on mines) were reported during the year:—

Fatal	Non-fatal	Non-casualty	Total
1	155	0	156

176. The location of the various injuries incurred from the above accidents may be classified as follows:—

Location of injury	(a)	(b)	(c)
Arms, hands or fingers	4	66	6
Legs, feet or toes	1	31	2
Eyes	—	9	1
Body or head	—	35	—

In this table — (a) indicates loss of member
(b) indicates injury to member
(c) indicates loss of use of member

177. These accidents may be classified further by type, as follows:—

Cause of accident	No. of accidents
Fall of ground	39
Transport of materials	2
Loading by hand or machinery	10
Fall of material	11
Splinters	3
Falling or slipping	10
Burning or scalding	2
Explosives	1
Sundry — minor	78
TOTAL	156

178. The total time, in days, lost as a result of accidents is given below with the average time lost per accident:—

No. of accidents	Total No. of shifts loss	Average shifts loss per accident
155	2,864	18.48

[E] LABOUR

179. A summary of the labour employed in the mining industry in Swaziland is given in table (Appendix III) on page 39 of this report.

VI. MACHINERY DEPARTMENT

180. Mr. T. G. Blofeld continued in office as Inspector of Machinery throughout the year.

Industry

181. The start of operations at the Matsapa industrial site was brought to completion in respect of the cotton ginnery and meat canning factories, bulk oil storage depots and a mechanized warehouse for transfer of goods from road to rail.

182. Other projects are contemplated at the site.

183. A new and modern saw mill has been brought into service. A peeling plant enterprise for making veneer from local timber is to be laid down.

184. The creosoting and treatment of wood poles has been further developed by the addition of a gauge cylinder and connected pressure vacuum installation to the existing plant.

New Legislation

185. The Mines and Quarries Law and Regulations were completed. This legislation will come into effect in the New Year.

186. The Factories Law and Regulations were similarly prepared.

Power Plant

187. The year ended with thirty seven steam boilers working in regular service and three additional large new W.T. units nearing completion at the Sugar Mills.

188. The shortage of competent operators continues to give cause for concern.

Mines and Quarries

189. A washing plant was erected and started up at the colliery during the year with satisfactory results.

Lifts and Elevators

190. Three more passenger and goods lifts were brought into service and licenced during the year.

Accidents

191. Accidents in mines and industry, involving lost time of three days or more, were reported to the Inspector of Machinery as follows:—

1965	Fatal	Lost time
Mines and Quarries	1	27
Industry	5	609
Contractors	4	15
Total	10	651

192. For classification of lost time accidents see tables I and II and III.

TABLE I

	Mines & Quarries	Industry & Contractors	Total	Fatal
Machinery (including electricity.)	6	26	32	1
Loading	7	80	87	–
Timber and Forestry	–	161	161	–
Canefields	–	96	96	–
Vehicles	1	18	19	4
Sundry	13	223	236	5
Total	27	624	651	10

TABLE II

Arms, hands and fingers	Legs and feet	Head & body	Eyes	Total
201	329	93	28	651

TABLE III

TOTAL NUMBER OF SHIFTS LOST

Mines and Quarries	Total No. of shifts lost	Average shifts lost per accident
Mines and Quarries	574	21.22
Industry	7,552	12.12
Contractors	227	15.12
Total	8,353	12.82

Fatal Accidents

193. Fatal accidents occurred to ten employees. One was caught in the driving end of an outside mine conveyor belt, unaccountably.

194. Five occurred in industry, of which vehicles out of control accounted for four, and one after falling from an overhead gangway for no apparent reason.

195. Contractors had four fatals, one due to a vehicle accident, one due to a falling girder which struck a workman on the rebound. Two fatal accidents were followed by prosecutions for endangering safety. The fatalities were caused by falling off a staging and being crushed by the failure of temporary pipe supports.

Lost time accidents

196. A large proportion again is shown to occur in timber and forestry and cane-fields, to hands, legs and feet, but a doubt remains whether all these accidents are being reported, despite the reduction in figures compared with last year.

Inspection and Enquiries

197. These have continued normally and all inspections are up to date.

Pressure Plant

198. Progress has been maintained in the certification and control of this type of plant in use, and before importation, through approved inspecting authorities.

VII. HEADQUARTERS

[A] Administration

199. Except for the Colonial Welfare and Development Schemes D 5926A "Location of Underground Water Supplies" and C.D. & W. Scheme D 6202 "Office Accommodation for Geologists" the Department is wholly financed from Territorial funds.

200. The block of new offices mentioned earlier did much to alleviate the serious accommodation position mentioned in last year's report. It also will be possible to accommodate the United Nations personnel in the new building when they arrive early in 1966.

201. During the year the Report of the Salaries Commissioner, Mr. T. M. Skinner, C.M.G., M.B.E., and the revised gradings of establishment posts in the Public Service were published. The implementation of the recommendations of the report and the effect of anomalies as affecting this Department have added to the burden of the administrative staff. The grading of certain Department posts were still under investigation at the year end.

202. The senior professional officers spend a considerable amount of time both in the office and in the field in discussions with members of geological and mining organizations.

[B] Drawing Office

203. The new office block housing the draughting section of the Department was completed in October. This section now has a spacious draughting office, a plan room, and a plan reproduction room housing the OCE printing unit.

204. In July the staff of this department was increased with the arrival of Miss M. E. Macpherson, assistant draughtswoman and Mr. A. Vilakazi, trainee draughtsman.

205. As if to justify this move the volume of work increased tremendously during the year and the number of finished drawings rose to 91 an increase of almost 300% over the preceding year.

206. The semi-dry printing machine continues to prove its worth, having produced 3,812 prints during the year.

[C] Library

207. The lady stenographer also acts as the Departmental librarian. The library works on a reciprocal basis with other geological surveys, university libraries and similar institutions throughout the world.

208. Conditions in the library, which is combined with a small museum, are extremely cramped. It, nevertheless, is as up to date as funds permit, containing a comprehensive list of textbooks and current mining and allied scientific magazines.

Laboratory

209. A total of 253 samples were prepared and sent for assay or analysis during the year. Included in the number were split borehole cores, concentrates and whole rock samples.

210. These samples were assayed for the following constituents:—

Alumina	14
Copper	4
Gold	123
Iron	14
Lithium	18
Magnesia	7
Mercury	9
Nickel	4
Silica	21
Titania	27
Complete analyses	12
	253

211. In addition to the panning operations carried out by the geologists in the field numerous samples were crushed and panned or elutriated to obtain concentrates for microscope examination.

212. A new high powered binocular microscope and a microscope lamp were purchased during the year.

[E] Publications

213. The following reports and bulletin were published during the year.

1. Annual Report of the Geological Survey and Mines Department for the year ended 31st December, 1964.

2. Bulletin No. 4 of the Geological Survey and Mines Department.

214. The following papers are to be published in the Congress supplement to the Transaction of the Geological Society of South Africa.

By D. R. Hunter: "The Precambrian Granitic Terrain in Swaziland."

By J. G. Urie: "A Reconnaissance Structural Investigation in the Forbes Reef Area, Swaziland.

By J. G. Urie and D. H. Jones "Metamorphic Zones in the Archaean Fold Belt in Northwestern Swaziland".

215. A list of the unpublished Department and other written reports written by the professional staff is contained in Appendix V. A list of maps and plans pro-

duced in the draughting office during the year is given in Appendix IV. Except for those of a confidential nature, all are available to the public on request.

[F] Visitors

216. Numerous visitors, mainly geologists and mining engineers representing the mining companies as well as geologists from Universities and research institutions visited the Department for discussions during the year. Many of the visitors also were taken on field trips to inspect areas both of academic and economic significance.

[G] Acknowledgement

217. The Department gratefully acknowledges its indebtedness and thanks to the following for their co-operation and assistance in a variety of ways.

The Staff of the Secretariat, Mbabane
The Director and staff of the Overseas Geological Surveys and also
The Director and staff of the Overseas Surveys.
The Director and staff of the Geological Surveys of the Republic of South Africa.
The Director and staff of the Geological Survey of Mocambique.
The Director and staff of the Bernard Price Institute, Johannesburg
District Commissioners and Police Force of the Territory.
The Manager and staff of the Havelock Mine.
The Manager and staff of Peak Timbers Limited
The Manager and staff of the Usutu Pulp Company.
The Manager and staff of the Ubombo Ranches Limited, Swazland.
The Manager and staff of the Mhlume (Swaziland) Sugar Company.
The many members of mining companies operating in the Territory for their assistance and freely-given hospitality.
To members of the public for their co-operation with the Department.

D. N. DAVIES
Director of Geological Survey and Commissioner of Mines.

Mbabane
15th February, 1965.

APPENDIX I.

MINERAL PRODUCTION FOR 1965

Mineral	1964		1965		Increase		Decrease	
	Short tons	R	Short tons	R	Short tons	R	Short tons	R
Chrysotile Asbestos	39,861.75	5,217,498	40,883.56	5,793,501	1,021.81	576,003	—	—
Iron Ore	66,351.04	318,638	1,124,310.00	4,426,735	1,057,958.96	4,108,097	—	—
Coal	4,489.80	7,009	33,032.40	66,388	28,542.60	59,379	—	—
Pyrophyllite	2,200.00	8,800	1,014.00	4,056	—	—	1,186.00	4,744
Diaspore	412.11	6,102	—	—	—	—	412.11	6,102
Barytes	16.56	170	540.85	3,322	524.29	3,152	—	—
Kaolin	343.77	2,482	829.50	3,222	485.73	740	—	—
Metallic tin	2.40	4,994	1.72	4,224	—	—	0.68	770
	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R
Gold	2,077.88	52,027	1,619.11	40,507	—	—	458.77	11,520
Silver	130.17	116	130.14	116	—	—	0.03	—
Totals		5,617,836		10,342,071		4,747,371		23,136

APPENDIX II.

MINERAL EXPORTS, 1965

MINERAL	COUNTRY TO WHICH EXPORTED	SHORT TONS	VALUE R
Chrysotile asbestos	Argentina	2,671	301,914
	Brazil	210	27,930
	Canada	1	179
	Ceylon	100	11,200
	Denmark	3,060	325,571
	Finland	900	102,990
	France	700	111,320
	Germany	5	573
	Italy	20	5,151
	India	15	1,860
	Nigeria	25	3,675
	Republic of South Africa	11,305	1,554,289
	Spain	5,190	658,054
	United Kingdom	16,231	2,643,795
	United States of America	450	45,000
Barytes	Republic of South Africa	541	3,322
Coal	Mocambique	8,365	10,195
Iron Ore	Japan	1,124,310	4,426,735
Kaolin	Republic of South Africa	830	3,222
Pyrophyllite	Republic of South Africa	1,014	4,056
Tin concentrates	Republic of South Africa	2½	4,224
		Fine ozs.	Value R
Gold	Republic of South Africa	1,619	40,507
Silver	Republic of South Africa	130	116

APPENDIX III

LABOUR STATISTICS

Month	SKILLED					UNSKILLED							TOTALS		
	Below Surface	On Surface	Total	Earnings R	Earnings c.	Below Surface	On Surface	Total	Earnings R	Earnings c.	Value for food R	Value for food c.	Total Labour	Total earnings and food R	Total earnings and food c.
January	43	156	199	51,608	89	628	1,150	1,778	44,849	58	12,061	44	1,977	108,519	91
February	37	160	197	53,557	00	615	1,197	1,812	46,949	12	12,792	87	2,009	113,298	99
March	40	165	205	53,376	00	630	1,161	1,791	42,920	18	10,456	69	1,996	106,752	87
April	37	166	203	57,162	44	661	1,161	1,822	47,026	20	11,180	50	2,025	115,369	14
May	38	160	198	54,486	76	661	1,167	1,828	49,333	31	12,222	16	2,026	116,042	23
June	37	196	233	53,994	35	659	1,134	1,793	49,499	33	12,626	85	2,026	116,120	53
July	36	157	193	57,142	75	661	1,134	1,795	54,939	77	11,988	82	1,988	124,071	34
August	39	159	198	56,707	12	680	1,183	1,853	54,701	60	12,278	07	2,061	123,686	79
September	38	159	197	54,267	02	650	1,159	1,809	55,234	13	13,427	93	2,006	122,929	08
October	39	157	196	56,075	01	629	1,160	1,789	54,558	39	11,595	93	1,985	122,229	33
November	34	173	207	60,648	22	648	1,182	1,830	51,480	08	13,693	10	2,037	125,821	40
December	37	175	212	59,455	81	689	1,162	1,851	54,188	52	10,076	76	2,063	123,721	09
Totals:	455	1,983	2,438	668,481	37	7,811	13,950	21,761	605,680	21	144,401	12	24,199	1,418,562	70

APPENDIX IV

SUMMARY OF DRILLING FOR YEAR ENDING 31st DECEMBER, 1965

B.H. No.	Depth Ft.	Formation	Locality	Remarks
245	271	Sandstone-Shale-Dolerite	C.M.A. 13	Anthracite — J.C.I. Colliery
248	352	" " "	C.M.A. 13	" " "
249	352	" " "	C.M.A. 13	" " "
250	270	" " "	C.M.A. 13	Coal Prospect — Maloma
251	651	" " "	C.M.A. 13	" " "
252	598	Serpentinite and Pyroxenite	Farm No. 55	Asbestos — Lichfield
253	385	Sandstone-Shale-Dolerite	C.M.A. 13	Coal Prospect — Maloma
254	321	" " "	C.M.A. 13	" " — "
255	382	Siliceous Gneisses	Lapsed Min. Con. 33A.	Gold — Daisy Mine
259	524	" "	Lapsed Min. Con. 33A.	Gold — Daisy Mine
262	658	" "	Lapsed Min. Con. 33A.	Gold — Daisy Mine
256	250	Sandstone	C.M.A. 9.	Water— Rand Mines
257	151	Sandstone-Shale-Dolerite	S.N.L. 26	Water— Lubuku. Dip.
258	216	" " "	" "	" — Nyetane Dip.
260 A,B.	225	" " "	" "	" — Magwanyama Dip.
261	155	" " "	" "	" — Magomba Dip.
263	239	Granodiorite	S.N.L. 23	" — Namaacha Dip.
264	77	"	" "	" — Namaacha Dip.
265	209	"	" "	" — Namaacha Dip.

CONTINUED ON NEXT PAGE

SUMMARY OF DRILLING FOR YEAR ENDING 31ST DECEMBER, 1965 CONTINUED FROM Page 40

B.H. No.	Depth Ft.	Formation	Locality	Remarks
266	202	Sandstone-Shale	Magomba Ranch	Water — D. P. Koch Esq.
267	52	Granite	C.M.A. 9	" — Rand Mines
269	259	"	" "	" — Rand Mines
268	142	Granite	Farm 47	Sillimanite — Mahlangatsha
270	109	Sandstone-Shale	C.M.A. 9	Coal — Rand Mines
271	211	" "	" "	Coal — Rand Mines
272	176	" "	" "	Coal — Rand Mines
273 A, B, C, D, E.	332	Quartzite	Lapsed Min. Con. 50	Kaolin — Kaolin Mine,
274	631	Talc-Schist-Quartzite	Farm 5.P.	Siderite — Forbes Reef
275	600	" " "	Farm 5.P.	Siderite — Forbes Reef
	9,000			

APPENDIX V

Reports by Professional Staff

BY D. N. DAVIES — DIRECTOR

[1] Overseas Geological Survey report for the period 1st January 1965 to 31st December, 1965.

[2] Monthly reports to Her Majesty's Commissioner and the Honourable Member for Natural Resources.

BY D. R. HUNTER — GEOLOGIST

[1] Note on visits to proposed dam sites

[2] Report on prospecting operations at Maloma Colliery.

[3] Prospecting and mining in the early days in Swaziland.

[4] Contribution to excursion guide. Annual Congress — Geological Society of South Africa.

BY J. G. URIE — GEOLOGIST

[1] Report on the investigation of clay fields in the vicinity of Maseru, Basutoland.

[2] An occurrence of Sillimanite bearing rock on Farm No. 588, Manzini District, Swaziland.

[3] Lithium bearing pegmatites in the vicinity of Kubuta, Shiselweni District, Swaziland.

BY D. H. JONES — GEOLOGIST

[1] "Geology, Structure and Mineralization of the Pigg's Peak — Havelock Area, Hhohho District, Northwestern Swaziland".

BY C. J. BEGGS — GEOLOGIST

[1] "Geology of the Sicunusa-Mankaiana Area, Manzini District, south western Swaziland."

APPENDIX VI

MAPS AND DIAGRAMS PRODUCED IN 1965

No.	*Title*	*Scale*	*Author*	*Date*
612	Maloma, Isopachyte Plan of Main Seam	1:10,000	D.R.H.	29. 1. 65.
613	Maloma, Isopachyte Plan of 100 Marker Seam	1:10,000	D.R.H.	29. 1. 65.
614	Maloma, Isopachyte Plan of Shale Roof	1:10,000	D.R.H.	29. 1. 65.
615	Maloma, Colliery Prospect	1:10,000	D.R.H.	29. 1. 65.
616	Maloma Colliery Prospect (Sections)	1:2,000	D.R.H.	29. 1. 65.
617	Maloma, Type Section Coal Zone Ecca Series	no scale	D.R.H.	29. 1. 65.
618	Geophysical Survey — Gollel	1:50,000	Jennings	1. 2. 65. (Dec. 1964)
619	Granite Contact North of Mahamba	1:50,000	D.R.H.	Jan. 64.
620	Granite Contact South West of Pigg's Peak	1:50,000	D.R.H.	Jan. 64.
621	Section through granite North of Hlatikulu	no scale	D.R.H.	Jan. 64.
622	Qz—Ab—O, diagram	no scale	D.R.H.	Feb. 64.
623	Fm—si diagram	no scale	D.R.H.	Feb. 64.
624	Or—Ab—An diagram	no scale	D.R.H.	Feb. 64.
625	K—si diagram	no scale	D.R.H.	Feb. 64.
626	K_2O—Na_20 diagram	no scale	D.R.H.	Feb. 64.
627	Si—al diagram	no scale	D.R.H.	Feb. 64.
628	Si—alk diagram	no scale	D.R.H.	Feb. 64.
629	Si—c diagram	no scale	D.R.H.	Feb. 64.
630	Variations of Niggle Values synorogenic granites	no scale	D.R.H.	Feb. 64.
631	G5 Contact and G4 Contact	no scale	D.R.H.	Feb. 64.
632	Joint Roses for G1, G4 and G5 granites	no scale	D.R.H.	Feb. 64.
633	Structural Reconnaisance Map of the Forbes Reef Area	1:25,000	J.G.U.	April.
634	Sterogram Plots — Forbes Reef Area. Figs. 3 and 4	no scale	J.G.U.	April.
635	Sterogram Plots — Forbes Reef Area. Fig. 2.	no scale	J.G.U.	April.
636	Metamorphic zoning across portion of the Southern extremity of the fold belt, Forbes Reef Area	1:50,000	J.G.U.	April.
637	Itinerary Plan (Geological Plan)	1:125,000	D.R.H.	April.
638	Locality Plan of Forbes Reef	1:500,000	J.G.U.	April.
639	Annual Production Chart of Havelock Mine	no scale	C.G.M.	May.
640	Borehole Sites, Rand Mines	no scale		May.

MAPS AND DIAGRAMS PRODUCED IN 1965 Continued from page 43.

No.	*Title*	*Scale*	*Author*	*Date*
641	Swaziland Coal Electrical resistivity depth probes	no scale		May.
643	List of Mineral Concessions		D.A.C.P.	May.
644	Design of office furniture	—	C.G.M.	May.
645	Overlays for No. 3 Bulletin.			
646	Composite plan of Mhlosheni Fluorspar Prospect. (Originally done in 1959)	Various	J.G.U.	June.
647	The location of Aluminium and Pyrophyllite Deposits	1:50,000	D.R.H.	June.
648	Geology of Silica Deposits	1:25,000	J.G.U.	June.
649	Locations of samples submitted for age determination	1:500,000	D.R.H.	June.
650	Koch's Ranch, Magomba Area	1:10,000	J.W.	July.
651	Namahasha Area. (Map. 1)	2 inches-1m.	J.W.	July.
652	Masjuga Area. (Map. 2)	3 inches-1m.	J.W.	July.
653	Namahasha School Area (Map. 3)	7.2 inches-1m.	J.W.	July.
654	Magwanyana Area	Linear	J.W.	July.
655	Gravimetric Station, Gollel Hotel, Zululand	Eng. ft.		July.
656	Gravimetric Station, Nelspruit High School Hostel	Eng. ft.		July.
657	Plan showing portion of Histermann's Ranch near Gollel	4 inches-1m.	J.W.	Sept.
658	Ganspan Livestock Centre	Linear	J.W.	Sept.
659	Plan showing location of Clay Fields, Maseru Basutoland	1:50,000	J.G.U.	Sept.
660	Site 1. Sikalasebodwe Village	Linear	J.W.	Sept.
661	Site 2. Matanjeni South	Linear	J.W.	Sept.
662	Site 3. Matanjeni Village	Linear	J.W.	Sept.
663	Site 4. Nkutshini, Matanjeni Valley	Linear	J.W.	Sept.
664	Site 5. Nkutshini, Mhamba Valley	Linear	J.W.	Sept.
665	Site 6. Sikalasebodwe East	Linear	J.W.	Sept.
666	Sketch map of Progress Ranch	Linear	J.W.	Sept.
667	Plan of Gollel Township Area	Linear	J.W.	Sept.
668	Map of area West of Gollel	Linear	J.W.	Sept.
669	Plan of Veterinary Holding Ground Gollel	Linear	J.W.	Sept.
670	Map of Native Area 31	Linear	J.W.	Sept.
671	Sketch map of Metropolitan Mission, Sifutaneni	Linear	J.W.	Sept.
672	Nazarene Mission, Stegi	Linear	J.W.	Sept.
673	Geology Sicunusa — Mankaiana Area	1:2,500	C.B.	Oct.
674	Sketch map of Namahasha Area showing Position of Sch., P.S. Water Tower and possible Borehole Site	1:50,000	J.G.U.	Oct.

MAPS AND DIAGRAMS PRODUCED IN 1965 Continued from Page 44.

No.	*Title*	*Scale*	*Author*	*Date*
675	Clayfield No. 2 Maseru Basutoland	Feet	J.G.U.	26.10.65.
676	Clayfield No. 3, Maseru Basutoland	Feet	J.G.U.	Oct.
677	Clayfield No. 4, Maseru Basutoland	Feet	J.G.U.	Oct.
678	Clayfield No. 5, Maseru Basutoland	Feet	J.G.U.	Oct.
679	Index to 1:50,000 sheets.			
680	Location of Borehole Sites — Balegane Area	Linear	J.W.	Nov.
681	Masinde Area	Linear	J.W.	Nov.
682	Nkambeni — Mbulu Area	Linear	J.W.	Nov.
683	Nomngqai — Mangela Area	Linear	J.W.	Nov.
684	Nyakato Area	Linear	J.W.	Nov.
685	Nkambeni School	Linear	J.W.	Nov.
686	Locality Plan Forbes Reef Area	Linear		Nov.
687	Map showing Concessions as at the 6th November, 1965	1:500,000	D.A.C.P.	Nov.
688	Geology Dwalile Lichfield Area	1:25,000	C.B.	Nov.
689	Mafuteni Area. (Map 1.)	Linear	J.W.	Nov.
690	Howe's Farm. (Map 2.)	Linear	J.W.	Nov.
691	South East part of Mafuteni Farm	Linear	J.W.	Nov.
692	St. Joseph's and St. Juliana's R.C. Mission	Linear	J.W.	Nov.
693	Mabuda Estate, Stegi	Linear	J.W.	Nov.
694	Woodley Estate, Mbabane	Linear	J.W.	Nov.
695	Plan and Borehole Sections, Mhlambanyati	1:2,500	D.R.H.	Dec.
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SWAZILAND

ANNUAL REPORT

of the

GEOLOGICAL SURVEY AND MINES DEPARTMENT

For the year ended
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Price: 50c(5/-)

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Draughtsman	C. G. Matthews.
Personal Assistant	Miss J. White.
Accounts Assistant	Mrs. D. L. Warburton.
Stenographer	Miss V. M. Slatem.
Grade 1 Clerk	M. D. Msibi.

II. INTRODUCTION

(A) General

The year has seen several staff changes. Mr. P. E. Winter, Geologist, resigned in June to take up an appointment in the Republic of South Africa. Miss V. M. Slatem, Stenographer, resigned in December and Mr. J. S. Houston, Inspector of Machinery gave notice of resignation in the same month. Mr. C. J. Beggs was appointed in October to fill the vacancy created by Mr. Winter's resignation. Mrs. D. L. Warburton was appointed to the post previously held by Mrs. A. W. Girdwood who retired on pension last year.

2. The work of the Department came to a complete standstill during the disturbances in June, following the commandeering of all the Departmental transport by the Army and Police. Male members of the Department during this period volunteered for service as special constables, acted as couriers and were actively engaged on a variety of security tasks. The ladies in the Department likewise performed the duties of special secretaries and telephone operators. I wish to place on record my sincere appreciation of the loyalty and extreme conscientiousness shown by these members of the staff during this troublesome period.

3. Professor Wegmann of Neuchatel University, accompanied by members of the Staff of the Economic Research Unit of the University of the Witwatersrand, visited the Territory in September when he was shown the various granitic rocks of the Pigg's Peak District by the staff of the Department.

4. The Director and Mr. D. R. Hunter attended the lectures of Professors Barth and Wegmann in Pretoria in October. This was followed by an excursion to the famous Vredefort Dome. In the same month Mr. J. S. Houston, Inspector of Machinery, attended a four day special course in Mafeking.

5. Early in the year the Department's second Bulletin "The Mineral Resources of Swaziland" was published and work initiated on Bulletin No. 3 which is in the press at the time of writing.

6. The costs of running the Department have been borne entirely from Territorial funds except for C. D. and W. Scheme D. 4918. Application has been made for C. D. and W. funds for two special schemes namely:—

(a) a geophysical and geochemical survey of the Territory and
(b) a scheme for the location of underground water supplies.

Although agreed to in principle no approval has been received to date. Following the visit of Mr. G. Ivan Smith of the United Nations Technical Assistance Board and Special Fund in October, consideration is being given to an application for funds for a complete airborne geophysical survey and a ground gravimetric survey of the Territory.

7. Construction of the railway line continued throughout the year and it is anticipated that the export of the iron ore from the Ngwenya (Bomvu Ridge) deposit will proceed on schedule. Preparatory construction work was in progress at Ngwenya at the year end.

III. GEOLOGICAL SURVEY

8. Mr. Urie, during the period January to March, mapped 10 square miles of country south of Forbes Reef on the scale of 1:10,000. During the course of this survey some 500 samples were panned and examined. Mr. Urie also mapped the Stormberg Volcanic rocks exposed in the railway cuttings in the Mbuluzi Gorge.

9. In the Pigg's Peak District, Mr. Jones mapped 65 square miles on the scale of 1:10,000. The area, which is highly dissected mountainous terrain, is underlain by rocks of the Swaziland System and Jamestown Igneous Complex. All major and minor structures, lineations, joints and cleavages were plotted in order to establish a relationship between gold mineralization and the structural pattern. Concurrently systematic sampling of all quartz veins and mineralized zones was carried out. A total of 285 samples were taken of which 199 were panned and the remainder fire assayed. In addition 451 loaming pits were sunk on a grid system. Mr. Winter, in the area adjoining that mapped by Mr. Jones, mapped 19 square miles on the scale of 1:10,000 prior to his resignation.

10. Mr. C. Roering, Research Fellow of the Economic Geology Research Unit of the University of the Witwatersrand, spent several months on detailed structural mapping of ten square miles on the Mozaan Series in the Mahlangatsha mountains. As a result of this work several new economically important deposits of kaolin have been discovered. The structural work has substantiated the age determination work and disproved conclusively the correlation with the Witwatersrand System. On known information the Mozaan Series now must be considered to be of an equivalent age to the Swaziland System.

(A) By D. R. Hunter — Geologist

11. The writer was on duty throughout the year but for a short period of leave in April. The drilling programme in connexion with prospecting deposits of gold, coal, tin, aluminous minerals and kaolin were supervized. He acted as Director in January and for two weeks in December

Gold

(a) Daisy Mine — Pigg's Peak District

12. The drilling programme at this dormant mine and the adjacent Gordon mine was completed during the year. Twelve boreholes were drilled at the Daisy mine and two at the Gordon mine.

13. It is concluded that two distinct ore bodies were exploited at the Daisy mine, the greater portion of the production having come from the No. 1 quarry area. At this quarry the ore body consists of siliceous biotite gneisses which have been veined by blue-black quartz veinlets over an average width of 4½ feet dipping at 70°S. concordantly with the dip of the foliation. This zone of impregnation has a strike length of 500 feet and appears to be related to a second period of deformation. The evidence for this is not conclusive as the underground workings are not accessible and the surface exposures are poor. Thus reliance has to be placed on borehole correlations. Evidence supporting the belief that folding may be present can be found in the rapid variations in thick-

ness of the sheared chert which lies 150 feet stratigraphically above the ore body.

14. The deepest borehole intersection of the ore body was 210 feet down dip from No. 2 level, which was the lowest level worked by the early miners and corresponds approximately to the depth of oxidation.

15. Twenty feet of the old No. 1 level adit are still accessible. The following table summarizes the assay values obtained here and in the boreholes which intersected the ore body.

Locality	dwts/ton	true width in inches	inch penny-weights
No. 1 Level	14.18	36	510.48
No. 1 Level	4.63	60	277.80
BH. 153	16.61	64	1,063.04
BH. 155	12.30	51	627.30
BH. 163	1.50	31	46.50
BH. 170	3.30	77	254.10
BH. 178	5.75	60	345.00
Average	8.26	54	446.31

In the block between No. 2 level and the deepest borehole intersection there are probable reserves of 25,000 short tons at a grade of 8.26 dwts/ton .

16. West of the No. 1 quarry are three smaller quarries which appear to have exploited ore lying in the footwall of the No. 1 quarry orebody. A distinctive green siliceous schist forms the immediate footwall of the No. 1 quarry ore body. This horizon may be followed along the full length of the old workings. This schist is underlain by talc-tremolite schists. In the central and western portions of the Daisy mine strike, remnants of biotite gneiss and chert occur in the talc-tremolite schists. The remaining quarries are all situated on these gneiss bodies. Boreholes drilled under the quarries failed to intersect gneiss xenoliths comparable in size to those exposed in the quarries. It is concluded that the gneiss remnants either represent tapering rafts or the variation in thickness results from complex folding. Low values were recorded from borehole intersections of some of the gneiss bands in the talc-tremolite schist. The gneiss bands rarely exceed 5 feet in width. No attempt has been made to correlate these values which are listed below:—

Locality	dwts/ton	True Width in inches	inch penny-weights
No.2 Quarry	4.66	60	279.60
No.2 Quarry	1.63	72	117.36
BH.162	2.90	34	98.60
BH.170	3.70	24	88.80
BH.173	3.20	26	115.20
BH.173	1.70	33	56.10

17. The gneisses are impregnated with sulphides throughout. The presence of sulphides which include pyrite, pyrrhotite, chalcopyrite and arsenopyrite is not in itself indicative of gold values in the main

ore body or in the gneiss remnants. Blue-black quartz veinlets must also be present. In one borehole (No.155) small needles of arsenopyrite occur in amphibolitic gneisses over a width of 6 feet which, on assaying, revealed values averaging 1.77 dwts/ton. The mineralization occurs 80 feet above the No. 1 quarry ore body and was not intersected in any of the other boreholes.

(B) Gordon Mine, Piggs Peak District

18. The Gordon mine is situated three-quarters of a mile along strike west-southwest of the Daisy mine. The old workings consists of two adits driven approximately parallel to the strike. The lower adit is inaccessible. The upper adit, 35 feet vertically above the lower adit, may be entered for 200 feet, beyond which it is heavily caved. There are no signs of stoping and it is assumed that the declared production of 41.73 ounces was won from ore mined during the development of the adits. The upper adit starts in the immediate footwall of a chert but cross-cuts to a quartz vein which was systematically sampled, the highest value obtained being 1.6 dwts/ton over a width of 51 inches.

19. Two boreholes were drilled, the second of which intersected a value of 3.8 dwts/ton over a true width of 41 inches in the immediate footwall of the sheared chert in a zone of quartz impregnation in quartz schists and biotite gneiss 320 feet down dip from surface.

20. The stratigraphy at the Gordon mine is comparable to that at the Daisy mine except that the thickness of biotite and amphibolitic gneisses underlying the chert is reduced to 25 feet. No green siliceous schists are found between these gneisses and the talc-tremolite schists Bands of foliated granite up to 20 feet wide occur lying conformably with the dip of the foliation of the gneisses which is 70°S.

21. No further holes were drilled at the Gordon mine and no ore reserves have been calculated.

(C) Red Reefs, Forbes Reef, Mbabane District

22. The small quarry on the western bank of the Black Mbuluzi River was sampled by P. E. Winter in 1962 (see Annual Report for 1962) and encouraging values were reported. Drilling at this prospect began in September and six boreholes were completed by the end of the year.

23. Gold mineralization is found in biotite and amphibolitic gneisses occurring in talc schists. The whole assemblage is isoclinally folded, the folds plunging at 50° to the southwest. The highest gold values are confined to the more leucocratic gneisses within the succession. Quartz veining is intensive and sulphides (pyrrhotite, chalcopyrite, pyrite and arsenopyrite) are present throughout. In three boreholes a distinctive brown chert band was intersected. As this chert is confined to the western flank of the main isoclinal fold it is tentatively assumed that this chert is of tectonic origin post-dating the folding. The maximum width of the chert intersected to-date is 10 inches. It has been traced over a strike length of 350 feet. Gold values are associated with this horizon as the following table shows.

Borehole No.	Width of Chert	dwts/ton	Borehole width of Sample
BH.191	6 inches	12.73	36 inches
BH.193	1 inch	1.13	36 inches
BH.197	10 inches	7.48	30 inches

24. In addition to the complex folding later faulting, post-dating the gold mineralization, appears to have taken place. Thus a borehole drilled to cut the chert band down dip from BH.197 failed to intersect the horizon. Work is continuing in an attempt to elucidate the geology.

25. The leucocratic gneisses carry uniform but low gold values with higher values ranging from 3 to 9.5 dwts/ton distributed throughout them. Insufficient work has been done at this stage to elucidate either the complex structure of the area or the distribution of the gold values.

Tin Pegmatite, Mineral Concession No. 28, Mbabane District

26. This deposit was drilled originally in 1952. Preliminary work to exploit the deposit started in 1963 but this work indicated that the pegmatite was sheet-like in form dipping to the northwest at a shallow angle. The original interpretation had been that the pegmatite dipped steeply. Three vertical boreholes were drilled to test the theory that pegmatites occur in a series of sheets. The drilling showed that the larger pegmatites are flat-lying (i.e. less than 30°) and that there are many narrow pegmatites lying conformably with the foliation of the gneisses. However, it was clear from the drilling that the pegmatites form a complex stockwork and economic tin values are confined to those portions of the pegmatites which invade the biotite gneiss xenolith.

27. As a result of this drilling further development at the property was suspended.

Kaolin, Mahlangatsha, Mankaiana District

28. Thirteen boreholes were drilled at this deposit. Five boreholes were drilled on the main body and its off-shoots to test the persistence of the kaolin in depth in a similar manner to last year's exploratory drilling. The remaining eight boreholes were drilled in order to locate the original rock from which the kaolin was derived.

29. The kaolin bodies occur along fault lines in the Mozaan quartzites which have been intruded by dykes. Further movement has taken place along these fault lines after the emplacement of the dykes. The dykes strike east-northeastwards and it is believed that the post-dyke faulting is slightly oblique to this direction. Further field work is being undertaken to provide more data.

30. Four bodies of kaolin occur in the immediate vicinity of the current mining area. Others are known beyond the limits of this area. Initially two boreholes were drilled under the main body. The first hole intersected a pinkish to red coloured clastic rock at the expected down

dip projection of the kaolin body. This rock was still weathered. A second borehole was sited to intersect the source rock at greater depth but this passed through quartzites entirely. It is believed that due to post-dyke faulting the source rock has been tectonically thinned out and this borehole intersected such a point. Core losses are high in the friable quartzites so that no conclusive evidence of faulting could be detected.

31. Further holes were drilled 500 feet east of these two holes. Three holes have been completed and each intersected kaolin. The deepest intersection of kaolin being 245 feet vertically below surface. A fourth and deeper hole is now being drilled.

32. Three holes were drilled on the so-called fourth body. The first of these intersected a dark greenish, slightly speckled dyke at the anticipated down dip projection of the kaolin body. On sectioning, this rock consists of ragged amphibole flakes set in a chloritic groundmass. Quartz occurs in the groundmass and in small irregularly shaped areas. Two further boreholes were drilled. These showed that kaolin persists in depth to 60 feet, below which partially kaolinized dyke material occurs which grades into the fresher dyke intersected in the first borehole.

33. Analyses of the various stages from dyke to kaolin are given below:—

	K 1	K 2	K 6	K 3
	%	%	%	%
Loss on ignition	2.08	7.10	9.43	11.91
Silica	49.48	50.81	62.85	51.73
Alumina	17.64	20.12	23.09	32.95
Ferric oxide	12.98	12.08	3.26	0.86
Titanium dioxide	0.98	1.42	0.96	2.01
Calcium oxide	10.34	2.83	Tr	0.30
Magnesium oxide	5.63	5.22	0.27	0.07
Sodium oxide	0.67	0.24	0.15	0.15
Potassium oxide	0.13	0.22	0.13	0.09
TOTAL	99.3	100.04	100.14	100.07

K 1 Dyke in borehole BH. 187
K 2 Weathered dyke BH. 190A
K 6 Intermediate between weathered dyke and kaolin BH 190B
K 3 Kaolin in surface trench

34. The analyses of kaolin from the fourth body show a markedly higher proportion of silica than the kaolin in the main body. Brownish partial kaolin from the main body was analysed as follows:—

	K 5 %	M.K. 2 %
Loss on ignition	13.38	12.89
Silica	39.93	44.28
Alumina	33.06	38.80
Ferric Oxide	10.82	0.82
Titanium dioxide	2.05	2.50
Calcium oxide	0.35	0.28
Magnesium oxide	0.05	0.34
Sodium oxide	0.12	0.31
Potasium oxide	0.29	0.12
TOTAL	100.05	96.34

K 5 Brown partial kaolin. Main body.
MK2 Pure white Kaolin. Main body.

From the above it will be seen that the brownish discolouration is due to the presence of a higher proportion of iron.

Further work is continuing on the occurrence and origin of these deposits.

Coal

(a) Mzimpofu River — Diamond C Ranch Area, Stegi District.

35. Three boreholes were drilled in this area to explore the area east of the Mzimpofu River. The first two boreholes intersected dolerite sheets at the expected depth of the main seam and burnt coal correlated with the main seam was intersected in the third hole between 285 feet and 288 feet 6 inches. A analysis of the raw coal showed:—

Cal. Val lb/lbs.	Moisture %	Ash %	Vol. Mat. %	Fixed Carbon %
11.86	1.6	22.0	5.8	70.6

In view of the large sheets of dolerite in the area further work was stopped.

(b) Lukula Ranch, Stegi District.

36. A borehole was drilled alongside an old borehole to obtain samples of coal for submission to the Fuel Research Institute, Pretoria, for testing for its coking properties. From the results of the various laboratory tests it appears doubtful whether coke can be produced from the coal by itself. However, the coal may be very useful for incorporation in blends containing an adequate proportion of coking coal.

Andalusite, Mozane Valley, Mankaiana District.

37. Drilling started towards the end of the year on an andalusite deposit occurring in the Insuzi lavas in the Mozane valley. Three boreholes have been completed to-date revealing that the andalusite-bearing rock varies in width from 45 to 60 feet. The strike length is 1,200 feet. The deposit was believed to dip at shallow angles to the northwest. However, drilling has shown that this is a well developed cleavage direction and the body dips steeply towards the south and south east.

38. The average analysis of the andalusite-bearing rock is as follows:—

Loss on ignition	2.99%
Silica	59.58%
Alumina	33.10%
Ferric oxide	0.43%
Titanium dioxide	1.15%
Calcium oxide	Trace
Magnesium oxide	0.11%
Sodium oxide	0.48%
Potassium oxide	2.05%
	99.89%

39. To be of economic value the crude ore requires beneficiation and samples are being prepared for submission to a metallurgical laboratory.

Diatomaceous Earth

40. Diatomaceous earth was reported from Swaziland for the first time. It was discovered during construction of the canal linking the Mkinkomo weir to the Edwaleni power station. The diatomaceous earth underlies a vlei area on the banks of the Usushwana River approximately one mile south of the Mbabane—Manzini road.

41. An analysis of the material is as follows:—

Loss on ignition	8.06%
Silica	89.69%
Alumina	1.06%
Ferric oxide	0.18%
Titanium dioxide	0.12%
Calcium oxide	0.20%
Magnesium oxide	0.06%
Sodium oxide	0.30%
Potassium oxide	0.31%
	99.98%

Engineering Geology and Underground Water Supplies

42. Advice was given and boreholes drilled at the Mkinkomo weir. Advice was given regarding supplies of underground water to farmers and various Government Departments.

Miscellaneous

43. Evidence was given in four court cases during the year involving the illegal possession of unwrought gold.

44. Professor Wegmann was shown typical granitic rocks in the Pigg's Peak District during his brief visit to the Territory in September.

45. Visits were paid to a montmorillonite deposit near Lourenco Marques, a beryl-tantalite pegmatite near Piet Retief and the Vredefort Dome.

46. Considerable time was devoted to the editing of Bulletin No. 3 which will contain papers on regional and economic geology.

(B) By J. G. Urie — Geologist

47. Apart from short periods of leave the writer was on duty throughout the year.

48. During the period January to March mapping on a scale of 1:10,000 was undertaken in the country between the Motjane River and Forbes Reef store in the Mbabane District. A total area of 10 square miles was covered. The rock types encountered comprise sediments of the Swaziland System, magnesia rich schists of the Jamestown Complex, a major intrusion of granite and other minor intrusions of varying age and composition. The schists of the Jamestown Complex are present as a huge, apparently lopolithic mass, which engulfs the Swaziland System sediments building the southern terminus of the Ngwenya mountain. To the west, south and east this lopolith has been intruded by the G.4 granite. The sedimentary pile and the Jamestown Complex have been subjected to severe orogenic stresses.

49. Panning of all streams in the area was concurrently undertaken. This involved sampling of gravels and sands in streambeds and any alluvial beds occurring along the banks at roughly 100 feet intervals. Approximately 400 samples were panned and examined. The heavy mineral assemblage naturally varies with the rock types traversed by the streams. Magnetite, ilmenite, goethite and haematite are ubiquitous. Tourmaline is commonly present and zircons and garnet occur in streams draining the granite country to the south and east. Gold in small, variable amounts was the only mineral of economic interest observed in the pannings. In each instance it was traced by methodical panning to its source area but no new areas of auriferous mineralization were indicated. In each instance the source area was found to be in the vicinity of previously known workings.

50. In addition, investigation, by pitting and trenching, of pegmatites was carried out in two places: one approximately half a mile northeast of Forbes Reef store and the other approximately half a mile northeast of Forbes Reef dam. Trenches totalling over 700 feet in length and 32 pits were dug in these localities. As the pegmatites in the area are deeply weathered and of considerable size it was thought that they may provide a source of kaolin. Bulk samples of this material were crudely washed

and settled. The resultant product contained a high percentage of fine muscovite flakes. Careful processing of material may however, yield a product of commercial value. Although columbite is known to be associated with pegmatites in the vicinity none was observed in panned samples from the trenches.

51. Between the Rashale prospect and the Art Union gold mine a broad zone of shearing with associated ferruginous gossans was located while mapping. The zone was trenched but, other than occasional specks of gold seen in the pan, no minerals of economic interest are present.

52. During March a short period was spent in the examination of rail cuttings through the Mbuluzi gorge, Lebombo mountain. A brief log of approximately 2 miles of exposures was recorded and a number of specimens collected. The rail cuttings through the Mbuluzi gorge start at a point some 4,000 feet east of the Mlawula-Mbuluzi confluence and continue intermittently to the Mozambique border. The cuttings expose rocks in the middle and upper portions of the succession of acid volcanics as occurring in Swaziland.

53. The evidence from these cuttings, representing approximately 10,000 feet of exposure, has merely served to confirm the conclusion reached from the 1:50,000 reconnaissance mapping undertaken in 1956-57. The main features which have emerged are summarized below:—

(1) Apart from the relatively rare tuffs, agglomerates and pitchstones, the acid volcanics are composed of a succession of stony, porphyritic ignimbrites of rhyolitic composition. Massive, banded, mottled and quartz-rich varieties are readily distinguishable in the field. The massive type in which banding is absent, indistinct or confined to isolated zones is the most common variety and occurs extensively throughout the succession. Banded types are rare. Mottled and spotted types characterised by blotchy markings and crenallated bands are commonly seen but to a larger extent are confined to the lower half of the succession. The quartz-rich types characterized by an abundance of quartz insets have a limited distribution and are confined almost exclusively to a narrow zone towards the middle of the succession.

(2) Recognizably tuffaceous and agglomeratic horizons are rare and constitute less than 5 per cent of the material exposed in the cuttings.

(3) Amygdaloidal and vesicular flows are uncommon. Amygdaloidal zones are fairly frequently seen towards the contacts of the flows but these are invariably narrow. These flows constitute only some 5 to 10 per cent of the total mass of volcanic rocks.

(4) Glassy flows (pitchstones) are extremely rare. A number of minor horizons were observed while mapping the Lebombo mountains during 1956-57 but none are exposed in the approximately 10,000 feet of rail cuttings through the gorge or in the 5,000 feet of exposures in cliff faces towards the western end of the Mbuluzi gorge.

(5) Dolerite dykes are surprisingly rare. Only five were observed in the actual rail cuttings; the smallest 2 feet thick and the largest 51 feet thick.

54. Investigation with a view to locating clay deposits was undertaken in the Gollel area on the flats between the Mzuzwane and Mhlofunga rivers. The banks of all streams and gullies were examined and further investigation was carried out by pitting and earth auger. No clays other than of a black loamy variety were encountered.

55. August and September were spent in the examination and sampling of exposures provided by forestry roads in the Pigg's Peak District. These roads run through country underlain by granites, sediments of the Swaziland System and talcose schists and serpentinites of the Jamestown Complex. Exposures along approximately 40 miles of road serving the A 2 and D 3 blocks of Peak Timbers plantations were examined and sampled.

56. Sampling was not confined to any particular rock type nor was the search confined to any particular mineral. However, non-metallic minerals and the majority of base metal minerals, if present in economic quantity, would be fairly readily detected even if only present as gossans. Sampling was therefore largely undertaken with an eye to the location of auriferous mineralization. 1026 samples were cut, crushed and panned. Twenty eight samples, mainly from exposures of fresh rock, were sent for gold assay. The highest value returned was 0.23 dwts.

57. Numbers of bodies of serpentinite are exposed in these road cuttings. These were all examined and the larger bodies followed along strike. In most instances they are severely weathered, but nevertheless it was possible to ascertain that all of them are of the dark green variety and fine-to medium-grained. Locally they are quite extensively steatized and in numbers of instances are carbonated. No serpentinite of the apple-green variety was encountered. Fibre ranging from a ¼ inch to 6 inches in length was occasionally observed in association with isolated slips.

58. The remainder of the year was spent in the investigation of kaolin deposits in the Mhlangatsha Mountain district. Mr. C. Roering of the Economic Geology Research Unit, University of the Witwatersrand, after a detailed structural analysis of the area, established that the kaolin deposits are located along faults transecting the Mozaan Series in a northeasterly direction. It is evident that other faults parallelling this direction may also mark the sites of kaolin deposits and an investigation of these was initiated.

59. The programme involved preliminary augering at intervals along the strikes of the faults followed by trenching where necessary. In order to complete the picture earlier trenches on the main and fourth bodies were re-opened and logged. To date 2,000 feet of trenching has been completed and 300 auger holes drilled.

60. It has been established that the bodies of kaolin result from the alteration of dykes which have been intruded along fractures. Fresh specimens of dyke rock are greenish-grey in colour. The rock is fine-

grained and frequently studded with insets of felspar. The essential constituent minerals are felspar, quartz, hornblende and chlorite. Much of the felspar is too clouded to identify but occasional twinned insets indicate that it is oligoclase.

61. The main body of kaolin, which is being worked by Kaolin (S.D.) (Pty.) Ltd., has been traced over a strike length of 5,500 feet. The central portion of the body consists of creamy-white to greyish-white kaolin which in places is patchily discoloured by reddish or yellow-brown iron oxides. Material of this sort occurs over a length of approximately 2,500 feet. Towards both the eastern and western extremities alteration of the dyke has, however, not been so complete. Here the kaolin, due to a higher iron content, is yellow-brown in colour. Particularly towards the western end of the body weathering does not extend to any depth at all and remnants and boulders of dyke rock were exposed by the trenches.

62. The fourth body, which lies approximately a third of a mile to the north of the main body, displays similar characteristics. The body averages 9 feet in width and has been traced for 5,000 feet. The eastern half of the body consists of creamy-white to greyish-white kaolin patchily stained by iron oxides. The eastern half is of yellow brown kaolin in which remnant textures of the original dyke are occasionally discernable. In both the main and fourth bodies the change from white to yellow-brown kaolin is surprisingly abrupt. The reasons for this variation along strike are not obvious.

63. Two other sympathetic fault directions have been investigated by augering and trenching. To date only minor occurrences of white and yellow-brown kaolin have been located. Examination of these and other fault directions is continuing.

64. In addition to the above and normal headquarters duties the following visits were made.

Mbabane District:

65. A number of visits to the Mantenga Falls area to examine the railway tunnels and exposures in the cuttings.

Hlatikulu District:

66. A number of visits to sort, weigh and ship beryl collected by African prospectors in the Sinceni area.

Mocambique:

67. A visit to a montmorillonite deposit in the company of Messrs. Davies and Hunter of the Swaziland Geological Survey and Mines Department, Mr. A. Greville of G.&W. Base Metals and Eng. J. Trigo Mira and Dr. A. F. Nunes of the Servicos de Geologia e Minas da Provincia de Mocambique.

Transvaal Province

68. Visited the beryl-tantalite pegmatite in the Piet Retief District with Messrs. Jones and Winter.

Mankaiana District:

69. Accompanied Mr. D. N. Davies. To briefly examine quartz reefs occurring in the Litchfield area.

Pigg's Peak District:

70. To site a borehole and supervise diamond drilling at the Daisy Gold Mine.

Hlatikulu District:

71. Accompanied Mr. D. N. Davies. To examine a lithium-bearing pegmatite in the Kubuta area.

Mankaiana District:

72. Accompanied Messrs. L. MacGregor and P. Jack of Vereeniging Brick and Tile Company Limited on a visit to a sillimanite deposit.

Pigg's Peak District :

73. Accompanied Mr. P. Conolly of Peak Timbers Limited. To examine an ancient smelting site.

Pigg's Peak District:

74. Accompanied Dr. Laubser of New Amianthus Mines Limited. To examine various bodies of serpentinite in the Pigg's Peak District.

(C) By D. H. Jones — Geologist

75. The writer was on duty throughout the year except for the month of December when leave was taken.

76. The period from January to the beginning of April was spent in headquarters examining rock sections and preparing geological maps and reports. A report on the sillimanite-bearing rocks of the Mahlangatsha area in the Mankaiana District was re-written during this period using further information derived from boreholes sunk on the deposits. On the 5th March a visit was made to a beryl tantalite-bearing pegmatite in the Piet Retief area of the Transvaal with Mr. Urie and Mr. Winter of this Department. In the same month an excursion was made with Mr. D. A. Pretorius and Mr. C. Roering of the University of the Witwatersrand to examine micro-structures in the Fig-tree Series of the Forbes Reef area.

77. The writer was engaged on field work from the beginning of April to the middle of October except for two weeks in June when work was interrupted by civil disturbances in the Territory. The whole of the field season was devoted to mapping a strip of country lying between Hhohho and Pigg's Peak in the Pigg's Peak District. The geological structure and stratigraphy of the rocks of the Swaziland System and Jamestown Igneous Complex in the area were examined in great detail in order to determine likely zones of gold mineralization. Some 65½ square miles were mapped in difficult mountainous terrain, using aerial photographs enlarged to a scale of 1:10,000. In addition to the mapping, systematic

sampling of all quartz veins and mineralized rocks was carried out, 285 samples being taken. A programme of loam sampling was also undertaken and 451 loam pits were sunk at strategic places. Futhermore, all streams and rivers in the area were panned for gold.

From the middle of October to the end of November the author returned to headquarters. During this period a report on the geology of the Malolotsha Valley area was completed and the plotting of data from the Hhohho-Pigg's Peak survey commenced.

The Hhohho — Pigg's Peak Survey (Pigg's Peak District)

78. The area mapped is bounded by the Transvaal to the north and northwest, by the contact of the granite to the southeast and a line drawn northwestwards from the Poponyane Falls which constitutes the south-western boundary. Included in this area are mineral concessions No. 51 and No 32 and Crown mineral area No. 3.

80. The Makonjwa Range, lying along the north-western boundary, is a deeply dissected mountainous area with peaks rising to 4,962 feet above sea-level. The range forms a steep escarpment overlooking the undulating valley of the Lomati River lying at 1,300 feet above sea-level.

Stratigraphy
The Swaziland System

80. Three distinct series, namely the Onverwacht Series, the Fig-tree Series and the Moodies Series constitute the Swaziland System. The lowest member of the System is represented by the Onverwacht Series.

81. The Onverwacht Series: The rocks of the Onverwacht Series are exposed in the core of an anticline at the foot of the Bearded Man Peak in the Makonjwa Range. The series consists of andesitic lavas intercalated with which are narrow bands of felspathic grit, conglomeratic grit, and mudstone. The lavas are greenish-grey in colour and generally amygdaloidal though non-amygdaloidal portions may be observed. The contact of the lavas with the intercalated sediments is sometimes enriched with limonite. The felspathic grits vary in colour from green to rusty brown with small chips of felspar standing out in contrast to the other constituents. The conglomeratic grits contain angular pebbles of grit, mudstone and lava. The mudstone is characterized by a pale green colour and slab-shaped outcrops. The basal beds of the Moodies Series lie in direct contact with the Onverwacht Series in this area.

82. The Fig-tree Series: The Fig-tree Series represents the argillaceous phase of the Swaziland System and consists of a highly varied group of sediments. The main exposures of the series occur on the foothills of the Makonjwa Range and the Kobolondo Heights. The succession includes phyllites, shales, banded ironstones and banded cherts together with coarser clastic sediments such as quartzites, grits, conglomerates and greywacke.

83. The phyllites vary from sandy to shaly in texture. They have a well laminated appearance but tend to break into blocks due to well developed cleavage. Because of their susceptibility to weathering outcrops are usually confined to erosion gullies and footpaths. In colour the phyllites display soft pastel shades of pink, fawn and orange.

84. The shales normally present subdued, laminated outcrops. In

colour they vary considerably and may be yellow, pink, red, purple, green or black. In areas which have undergone stress micaceous varieties with a schistose texture are observed. Many of the shale horizons have been indurated or undergone chertification.

85. Banded ironstones occur as narrow beds in the succession. They consist of white chert ¼ inch to ½ inch thick with partings of ferruginous shale or ironstone of similar dimensions.

86. The cherts are the most prominent rock type in the Fig-tree Series. They vary in thickness from a few inches to several hundred feet and in colour from grey to greenish-grey, white or black. Some of the cherts have a banded appearance due to alternating layers of black or white chert. In other cases the banding is due to fine-grained quartzite or indurated shale interlaminated with the chert. Many of the cherts have been subjected to tectonic stress so that mylonitization is a common feature. Mylonitization may occur also along fault and shear planes varying in width from a few inches to over a hundred yards. To differentiate between primary and secondary mylonitized chert bands is one of the major difficulties in interpreting the geological succession and structure of the Fig-tree Series in the area.

87. Coarser clastic sediments are also present; their distribution being generally in localities adjacent to the lower contact of the Moodies Series. It is concluded, therefore, that these sediments are confined to the upper beds of the Fig-tree Series and that the shales, banded ironstones and chert bands occur towards the base of the Series. The clastic sediments are made up of quartzites, grits, greywacke and conglomerates.

88. The quartzites are fine-to medium-grained and rather sugary in texture. In colour they may range from buff to orange or in some cases to dark grey. Pebbles of chert and quartzite are scattered indiscriminately throughout. Instances occur where the quartzites are almost completely re-crystallized and bear a superficial resemblance to a dark grey, almost black chert. Such a quartzite provides a useful marker horizon along the flank of the Makonjwa Range between the Intintinyane River and the Wyldsdale mine. In the Kobolondo Heights area there occurs a banded quartzite, its banding being due to intercalations of ferruginous shaly material up to two inches thick.

89. The grits are characterized by a dark orange colour and tend to be brittle and decomposed. Felspathic and micaceous varieties are to be found. Some of the grits grade locally into greywacke with a distinctive dark blue-grey colour.

90. The conglomerates of the Fig-tree Series occur only in narrow bands up to 15 feet in width. They contain pebbles varying from pea-size to 4 inches in diameter set in an argillaceous matrix. The pebbles are well rounded and those composed of hard rock tend to be ellipsoidal, whereas those of softer rock are flattened. The conglomerates generally have a sheared appearance.

91. Metasediments of the Series are confined to areas in close proximity to the granite contact or where there has been intense tectonism. They include quartz-sericite schists, quartz-mica-chlorite schists, chloritic schists, biotite and amphibole-bearing gneisses, dolomitic phyllites and andalusite schists.

92. It is estimated that the Fig-tree Series attains an overall thickness of 3,000 feet in the area surveyed.

93. The Moodies Series: The Moodies Series consists of psammitic and psephitic sediments and is responsible for building the Makonjwa Range. The Moodies Series is clearly seen to be unconformable to the underlying Fig-tree Series and in the Mooiplaas Valley at the foot of Bearded Man Peak its basal beds lie directly on the Onverwacht Series. Only the lower beds of the Moodies Series occur in the area. These are represented by approximately 2,000 feet of sediments.

94. The succession is as follows:—

DESCRIPTION	APPROX. THICKNESS FEET
6. Coarse, uneven-grained, gritty quartzite with occasional scattered rounded pebbles of chert and quartzite	350 +
5. Compact conglomerate with sub-angular pebbles and boulders of chert, banded ironstone, shale, ferruginous shale and possibly altered volcanic rocks	80—200
4. Fine-grained, sometimes micaceous quartzites with scattered chert and quartzite pebbles. A loosely packed pebble conglomerate is sporadically developed at the base	400—620
3. Fine-to medium-grained micaceous and felspathic quartzite frequently cross-bedded	85—370
2. Medium-grained quartzite with scattered pebbles of chert, grit and quartzite and numerous narrow loosely packed conglomerate bands	400—600
1. Compact ill-sorted conglomerate with pebbles and boulders of chert banded ironstone grit and quartzite.	0—80

95. The Jamestown Igneous Complex: The complex is represented by a suite of ultrabasic instrusives which have been subjected to metamorphism. Amphibolite, talc schist, talc-tremolite schist and talc-chlorite schist are typical of the rock types occurring in the area. The rocks of the Jamestown Igneous Complex are confined mainly to the low lying ground between the foothills of the Makonjwa Range and the Lomati River.

96. The amphibolite occurs predominantly as a broad strip along the granite contact. It is generally fine-grained and dark olive green in colour but a coarser grained amphibolite builds a prominent hill 2½ miles southwest of Hhohho police post.

97. The main body of schist underlies the strip of country intervening between the amphibolite and the lower hills of the Makonjwa Range.

98. They are intimately associated with the sediments of the Fig-tree Series and it would appear that the invading magma was capable of selective assimilation along argillaceous sediments leaving more siliceous horizons as rafts surrounded by schists.

99. In the foothills of the Makonjwa Range, where the Fig-tree Series sediments predominate, the metamorphosed ultra-basic rocks of the Jamestown Igneous Complex occur only in zones of faulting or in areas that have been subjected to intensive folding.

100. The Granite: The granite, which is classified as G.4 type, intrudes all the preceding rock types and occupies the northeastern boundary of the area. It is a medium-grained, grey, biotite granite which is frequently foliated along portions of its contact with rocks of the Swaziland System and Jamestown Igneous Complex.

101. Isolated small bosses of granodiorite occur in the vicinity of the Mzimnene Valley and the Wyldsdale mine. The gold mineralization at the latter is intimately associated with the instrusion of granodiorite.

102. Hyperbyssal Rocks: Hyperbyssal intrusions in the area occur chiefly in the form of dykes that post-date the granite in age. They are commonly medium-grained, dark greenish-grey diabase dykes. Their presence is marked either by prominent ribs strewn with rounded boulders or by inversion of the topography. The dykes are generally aligned along a north-northeast direction in the northernmost part of the area and along a north-northwest strike as in the southernmost part.

103. One epidiorite type dyke is intruded into sediments of the Fig-tree Series 2¾ miles northwest of Lomati Store and strikes northeast to southwest. It is possible that this dyke pre-dates the Moodies Series in age.

104. Quartz Veins: Quartz veins are common in the Swaziland System and rocks of the Jamestown Igneous Complex. Some of the quartz veins may be gold bearing as in the Lomati gold mine. The quartz veins are commonly milky white in colour though a smoky-grey variety may also occur. The general alignment of the veins is northeast to southwest, a direction which is sympathetic with the main structural line of the area.

Structure

105. The essential structure of the area is that of a synclinorium with its axis aligned in a northeast to southwest direction. The synclinorium was subsequently subjected to a later stage of folding and faulting along northwest and southeast directions. It is possible that this orogeny occurred in two phases, the first prior to the deposition of the Moodies Series and the second post-dating it. Evidence for this theory is afforded by the following:—

(a) The uncomformable relationship between the Moodies Series and the underlying Onverwacht and Fig-tree Series.

(b) Many of the small folds and minor contortions in the Fig-tree Series have no counterpart in the quartzites of the overlying Moodies Series.

(c) Pebbles of contorted chert and banded ironstone derived from the Fig-tree Series have been observed in conglomerates of the Moodies Series. The structural history of the area may be summarized as follows :—

(a) As a result of compressive forces probably from the south-east due to or as a result of the emplacement of the granite, a synclinorium was formed. The strata were crowded and piled into a series of isoclinal overfolds with their axes sympathetic with the main axis of the synclinorium.

(b) Relief of the compressive forces by a series of closely spaced strike faults. These strike faults are high angle thrusts which downthrow on to the northwest and with concomitant shearing and brecciation.

(c) Folding along a series of widely spaced northwest to southeast axes resulting in the buckling and warping of pre-existing fold keels and fault planes. These imposed folds show a tendency to pitch to the northeast.

(d) Faulting along northwest to southeast directions possibly during a period of relaxation after main orogeny. It is supposed that the movement along these faults was mainly horizontal.

Economic Geology

Gold Mineralization.

106. Four gold mines are known in the area, namely the Gordon, Daisy, Wyldsdale and Lomati mines, of which only the Wyldsdale mine is in production at the present time. Detailed geological examinations of the four mines have been completed by this Department and nothing further can be added on their gold mineralization at the present time. The writer discovered another two hitherto unknown old mine workings during the survey of the area. One is located near Trech beacon in the Mzimnene Valley and the other on the northern slopes of the Kobolondo Heights. Insufficient work has been carried out on these old workings for any comments to be made, but it is doubtful whether they have any economic significance. Traces of gold mineralization were found at a number of localities in the area but a programme of systematic trenching will have to be undertaken on the more promising sites to obtain further information.

107. From the distribution of gold deposits in the area, it is apparent that gold mineralization is localized by structural controls which are related to the deformation accompanying the intrusion of the granite. Consequently there is a general tendency for the auriferous zones to be aligned concordantly with the major northeast to southwest striking structures. It has been observed also that all the known centres of gold mineralization occur where there has been flexuring or faulting along northwesterly directions. Whether or not there is any connexion between the gold mineralization and these last mentioned structures will have to be further investigated.

Barytes

108. Barytes float was observed on a steep, scree covered slope three miles northeast of the Wyldsdale mine. This indication lies ¾ mile east-northeast of the barytes deposit discovered by Mr. P. E. Winter of this Department and lies in the same stratigraphical horizon.

Asbestos

109. A vein of brittle, slip fibre ½ inch to 2 inches wide was discovered in a body of steatized amphibolite with rafts of serpentinite two miles southeast of the Wyldsdale mine. An X-ray determination showed the fibre to be tremolite and without commercial value.

(D) by C. J. Beggs — Geologist

110. The writer took up the appointment of Geologist with the Department on October, 21st 1963, and has been on duty since this date except for two days sick leave in December.

111. Familiarization with the geology of Swaziland has occupied the writer since this date, and frequent visits have been made with other members of the staff to various localities. These visits include:—

(I) To Big Bend with Mr. D. N. Davies to take magnetometer readings over an unusually high magnetic anomaly.

(II) To Sicunusa to visit the diaspore/pyrophyllite mine and to Mahlangatsha to visit the kaolin deposits in the company of Messrs. Hunter and Purser of this Department.

(III) To Maloma with Mr. Brook of Tavistock Mine and Mr. Hunter of this department to site coal boreholes.

112. A plane table survey in the Red Reef area was carried out in connexion with a drilling programme for gold investigation.

(E) Diamond Drilling

113. Although considerable drilling time was lost due to the new accumulative leave regulations and local disturbances it is gratifying to record that footage for the year under review exceeded 1962 by 3,212 feet.

114. Of the 45 holes drilled during the year, only 5 were concerned with engineering projects.

115. All boreholes were completed. There were no delays due to breakdowns or worn out equipment and consequently no equipment lost down the hole or boreholes abandoned.

116. This reflects very highly on the skill and efficiency of the drilling section.

IV. MINERAL DEVELOPMENT

117. A large deposit of andalusite intimately associated with pyrophyllite and subordinate amounts of diaspore has been investigated by diamond drilling. The first borehole indicated a thickness of 62 feet for the ore body which has a strike length of 1,000 feet. This body occurs in the Insuzi Series in the Mankaiana District. Along the same horizon several other alumina-rich bodies which require further investigation, preferably by diamond drilling, are located. The potassium oxide content of four grab samples at the Atoll deposit averages 6.7%.

118. The strike at the Havelock asbestos mine which stopped production for over a month fortunately did not interrupt sales of the fibre as the mine has a considerable stock pile. The sales figures for the first eight months of the calendar year exceed slightly the figures for the equivalent period last year. The exploration operations by the concessionaires on mineral concession No. 41, immediately adjacent to the Havelock mine, have been suspended.

119. Two new barytes deposits were discovered during the course of the mapping in the Pigg's Peak District. The barytes, a grab sample of which assayed 91.4 per cent $BaSO_4$, occurs in veins up to 7 feet wide which have been traced continuously on outcrop for 700 feet. Unfortunately the deposits are situated high in the mountains and are difficult of access.

120. Beryl continued to be produced in a small way in the Sinceni area of the Hlatikulu District. Several miles from the known beryl deposit a new occurrence was discovered.

121. Considerable interest has been shown in brickmaking clays during the year. The shales of the Upper Ecca Series on testing have proved to be suitable for the production of face bricks.

122. As a result of enquiries for anthracite, several boreholes were drilled in the vicinity of the Mzimpofu River. One borehole intersected burnt coal and in the other two boreholes, dolerite with remnants of burnt coal occurred at the anticipated position of the main seam.

123. The planning of the colliery at Mpaka which is to be opened early next year has reached an advanced stage. A potential consumer in the Territory, following tests on earlier smaller samples, has now requested a bulk sample of 200 tons. Boreholes have been drilled with the permission of the concessionaires on the Corbett Ranch block to enable the Fuel Research Institute of South Africa to carry out dilation and other tests on samples from the main seam and also on over-and underlying seams.

124. A deposit of diatomaceous earth with a silica content of 89 per cent has recently been discovered during excavations for the Edwaleni hydroelectric station. If the laboratory tests on this material are satisfactory the deposit will be prospected more fully.

125. Considerable quantities of felspar were discovered in "The Rocks" area of the Mankaiana district. This block of ground warrants further investigation.

126. Drilling was completed at the dormant Daisy and Gordon mines, Pigg's Peak District. At the former mine the existence of 25,000 short tons of ore averaging 8.25 dwts/ton was indicated. No reserves were calculated at the Gordon mine where only one borehole was drilled which intersected a payable value of 3.8 dwts/ton over a true width of 41 inches.

127. Exploration was commenced at the Red Reef prospect, Mbabane District, towards the end of the year. Six boreholes have been completed. In the first borehole a value of 12.75 dwts/ton over an uncorrected width of 36 inches was obtained. Values of 7.48 dwts/ton and 9.53 dwts/ton over uncorrected widths of 30 and 28 inches respectively were obtained in two other boreholes. One borehole failed to intersect the ore body due to a steepening of the plunge of the fold and the assay results of the most recently completed hole are still awaited. The gold occurs in amphibolitic gneisses which have been impregnated by quartz veinlets and sulphides. Low gold values are fairly uniformly distributed through the gneisses. Work is continuing at this prospect.

128. Gold production at the two gold mines in the Forbes Reef area and one in the Pigg's Peak District has been maintained at almost the same level as last year. Production should increase next year with the installation of a new mill and the re-working of the dumps at the She mine.

129. Drilling on the kaolin deposits in the Mahlangatsha Mountain, Mankaiana District, is still continuing. The boreholes are being drilled to determine the origin of the deposits. In the course of this work it has been established that one of the kaolin bodies has been derived from a basic dyke, composed almost exclusively of amphibolite, which has been traced on strike for 2,600 feet. In this body kaolinization has occurred to a depth of 60 feet. The main body has been kaolinized in portions to a depth of 245 feet but the unkaolinized host rock has not been intersected in any borehole in a fresh state. Prospecting indicates a strike length of 4,500 feet for this body. Drilling and prospecting by pitting and auguring on other kaolin bodies in the same area is continuing. It now has been shown conclusively that the dykes from which the kaolin is derived have been intruded along lines of faulting and structural weakness.

130. These deposits of kaolin, without question, are very extensive and the ore reserves of good quality kaolin are large. There seems little doubt that with intensive prospecting further bodies of kaolin will be found. Tests on the raw kaolin have shown that the Swaziland material can be beneficiated to enable it to compete with the best kaolin produced elsewhere.

131. Kaolinized pegmatites were also investigated in the Forbes Reef area. These pegmatites occur over quite an extensive area, the kaolin being associated with muscovite mica of the scrap variety. Preliminary tests have shown this kaolin to be of a reasonable quality.

132. Considerable amounts of molybdenite, with associated chalcopyrite and pyrite were found in a narrow pegmatite vein exposed in a new railway cutting in the Mantenga area, Mbabane District. The area requires further prospecting preferably by geochemical methods as

molybdenite is known to occur elsewhere in the vicinity of the cutting.

133. Areas to be investigated in the future include Ncandu Hill area in the Maloma-Lubuli-Big Bend triangle where a magnetic anomaly of considerable magnitude occurs and the shale horizons of the Insuzi Series which are possible sources of aluminous and potassium minerals.

134. In the sphere of engineering geology the Department continues to advise on engineering problems in connexion with railway bridge foundations, tunnel sites, earthworks, cuttings etc. and undertook drilling at the Mkinkomo weir site for the Edwaleni hydro-electric scheme to test the foundations of the west flank of the wall.

135. Advice was given to farmers, small holders and others in connexion with the variety of water supply problems. The Department also was consulted in regard to the location of underground water supplies for railway stations and sidings in the Lowveld and advised on the problems of water supplies for Gollel township. As a result of several consecutive years of near drought in the Middle and Lowveld areas the need for the early approval of the proposed scheme to locate underground water suppplies in these areas becomes imperative.

V. MINES DEPARTMENT

(A) Mineral Statistics and Export

136. The mineral production figures for the year ending 31st. December 1963, are given in the table (Appendix 1) on page 33 of this report together with those for 1962 for comparison purposes.

137. Asbestos sales have shown a remarkable consistency and the total value of production differs by only R96 from that for 1962, a small increase. Actual production was up by 521 short tons.

138. Despite a decrease of R2,850 (122 fine ounces) in production value, gold remains the second most important mineral in the territory. Production for the year was 2,092 fine ounces valued at R52,381 with 120 fine ounces of associated silver valued at R108.

139. Kaolin and pyrophyllite have each suffered a drop in production, that for pyrophyllite being due to the increased difficulties of mining and that for kaolin being mainly due to a "mark time" policy while beneficiation and marketing problems have been sorted out. Kaolin production dropped by 531 short tons to 2,212 short tons valued at R16,108 while pyrophyllite production dropped by 850 short tons to 3,052 short tons valued at R13,875.

140. As the amount of easily obtainable diaspore has dwindled production has dropped considerably to a mere 64 short tons valued at R927.

141. The demands for barytes have been poor and, while production is up on last year, sales have amounted to only 93 short tons valued at R1,246.

142. A small production of beryl is again recorded after a "nil" return last year. Collected from surface rubble by Swazis in the Sinceni area beryl production maintains a small village industry which, however, is dwindling year by year as the surface yields less and less beryl. Production of 2.54 short tons was valued at R507.

143. A table on page 34 (Appendix II) shows the countries to which the various minerals have been exported and the amounts and values of each.

(B) Inspections

144. Routine inspections of the various mines and prospects in the Territory were carried out during the year. Enquiries were also held on the causes of fatal and other serious accidents. There were seven fatal accidents on the mines during the year, three involving Europeans and four involving Africans. Known breaches of the Mines, Works and Machinery Regulations were also investigated.

145. Once again considerable time was taken up in inspecting explosives magazines designed for storage of anti-hail rockets, which are now used extensively in the Territory.

(C) Accidents

146. To avoid duplication mine accidents have been classified in the "Machinery Department" section of this report.

(D) Labour

147. A summary of the labour employed in the mining industry in Swaziland is given in a table (Appendix III) on page 35 of this report. Although total earnings for the year have remained fairly static (there is an actual increase of just over R1000) the average monthly labour force in the mining industry has dropped from 1,910 to 1,675 persons. Wages of unskilled labour have again increased by some 19 per cent from R16.42 per month in 1962 to R19.53 per month in 1963. Food provided amounted to R5.73 per person per month. Wages of skilled labour showed no appreciable increase.

VI. MACHINERY DEPARTMENT

(A) Remarks on Machinery Inspections and Tests

148. There are 106 concerns registered as users of machinery which include 47 Steam Boilers installed in the Territory.

Boilers

149. Certificates of Permission were granted unprovisionally to:—

Raleigh Fitkin Hospital — 2 Boilers

Tip-top Dry Cleaners — 1 Boiler

Winding Plant

150. Amended Certificates of Permission were granted as follows:—
Havelock mine main vertical shaft: Whole shaft

Elevators

151. A certificate of Permission was granted as follows:—
Mbabane House 16 persons or 2,400lbs material.

(B) Accidents

152. The Mines, Works and Machinery Proclamation No. 61 of 1960 and the Explosives Proclamation No. 4 of 1961 and the regulations published thereunder provide for the safety of workmen employed in mines and works, including quarries and factories. The employment of women, young persons and children in mines or works is also regulated by the Employment Proclamation No. 51 of 1962.

153. The following tables are a reflection of the various types of accidents in mines or works which have been reported to the Inspector of Mines and the Inspector of Machinery. The following accident rates and death rates are based on average labour figures for the year.

	Death rate per 1,000	Accident rate per 1,000
Mines & Quarries	3.42	16.62
Industry	1.24	27.28
Overall	1.67	26.13

154. The following accidents were reported during the year.

	Fatal		Non-Fatal		Non-Casualty		Total	
	1962	1963	1962	1963	1962	1963	1962	1963
Mines & Quarries	4	7	147	101	1	Nil	162	108
Industry	8	25	422	517	2	1	432	543

155. Classification of non-fatal accidents into location of injury.

Location of Injury	Mines & Quarries			Industry			Total		
	a	b	c	a	b	c	a	b	c
Arms, hands or fingers	2	35	1	21	157	2	23	192	2
Legs, feet or toes	1	32	—	1	224	—	2	256	—
Eyes	1	10	—	—	18	—	1	28	—
Body or head	—	19	—	—	94	—	—	113	—
TOTAL	4	96	1	22	493	2	26	589	3

In this table (a) indicates loss of member,
(b) indicates injury to member, and
(c) indicates loss of use of member.

Classification of non-fatal accidents into type of accident

TYPE OF ACCIDENT	MINES & QUARRIES	INDUSTRY	TOTAL
Fall of ground	30	—	30
Machinery	—	36	36
Trucks & Trams	10	24	34
Fall of Material			
On Surface	6	90	96
Underground	3	—	3
Electricity	—	5	5
Miscellaneous			
Burning Scalding	—	18	18
Falling & Slipping	7	52	59
Splinters	7	11	18
Sundry	35	281	316
Explosions during Blasting	2	—	2
Sundry	1	—	1
TOTALS	101	517	618

Shifts lost as a result of non-fatal accidents.

156. The total time, in days, lost as a result of accidents is given below with the average time lost per accident:—

	Total No. of Shifts lost	Average shifts lost per accident	No. of accidents in which persons have been injured
Mines & Quarries	2508	24.83	101
Industry	10455	20.22	517
TOTAL	12963	20.97	618

157. The number of non-fatal accidents has risen from 569 in 1962 to 618 in 1963 due to a more intensive programme of construction.

158. The higher lost time per accident, which rose from 17.8 shifts/accident in 1962 to 20.97 shifts/accident in 1963 was partly due to construction work, where unskilled labour was used in a tight programme, and inexperience of the labour force which resulted in higher severity rates. In the permanent industries the actual lost time is well below the average. The same observation is true in respect of the lost time rate for mines, where a shaft sinking programme was in progress.

159. Allowing 280 shifts per man per year the time lost in accidents amounts to one man not working for 46.3 years.

160. In one company where a safety officer is employed, there is a continued drop in the accident and lost time rates.

(C.) New Construction

Swaziland Railway

161. Work continued on the construction of the Swaziland Railway and is being carried out by R. M. R. (Swaziland) Contractors.

Swaziland Electricity Board

162. Work continued on the Edwaleni Scheme for the Swaziland Electricity Board.

(D.) Electric Power

163. There was no increase in generating capacities of sets installed in the Territory.

(E.) Inspections

164. The following is a summary of the official duties performed by the Inspector of Machinery during 1963:—

Boiler Inspections

External	45
Internal	37
Hydraulic Test	29

Machinery Inspections
Surface-Satisfactory 6

Unsatisfactory 4

Underground-Satisfactory 1

Winding Plant
Inspection 2

Tests 2

Elevators
Inspections 5

Attendance at Law Court..... 9
Number of trips in connection with accidents 58

VII. HEADQUARTERS

(A) Administration

165. As expressed earlier in the report the work of the Department came to a virtual standstill as a result of the strike and civil disturbances. It took some time to sort out the repercussions of the disturbances and for the Department to return to its normal state of efficiency.

166. Interest has been keenly maintained in the mineral resources of the Territory, with the result that a considerable proportion of the professional and technical officers time has been taken up in interviews and discussions with representatives of mining houses and others interested in the exploitation of the Territory's minerals.

167. Much of the senior officers time has been taken up in preparing Bulletin No. 3 for publication which is due early in the coming year.

168. Two further receiving-transmitting sets for mounting in Landrovers were purchased. The whole of the field staff will now be in communication with Headquarters. The time and money saving value of the wireless sets has been shown amply over the past year.

169. It is with gratification that I place on record my sincerest appreciation of the services of the professional, technical and administrative staff whose efforts have meant so much in the efficient operation of the Department.

(B) Drawing Office

170. The extremely cramped conditions in the draughting office still remains a matter of concern. Fortunately the facilities for the filing of plans has been alleviated by the purchase of new special map filing cabinets.

171. A total of 6,502 prints were made during the year. This considerable increase over the figure of 2,697 for last year was brought about by the printing of maps and plans for the Bulletin. In the past prints have been produced by the slow ammonia process but it is hoped to be able to purchase a faster, more modern machine in the coming year.

(C) Library

172. The library facilities as usual have been used extensively by the professional staff as well as by members of the public. The Department subscribes to all the main geological and mining periodicals and in addition purchases the latest textbooks on geology and allied sciences to keep abreast of advances in these spheres. Reciprocity and exchange of publications, reports etc. is enjoyed with geological surveys and universities and other institutions throughout the world.

173. The lady stenographer also undertakes the duties of librarian.

Laboratory

174. The total number of samples prepared and dispatched for assay and/or analysis was 487. These were assayed and/or analysed as follows:—

Alumina	12
Barium	1
Beryllium	6
Cobalt	1
Gold	421
Iron	8
Lithium	3
Nickel	1
Potash	4
Silica	4
Tin	6
Complete analyses	20
	487

175. The field parties in the course of their geological mapping and prospecting operations crushed and panned many hundreds of samples.

(E) Publications

176. The following publications were issued during the year.

(1) The Annual Report of the Geological Survey and Mines De partment for the year ended 31st December 1962.

(2) Bulletin No. 2 "The Mineral Resources of Swaziland" of the Geological Survey and Mines Department.

177. In the Press

To be published in the Special Volume on the Economic Geology of South Africa by the Geological Society of South Africa.

(1) "The Tin Deposits of Swaziland" by D. N. Davies.

(2) "The Gold Deposits of the Barberton Mountainland in Swaziland" by D. N. Davies and D. R. Hunter.

178. Appendix V contains the list of unpublished reports written by the professional staff during the year. The list of maps and plans made during the period under review is found in Appendix VI. These and the reports are on sale to the public at a nominal charge.

(F) Visitors

179. Numerous visitors, mainly professional and technical officers of the mining and industrial houses, visited the Department during the year, In many instances these visitors were conducted over mineral occurrences by members of the staff.

(G) Acknowledgements

180. The Department gratefully acknowledges its indebtedness and thanks to the following for their co-operation and assistance in a variety of ways.

The Staff of the Secretariat, Mbabane.

The Director and staff of the Overseas Geological Surveys and also

The Director and staff of the Overseas Surveys.

The Director and staff of the Geological Surveys of the Republic of South Africa.

The Director and staff of the Geological Survey of Mocambique.

The Director and staff of the Bernard Price Institute, Johannesburg.

District Commissioners and Police Force of the Territory.

The Manager and staff of the Havelock Mine

The Manager and staff of Peak Timbers Limited

The Manager and staff of the Usutu Pulp Company.

The Manager and staff of the Ubombo Ranches Limited, Swaziland.

The Manager and staff of the Mhlume (Swaziland) Sugar Company.

The many members of mining companies operating in the Territory for their assistance and freely-given hospitality.

To members of the public for their co-operation with the Department.

D. N. DAVIES

Director of Geological Survey and Commissioner of Mines.

Mbabane
20th March, 1964.

APPENDIX I

MINERAL PRODUCTION FOR 1963

	1962		1963		INCREASE		DECREASE	
	Short tons	R	Short tons	R	Short tons	R	Short tons	R
Chrysotile asbestos	32,829.81	4,939.675	33,351.08	4,939,771	521.27	96	—	—
Pyrophyllite	3,902.00	21,410	3,052.00	13,875	—	—	850.00	7,535
Kaolin	2,743.00	20,569	2,211.69	16.108	—	—	531.31	4,461
Metallic tin	5.10	9,116	4.92	9,000	—	—	0.18	116
Diaspore	224.00	3,276	64.00	927	—	—	160.00	2,349
Barytes	67.87	973	93.00	1,246	25.13	237	—	—
Beryl	—	—	2.54	507	2.54	507	—	—
	fine ozs	R	fine ozs	R	fine ozs	R		
Gold	2,214.16	55,231	2,092.34	52,381	—	—	121.82	2,913
Silver	132.11	95	119.97	108	—	13	12,14	—
TOTALS		R5,050,345		R5,033,923		889		17,311

APPENDIX II

MINERAL EXPORTS, 1963

MINERAL	COUNTRY TO WHICH EXPORTED	SHORT TONS	VALUE R.
Chrysotile Asbestos	Argentina	154.00	22,353
	Australia	25.25	2,462
	Belgium	551.25	70,950
	Brazil	233.00	29,424
	Denmark	320.00	32,903
	England	18,807.19	3,043,765
	France	1,000.40	127,975
	Germany	46.56	5,471
	Holland	165.00	18,502
	India	20.00	3,016
	Ireland	10.00	1,011
	Italy	109.19	10,719
	Japan	4.00	665
	Mocambique	5.00	125
	Nigeria	265.00	41,332
	Norway	175.25	17,830
	Spain	1,626.00	235,019
	Republic of South Africa	9,833.38	1,276,249
Barytes	Republic of South Africa	93.00	1,246
Beryl	United States of America	2.54	507
Diaspore	Republic of South Africa & England	64.00	927
Kaolin	Republic of South Africa	2,211.69	16,108
Pyrophyllite	Republic of South Africa	3,052.00	13,875
Tin concentrates	Republic of South Africa	7.29	9,000
		fine ozs	Value R
Gold	Republic of South Africa	2,092.34	52,381
Silver	Republic of South Africa	119.97	108

APPENDIX III

LABOUR STATISTICS

Month	Skilled					Unskilled							Totals		
	Below Surface	On Surface	Total	Earnings R.	c.	Below Surface	On Surface	Total	Earnings R.	c.	Value of food R.	c.	Total Labour	Total earnings & food R.	c.
January ...	51	128	179	36,090	13	577	1,160	1,737	28,786	77	9,292	49	1,916	74,169	39
February ...	50	128	178	40,933	42	615	1,136	1,751	29,856	65	9,910	30	1,929	80,700	37
March ...	48	127	175	37,128	56	625	1,119	1,744	28,910	07	9,233	20	1,919	75,071	83
April ...	46	121	167	36,151	29	638	1,129	1,767	28,966	41	9,486	29	1,934	76,603	99
May ...	47	126	173	33,385	32	627	1,140	1,767	22,540	99	7,877	24	1,940	63,803	55
June ...	46	126	172	34,260	40	283	550	833	16,429	87	4,612	98	1,005	55,303	25
July ...	43	129	172	35,796	01	553	912	1,465	34,681	28	4,693	24	1,637	75,170	53
August ...	46	127	173	36,859	37	553	899	1,452	32,333	67	9,596	65	1,625	78,789	69
September	47	128	175	36,180	93	542	611	1,153	31,756	33	9,676	25	1,328	77,613	51
October ...	47	125	172	37,607	06	629	920	1,449	33,488	33	9,324	80	1,621	80,420	19
November	48	116	164	35,670	15	640	919	1,459	32,918	87	11,417	34	1,623	80,006	36
December ...	46	124	170	38,329	81	556	903	1,459	32,775	78	8,289	39	1,629	79,394	98
Total	—	—	—	440,392	45	—	—	—	353,245	02	103,410	17	—	897,047	64

APPENDIX IV

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDING 31st. DECEMBER 1963

B.H. No.	Depth	FORMATION	REMARKS
167	205	Siliceous Gneisses	Daisy Mine. Lapsed Min. Conc. 33A
168	384	" "	" " " " " "
162	144	" ".	" " Deepening 396—540
163	124	" "	" " " 232—356
169	659	" "	" " Lapsed Min. Conc. 33A
170	410	" "	" " " " " "
171	523	" "	" " " " " "
172	83	Granite	Pegmatites. Min. Conc. No. 28
173	460	Siliceous Gneisses	Daisy Mine. Lapsed Min. Conc. 33A
174	110	Granite	Pegmatites. Min. Conc. No. 28
175	70	"	" " " "
176	228	"	" " " "
177	458	Siliceous Gneisses	Daisy mine. Lapsed Min. Conc. 33A
178	427	" "	" " " " " "
179	420	Quartzite	Kaolin Mine. Lapsed Min. Conc. 50
180	312	Siliceous Gneisses	Daisy Mine. " " " 33A
181	630	Siliceous Gneisses	Daisy Mine. Lapsed Min. Conc. 33A
182	221	Quartzites	Kaolin Mine " " " 50
183	341	Siliceous Gneisses	Daisy Mine. " " " 33A
184 A, B.C.	254	Kaolin	Kaolin Mine " " " 50
185	147	Sandstone — Dolerite	Anthracite Prospect Min. Conc. 21
186	432	Sandstone, shale, Dolerite	" " " " "
187	351	Quartzite	Kaolin Mine. Lapsed Min. Conc. 50
188 A, B, C, D & E.	105	Granite	Engineering Project, Mkinkomo Weir
189	416	Sandstone, shale, Dolerite	Antharcite Prospect. Min. Conc. 2
190 A	158	Quartzite	Kaolin Mine. Lapsed Min. Conc. 50
190 B	150	"	" " " " " "
191	272	Siliceous Gneisses	Red Reef Gold Prospect. C.M.A. 7
192	251	Quartzite	Kaolin Mine. Lapsed Min. con. 50
193	198	Siliceous Gneisses	Red Reef Gold Prospect. C.M.A. 7
194	202	Andalusite	Atoll Prospect. Lapsed Min. Conc. 50
195	310	Quartzite	Kaolin Mine " " " "
196	133	Andalusite	Atoll Prospect " " " "
197	262	Siliceous Gneisses	Red Reef Gold Prospect C.M.A. 7
198	272	" "	Red Reef Gold Prospect C.M.A. 7
199	317	Quartzite	Kaolin Mine. Lapsed Min. Conc. 50
200	302	Sandstone Shale & Coal	Coal Prospect. Min. Conc. 2
201	272	Siliceous Gneisses	Red Reef Gold Prospect. C.M.A. 7
202	399	" "	" " " " C.M.A. 7
	11,412 feet		

APPENDIX V

Reports by Professional Staff

by D. N. Davies — Director

(1) Report for the European Advisory Council for the period September 1962 — February 1963.

(2) Report for the European Advisory Council for the period March 1963 — August 1963.

(3) Overseas Geological Surveys Report for the period 1st January 1963 — 31st December 1963.

by D. R. Hunter — Geologist.

(1) Report on the drilling at Droxford farm barytes occurrence, mineral concession No.25.

(2) Note on the further drilling of the cassiterite-bearing pegmatite mineral concession No.28.

(3) Report on a visit to the Mahamba area.

(4) Note on Mpaka colliery.

by J. G. Urie — Geologist.

(1) Notes on mapping and prospecting undertaken in the Motjane Valley and Forbes Reef Area.

(2) Notes on an examination of the rail cutting through the Mbuluzi Gorge, Lebombo Mountains.

(3) A prospecting programme undertaken in the Gollel Area – Hlatikulu District.

(4) Notes on an ancient Smelting Site, Peak Timbers, Pigg Peak District.

(5) The Geology of the Stormberg Volcanics, Swaziland. (Hunter and Urie).

by D. H. Jones — Geologist.

(1) Report on two sillimanite bearing zones occurring on lapsed mineral concession No. 50, Mahlangatsha area, Mankaiana District.

(2) Geology of the Malolotsha Valley, Mbabane District, Swaziland.

(3) Geology of the Daisy and Gordon Gold Mines (Hunter and Jones), Piggs Peak District. Swaziland.

APPENDIX VI

Maps and diagrams produced during 1963 in the drawing office

Plan	Date	Author	Title	Scale
535P	20. 1.63	D.H.J.	Geological plan of the Kobolondo Mine	1:1,000
536P	14. 2.63	D.H.J.	Geological plan of alumina and pyrophyllite deposits.	1:2,500
537P	14. 2.63	D.H.J.	Assay plan of the Black Diamond Creek Gold Mine	1:1,000
538P	20. 2.63	D.H.J.	Assay plan of the Kobolondo Mine North East section	1:1,000
539P	14. 3.63	D.H.J.	Location plan of alumina deposit Mahlangatsha area.	1:300,000
540MD	23. 3.63	D.A.C.P.	Plan of Exclusive Prospecting Licence, R. J. Sole' Farm 661, Hlatikulu.	1:25,000
541MD	23. 8.63	D.A.C.P.	Plan of Mining Location Farm 661, — Hlatikulu, R. J. Sole.	1:25,000
542MD	7. 7.63	D.A.C.P.	Plan showing 2½ sq. miles granted to Swaziland Collieries.	1:50,000
543MD	1. 3.63	D.A.C.P.	Approved type of transport box for Anti-hail Rockets.	not to scale.
544MD	19. 8.63	D.A.C.P.	Plan showing area bounded by Beacons CB1 — CB2 — CB3 — LB and DB, Swaziland concession No. 20, Mahlangatsha area.	1:2,000
545P	9. 5.63	D.R.H.	Section through boreholes drilled on Tin Pegmatite mineral concession No. 28.	1:100
546P	—	D.R.H.	Locations of Gold Reefs, Forbes Reef.	1:25,000
547P	12. 5.63		Portion of the country between Mankaiana and Hlatikulu.	1:50,000
548P	12. 5.63		Portion of the country between Komati and Usutshwana Rivers.	1:30,000
549MD	15. 7.63	D.A.C.P.	Diagram to accompany temporary water permit granted to R.J. Sole.	1:12,000
550MD	18. 6.63	D.A.C.P.	Diagram showing site of fatal accident in 17 East Cross-cut Havelock mine.	not to scale.
551MD	23. 7.63	D.A.C.P.	Diagram showing approved security attachment for anti-hail rocket magazine.	not to scale.
552MD	10.12.63	D.A.C.P.	Diagram of approved type magazine for Rain Making Rockets.	not to scale.

553MD	18.12.63	D.A.C.P.	Diagram of approved explosive magazine (200 cases).	various scales.
554MD	18.12.63	D.A.C.P.	Diagram of approved type 20 case magazine.	1" = 2'
555P	20.12.63	D.H.J.	Section showing sillimanite bearing zone in borehole 165B.	1:30,000
556P	20.12.63	D.H.J.	Location plan of sillimanite occurrences.	1:300,000
557P	12. 8.63	D.H.J.	Geological section of the Malolotsha Valley.	1:25,000
558P	20. 8.63	D.H.J.	Geological plan of the Malolotsha Valley.	1:5,000
559P	5. 9.63	D.R.H.	Distribution of the Mozaan Series in Swaziland.	1:500,000
560P	18. 9.63	J.G.U.	Geology of the Stormberg Volcanics.	1:250,000
561P	12. 2.63	D.R.H.	Section of Forbes Main Reef Mine.	not to scale.
562P	15.12.63	D.R.H.	Section through B/Hs 162 and 173.	1:500
563P	20.12.63	D.R.H.	Section through B/Hs 169 and 171.	1:500
564P	9.12.63	D.R.H.	Section through B/Hs 155, 178 and 181.	1:500
565P	12.12.63	D.R.H.	Geological plan of the Gordon mine and sections through B/Hs 180 and 183.	Plan 1:1,000 Sections 1:500
566P	3. 1.63	D.R.H.	Locations of Antimony occurrences Forbes Reef.	1:12,500
567P	4. 2.63	D.R.H.	Geological plan of the Daisy Mine	1:1,000
568P	28.12.63	D.R.H.	Diagramatic representation of the assumed structure in the vicinity of No. 1 Quarry Daisy Mine	1:500
569P	9. 9.63	D.R.H.	Stratigraphic columns of the Daisy and Gordon Mines.	not to scale.
570P	24. 9.63	D.R.H.	Longitudinal section of the Daisy Ore Body.	1:500
571P	4. 3.63	P.E.W.	Belmont Reefs C.M.A. 7, Geological and Assay Sketch plan.	1:100
572P	9. 4.63	D.N.D.	Columnar section showing correlation of B/Hs drilled on upper coal zone, Mtendekwa River, Stegi.	1:500
573P	10. 2.63	D.R.H.	Typical B/H section of Main Coal Zone, Stegi.	1:500
574P	18. 2.63	D.N.D.	Sampling of cassiterite bearing pegmatite on mineral concession No. 28.	1:100
575P	3. 1.63	D.R.H.	Ngwenya Haematite Deposit.	1:5,000

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SWAZILAND

ANNUAL REPORT

of the

GEOLOGICAL SURVEY AND MINES DEPARTMENT

For the year ended
31st December, 1962

Price: 50c (5/-)

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CONTENTS

I. STAFF OF THE GEOLOGICAL SURVEY

Director and Commissioner of Mines	D. N. Davies, O.B.E., M.Sc.(Rand), B.Sc.(Stell.), M.G.S.
Geologist	D. R. Hunter, M.Sc.(Lond.), F.G.S., M.G.S.
Geologist	J. G. Urie, M.Sc.(Rand), B.Sc. (Hons)(Rhodes), M.G.S.
Geologist	D. H. Jones, B.Sc.(Hons)(Wales), F.G.S.(Lond.), M.G.S.
Geologist	P. E. Winter, B.Sc.(Hons)(Rand), B.Sc.(Pret.)
Mineral Development Officer and Inspector of Mines	D. A. C. Purser, A.C.S.M., A.M.I.M.M.
Inspector of Machinery	J. S. Houston, B.Sc.(Elect. Eng.) (Rand), A.M.I.E.E., A.M.(S.A.) I.E.E., A.M.S.A.I.Mech.E., A.M.I. Cert.M.E.E.
Drilling Superintendent	D. Horn
Diamond Driller	R. A. M. Myburgh
Diamond Driller	J. S. McCall
Diamond Driller	I. L. H. Smith
Draughtsman	C. G. Matthews
Personal Assistant	Miss J. White
Accounts Assistant	Mrs. D. L. Warburton
Stenographer	Miss V. M. Slatem
Grade I Clerk	M. D. Msibi

II. INTRODUCTION

(A) General

The only staff addition was the appointment of Mr. I. L. H. Smith, Diamond Driller, in April with the inception of the C.D. and W. Scheme No. D 4918.

2. Mrs. A. W. Girdwood proceeded on leave in July pending retirement in December after 10 years of loyal and devoted service to this Department.

3. The Director, Mr. D. N. Davies, was awarded the Order of the British Empire in Her Majesty's New Year Honours List.

4. Except for C.D. and W. Scheme No. D 4918, the running costs of the Department have been borne by Territorial funds. Provision has been made in the estimates for the coming year for two additional C.D. and W. Schemes, namely a geochemical and geophysical prospecting programme and a scheme for the location of underground water supplies.

5. The year was noteworthy on account of the publication of the first Bulletin of the Department together with the publication of the explanation of the 1:125,000 Geological Map of the Territory. The work of compilation and editing the bulletin for 1962 entitled "The Mineral Resources of Swaziland" was completed. The publication is in the press at the time of writing. The Department possesses numerous unpublished reports on various aspects of the geology of Swaziland. It is proposed to issue these reports which are of considerable scientific interest both academic and economic, in the bulletins in the coming years. Consideration also has been given to the early publication of the geology of the Swaziland coalfields particularly in view of the forthcoming development of the coalfield.

6. Mr. D. R. Hunter attended the conference of the African Geological Surveys Association in Lusaka in August and participated in the excursions to the Kariba dam and the mines of the Copperbelt. In November, Mr. J. S. Houston attended the International Labour Organization conference in Freetown, Sierra Leone.

7. In May, the Special Mining Lease over the Ngwenya (Bomvu Ridge) haematite deposit was signed between Government and the Swaziland Iron Ore Development Company Limited. The lease grants mining title for a period of twenty-one years with the right of renewal for a further twenty-one years. The company also have given the assurance that they will investigate the possibility of beneficiating the ore in the Territory and of establishing an iron or steel industry in Swaziland.

8. The construction of the railway line has commenced with work proceeding in the Mbuluzi gorge where cuttings are exposing very good sections of the Stormberg volcanics. Work is in progress simultaneously on the bridge and tunnel sites.

9. The Department continued its co-operation with the Economic Geology Research Unit of the University of the Witwatersrand. The Territory was visited by Mr. D. A. Pretorius, Senior Research Fellow, who was conducted over the area underlain by the Insuzi and Mozaan Series. These two series together previously formed the Pongola System which was correlated with the Witwatersrand System. The most recent work together with recently received age determinations has shown fairly conclusively that these rocks are older than 3,000 million years, i.e., they are of Swaziland System age.

10. The Unit proposes to carry out further investigations into the origin of these formations in the next field season and also to undertake detailed investigations in the Forbes Reef gold belt.

III. GEOLOGICAL SURVEY

11. In the Mahlangatsha mountains in the Mankaiana district, Mr. Winter mapped 167 square miles on a scale of 1:50,000. The rock-types comprise the Insuzi Series composed essentially of lavas and phyllites and the Mozaan Series consisting essentially of quartzites and conglomerates with subordinate alumina-rich shale horizons.

12. Detailed mapping of the auriferous belt in the Horo area of the Pigg's Peak district was commenced. Messrs. Winter and Jones completed 3 and 4½ square miles of mapping respectively on a scale of 1:10,000. In all the areas mapped, the geologists in addition have been panning all streams and taking loam samples on a systematic grid basis.

13. As a follow-up to the discovery by Mr. Winter of new deposits of pyrophyllite, diaspore, sillimanite and kaolin in the course of the mapping in the Mahlangatsha mountains, Mr. Jones mapped the various new mineral occurrences by plane table on scales varying from 1:200 to 1:2,500. Mr. Jones also mapped 32 square miles on a scale of 1:25,000 in the highly dissected mountainous terrain of the Komati river valley. The rocky-types of this area consist of highly folded and complexly faulted sediments of the Swaziland System.

14. Mr. Urie completed the detailed mapping of 10 square miles in the Forbes Reef Motshane valley block on the scale of 1:10,000. During the course of this work all streams were panned and all old prospects and underground workings systematically sampled.

15. The value of these detailed surveys is shown by the discovery of new kaolin, pyrophyllite, sillimanite and manganiferous iron ore-bodies. It is hoped that the detailed survey of the rocks of the Swaziland System in the Pigg's Peak district likewise will yield fruitful results, particularly in connexion with gold mineralization. The possibility also exists of the discovery of base metal in the same area. As previously stated it is hoped to support the geological mapping in the coming year with geophysical and geochemical surveys.

(A) By D. R. Hunter—Geologist

Economic Geology

16. During the year drilling programmes and ancillary geological work in connexion with these programmes were supervised.

Copper-Nickel

17. Outcrops of gabbro containing copper and nickel-bearing sulphides occur on the northern flank of Maloya hill, Mbabane district, being a westerly continuation of the lower mineralized zone of the Usushwana Complex explored at Embo, three miles distant, last year.

18. Three boreholes were sited in this area; two at a distance of 2,000 feet from each other along strike and a third 400 feet down dip from the borehole drilled at the south-eastern end of the area explored.

19. These boreholes revealed the following succession:—

(ii) Coarse-grained gabbro with variably sized xenolithic blocks of olivine gabbro.

(i) Footwall zone of alternating bands of coarse gabbro and medium-grained, dark gabbro.

20. The mineralization occurs in the basal portion of the coarse gabbro overlying the footwall zone. In one borehole (No. 145) further mineralization was intersected 25 feet above the base. No mineralized zone was intersected in borehole No. 146.

21. The sulphide mineralization is typical of the lower zone, i.e., coarse blebs of pyrrhotite and chalcopyrite scattered irregularly in the gabbro. In the footwall zone stringers of pegmatitic gabbro occur which are heavily charged with sulphides. The greatest width of these stringers is 6 inches.

22. The drilling indicates that the mineralized zone dips towards the centre of the complex at between 25° and 35°. The assay values may be summarized as follows:—

Borehole No.	Cu%	Co%	Ni%	True width inches
144	0.31	0.06	0.14	38
		Parting 1 foot 3 inches		
	0.28	0.04	0.12	31
145	0.40	0.04	0.27	42
		Parting 29 feet 3 inches		
	0.35	0.05	0.24	36

These values compare closely with those obtained in the Embo area.

Magnetite

23. During the course of the geological mapping of the Usushwana Complex, outcrops of magnetite bands were located at several places, notably on the north-east side of the Buhlungu valley where the bands appeared to reach their maximum development. As trenches dug on the steep scree-covered slopes provided only meagre information, three boreholes were drilled to explore the magnetite bands.

24. The gabbro in this area is essentially a coarse-grained rock often rich in magnetite and composed of altered clinopyroxene and felspar. Near certain of the magnetite bands the gabbro has a spotted appearance due to the concentration of the mafic minerals into eliptical areas. Towards the base of the succession a gabbro was intersected which was found to be notably richer in apatite than the normal variety.

25. In spite of the abundance of magnetite float only two substantial bands of magnetite were intersected and there is a possibility that these bands may represent only one horizon which has been duplicated by faulting. In borehole 148 this 6-foot band dipped at a shallow angle and it is possible that a fault with a small throw could account for the presence of a similar band found in borehole 147. Below this main band there are no further bands for a vertical distance of 250 feet. There follows a zone varying in width from 120 to 160 feet in which narrow bands of magnetite are common. This is underlain by the apatite-bearing gabbro.

26. Analyses of bands intersected in the boreholes reveal the following:—

Borehole No.	Depth	V_2O_5%	TiO_2%	Ni%	Fe%
147	260′ 4″—266′ 5″	0.26	12.91	Nil	47.40
148	45′ 9″— 51′ 5″	0.20	12.42	Nil	40.95
148	315′ 1″—315′ 6″	0.18	11.23	Nil	43.15
148	379′ 3″—379′ 7″	0.31	11.76	Tr.	42.45

These analyses agree in all respects with those obtained from outcrop samples and confirm that there is only a slight variation from band to band.

27. Two sections of apatite-bearing gabbro were submitted for analysis as follows:—

Borehole No.	Depth	P_2O_5%
148	429′ 0″—434′ 0″	0.87
148	434′ 0″— 43′ 9″	0.82

28. Although gabbro float containing chalcopyrite and pyrrhotite occurs on the hill-slopes no traces of such mineralization were observed in borehole cores.

Barytes

29. The prospection of the barytes occurrence on Droxford farm was completed during the year. All three boreholes failed to intersect more than a few narrow stringers of barytes.

Coal

30. Drilling was undertaken on Magomba and adjacent ranches in an endeavour to locate the outcrop of the main coal seam in this area. However, the presence of strike faults prevents this seam from outcropping in this area. The faults are of such a magnitude as to displace the seam to considerable depths.

Kaolin

31. At the request of Kaolin (S.D.) (Pty.) Limited boreholes were drilled at their property to test the persistence in depth of the kaolin. It was found that kaolin of good quality persists in depth to at least 125 feet below surface. At this depth there are no indications of deterioration in quality or of a transition into unaltered rock.

Sillimanite

32. Preliminary boreholes were drilled at occurrences of sillimanite in the Mahlangatsha hills, Mankaiana district. Sillimanitic quartzites form hard, prominent outcrops. The initial boreholes failed to intersect any of the harder material. Only sparse amounts of sillimanite occur in the softer variety which has been altered to kaolinite and dickite.

Gold

33. Two boreholes were drilled at the dormant Kobolondo gold mine on mineral concession No. 32A. Neither holes intersected any payable values. It would appear that the old mine extracted ore from small high grade patches.

34. At the Daisy gold mine on mineral concession No. 33, a detailed drilling programme was begun after the first two boreholes had intersected the ore-body assaying 16.61 pennyweights over a true width of 72 inches and 12.5 pennyweights over a true width of 50 inches. The ore-body is a zone of quartz impregnation in siliceous biotite gneisses occurring 150 feet stratigraphically below a prominent, sheared chert.

Water Supply

35. Further advice was given regarding underground water at the

Gollel cattle holding ground. The first borehole sited in 1961 was dry but the second hole was reported to yield 1,800 gallons per hour.

36. A borehole was sited at Matsapa airfield which yielded in excess of 1,200 gallons per hour.

37. Sites for three boreholes were indicated on the property of Usutu Orchards should a need arise for a supply of water from underground sources. Five sites were selected to supply water to the houses to be erected at the hydro-electric power station.

Engineering Geology

38. Boreholes were drilled in connexion with the construction of the hydro-electric power scheme installation and to test bridge foundations at Manzini. Advice was also given regarding bridge foundations across the Mzimpofu river for the railways.

Miscellaneous

39. Several visiting consulting engineers and geologists were conducted to areas of potential economic interest.

40. Gravels in the Buhlungu valley were panned to examine their heavy mineral content and the old dumps at the Daisy mine were sampled by means of the Mackintosh prospecting tool.

41. The conference of the Association of African Geological Surveys was attended in Lusaka. This was preceeded by a tour of the copper mines in Northern Rhodesia.

42. The compilation of the bulletin entitled "The Mineral Resources of Swaziland" was completed during the year and the preliminary galley proofs corrected.

(B) By J. G. Urie—Geologist.

43. Apart from two leave periods of two weeks each the writer was on duty throughout the year.

44. During the absence on leave of Mr. D. N. Davies the writer acted as Director of the Department for a period of two weeks during January.

45. From January to the end of July the writer assumed duties as Inspector of Mines and Explosives as Mr. D. A. C. Purser was on overseas leave. Routine inspections of mines and quarries were carried out and in addition the writer accompanied the Inspector of Machinery on investigations of various accidents at quarries and mines.

46. Preparation for the construction of the rail link between Ngwenya Iron Deposit and Goba commenced during this period. Appreciable quantities of explosives are required for this undertaking and much time was spent in discussion and correspondence with representatives of African Explosives and Chemical Industries and R.M.R. Contractors concerning the importation, distribution and storage of explosives and the security measures to be adopted.

47. Limited quantities of anti-hail rockets of French manufacture had been brought into the territory towards the end of the previous year, but it was during early 1962 that the extensive use of anti-hail rockets was seriously considered. The Department was approached by Mr. R. B. Black who wished to obtain permission to import considerable quantities of rockets of Italian design. As this type of rocket had not been used in Southern Africa before it was necessary to establish within the framework of existing regulations, procedures to be adopted for importation and distribution of the rockets and to design suitable storage magazines of various capacities.

48. The writer carried out the duties of the drilling superintendent while the latter was away on a short period of leave.

49. Office and laboratory work involving the compilation of a concession tax and mining and prospecting rights ledger and the identification of minerals by X-ray and other methods was undertaken.

50. During November and December the writer re-mapped an area of approximately 10 square miles on a scale of 1:10,000 in the Motshane valley Mbabane district. Simultaneously panning of all streams in the area was carried out.

51. Mapping covered an area largely underlain by altered ultrabasic rocks of the Jamestown Complex. In this area the Jamestown Complex is present as a huge lopolitic mass which engulfs Swaziland System sediments building the southern terminus of the Ngwenya mountain range. To the west, south and east this lopolith is intruded by G.4 granite.

52. The ultrabasics are severely altered having been subjected to orogenic stresses and invasion by the granite. Their metamorphism has included serpentinization and steatization and the Complex has been extensively carbonated. Detailed mapping has revealed that in this area a distinct metamorphic zoning of the ultrabasic mass is discernible. This zoning can largely be attributed to the effects of the granite intrusion for a decided relationship exists between the degree of alteration of the ultrabasic rocks and their relative distance from the granite contact. In the field the ultrabasics can be broadly sub-divided into (1) Tremolite-antigorite zone with associated serpentinitic rocks. (2) Tremolite-talc zone. (3) Talc-chlorite zone with minor amounts of carbonate. (4) Talc-carbonate zone.

53. Panning of all streams in the area was simultaneously undertaken. This involved sampling of gravels and sands in the stream beds and any alluvial beds occurring in the banks of the streams at roughly 100 feet intervals. In all some 500 samples were panned and examined. The heavy mineral assemblage naturally varies with the rock-types traversed by the streams. Magnetite, ilmenite, goethite and haematite, although varying in proportion, are ubiquitous. Tourmaline is commonly present, but more abundant in those streams draining from the north and west, i.e., towards the contact with the sediments. Zircon and garnet are particularly common in streams draining from the granite country to the south and east and traversing rafts of granulites and gneisses.

54. Samples taken from the upper reaches of the Motshane river contain heavy mineral assemblages which are fairly typical of the area. Examination of these revealed the following.

Magnetite

55. Present as irregular grains and distorted octahedra which vary in colour from metallic black to dull brownish depending on the degree of weathering.

Ilmenite

56. Present as black irregular grains.

Haematite

57. Friable aggregates and pellets of red-brown colour.

Goethite

58. Yellow-brown to dark brown pellets and nodules. Very occasionally as cubes pseudomorphic after pyrite.

Tourmaline

59. Irregular fragments but more usually as striated prisms. A wide range of colours with dichroism ranging from dark brown to pale amber,

blue-black to brownish, and very occasionally olive-green to pale green, bright blue to near colourless.

Zircon

60. Most typically present as prisms occasionally as tetragonal pyramids or irregular fragments. Colour varying from near white to dark amber.

Amphibole

61. Pale amber to pale-green columnar fragments characterized by irregular cross fractures. Cleavage distinct. Of the tremolite-actinolite group.

Siderite

62. Crystalline aggregates of creamy or brownish colour.

Gold

63. Present as minute specks and small irregular flakes.

64. Gold in small, variable amounts was the only mineral of economic interest observed in the pannings. In each instance gold was traced to its source area by methodical panning of the stream and its tributaries. To date panning has not revealed any new areas of auriferous mineralization for in each instance the indicated source area is in the vicinity of previously known workings. The method of investigation is rapid and does serve to define those areas which warrant closer examination.

65. In addition to routine inspection of mines and quarries the following visits were made during the course of the year.

(1) *Mankaiana District:* Accompanied by Messrs. W. Talbot and W. Briggs to visit and pay out beryl prospectors in the Sinceni area.

(2) *Mbabane District:* Accompanied by Messrs. Payne and Barth of the Anglo-American Corporation on a visit to the Ngwenya Iron Deposit.

(3) *Pigg's Peak District:* Accompanied Mr. D. N. Davies to Pigg's Peak for discussions with the District Commissioner and local chiefs concerning the possibility of starting a gold mining village industry in that district. Subsequently during the year two further visits were made to inspect areas on which the Swazi wished to obtain prospecting rights.

(4) *Mankaiana District:* To examine alleged occurrences of tin and asbestos in the vicinity of Mankaiana.

(5) *Mankaiana District:* Accompanied by Mr. D. Horn to the Mahlangatsha kaolin deposit to give advice concerning a proposed drilling programme.

(6) *Hlatikulu District:* To Pentouyz tin deposit to define the limits of the prospecting right granted to Mr. R. Solé.

(7) *Mbabane District:* Number of visits to the Forbes Reef area to site and supervise the drilling of a borehole on a tin-bearing aplite vein.

(8) *Pigg's Peak District:* To Pigg's Peak mine to site a borehole on a serpentinite body occurring in the vicinity of the mine.

(9) *Pigg's Peak District:* Accompanied Dr. A. Waters and Dr. Percival to examine banded ironstones and occurrences of iron ore in the Nottingham Peak area.

(10) *Pigg's Peak District:* Number of visits to Pigg's Peak to give evidence in cases of illicit gold dealing.

(11) *Stegi District:* Accompanied Mr. D. N. Davies to examine rock exposures in the rail cutting through the Mbuluzi Gorge.

(12) *Mbabane District:* Accompanied Dr. Drysdall on visits to the Ngwenya Iron Deposit and the She and Waterfall gold mines.

(13) *Hlatikulu District:* Visit to the Sinceni area to examine the beryl collected by Swazi prospectors during the course of the year.

(C) By D. H. Jones—Geologist

66. The writer was on duty throughout the year except for 3 weeks annual leave early in May and 5 days in November. From January to 15th of March the compiling of plans and reports in connexion with the previous year's field work was completed. During this period a visit was made to Bulungu Gorge, with Mr. P. Davies of Swaziland Consulting Engineers to locate a quarry site for the provision of railway ballast.

67. From 15th March to 17th June the writer was engaged in the re-mapping of the area lying between Forbes Reef to the south, the Komati river to the north, the Transvaal border to the west and the contact of the G.4 granite to the east. This area, which occupies 32 square miles, is highly dissected mountainous terrain and is not readily accessible. Consequently four camps were established during the investigation in order to thoroughly examine the area. The first two camps were situated 2 and 4 miles respectively north of Forbes Reef store on the Mbutu hills whereas the third was sited one and a quarter miles north-east of the She gold mine. All three camps were accessible by Land Rover. The fourth camp was established west of the Malolotsha river at the foot of Silotwane peak and the hiring of donkeys was necessary to transport camp equipment. Aerial photographs on a scale of approximately 1:30,000 were used for the re-mapping of the area, the geological data then being re-plotted on a 1:25,000 scale topographical map. Besides re-mapping, the area was also carefully scrutinised for occurrences of minerals with economic value.

68. During the period 12th June to 15th October a detailed survey was undertaken in the Mahlangatsha area of the Mankaiana district on four deposits of alumina and pyrophyllite and two of sillimanite, which were located by Mr. Winter of the Department during his regional mapping of the area. In addition, occurrences of kaolin and manganiferous iron ore, also discovered by Mr. Winter, were examined. The four deposits of alumina and pyrophyllite, namely, the Bikini, Atoll, Brickworks and Eslindini deposits, were surveyed by means of a plane-table and systematically sampled to ascertain their economic potential. Detailed geological plans on scales varying from 1:200 to 1,000 were produced of each deposit together with a 1:5,000 geological map covering some 8 square miles of the area surrounding the Bikini, Atoll and Brickworks deposits. The two sillimanite-bearing deposits occurring in an area of 1/6 square mile, were also plane-table surveyed and a 1:2,500 scale map, showing the salient geological features, produced. In addition the two deposits were sampled. The continuity of the kaolin was established by the Mackintosh prospecting tool and auger drilled together with trenching and pitting over an area of three quarters of a square mile. This area was surveyed by plane-table on a scale of 1:500. The occurrence of manganiferous iron, occurring over an area of three and a half square miles, was mapped using aerial photographs on a scale of approximately 1:30,000. The horizon was sampled at regular intervals and a number of shallow trenches dug at strategic points. During the period a visit was made to the Kobolondo mine in the Pigg's Peak district to site a diamond drill borehole.

69. From 6th September to 5th October, work was continued mapping the auriferous belt in the Horo area. A camp was established on the bank of the Mgubudhla river where it crosses the old Pigg's Peak-Hectorspruit road. Using aerial photographs with an approximate scale of 1:10,000, an area of four and a half square miles immediately south-west of the Daisy gold mine was mapped in detail. In addition, the panning of all streams in the area and loam sampling on a systematic grid was carried out. During

this period the writer and Mr. Winter visited Louws Creek and spent two days with the Rand Mines Limited geologists studying the gold-bearing zones of that area.

70. Two days were spent touring the alumina and pyrophyllite deposits of the Mahlangatsha area with Mr. A. E. Greville and Mr. Fockson of G. & W. Base and Industrial Minerals (Pty.) Limited. A further day was spent with Mr. D. R. Hunter of this Department and Dr. R. Davis of Falconbridge Nickel Corporation visiting the Daisy gold mine area in the Horo valley.

(a) *The Komati Area Survey (Mbabane District)*

71. The area of 32 square miles surveyed lies in Crown mineral area No. 7. The area was originally mapped as part of a regional survey by D. A. Pretorius in 1947 when he was a member of this Department. The survey carried out by the writer was with the intention of revising some of the stratigraphical and structural interpretations of the original survey and to prospect for economic minerals.

(i) *Topography*

72. The area is very mountainous being dominated by the Mpanda-Silotwane-Masali mountains on the western part of the area and by the Mhlope-Majalombe-Mbutu mountains on the eastern portions. These mountain ranges are separated by the deep valley of the Malolotsha river which flows north-eastwards to join the Komati. The deeply dissected nature of the country is illustrated by the fact that from Silotwane peak to the Malolotsha river represents a fall of 2,830 feet in just over two miles, and from the Mbutu hills to the Malolotsha a drop of 1,300 feet over a distance of one and a quarter miles. The Silotwane peak has an elevation of 5,511 feet and the Mbutu hills of 4,130 feet above sea-level. Tributaries of the Malolotsha river, such as the Mpandagasi, Mbutu and Impuzi also form deep valleys and gorges. The Mhlangampepa valley to the south-west of the area is another prominent topographic feature. A number of waterfalls occur in the area the most prominent being the Malolotsha falls which plunge 350 feet into the deep and wild Ekwayini gorge.

(ii) *Stratigraphy*

73. The area is underlain by rocks of the Swaziland System which have been intruded by the Jamestown Complex, the G.4 granite, and by post granite intrusives ranging from granodiorite to dykes of basic composition. The Swaziland System is represented predominantly by grits, quartzites and conglomerates of the Moodies Series which are responsible for the hills and mountains of the area. The Fig-tree Series is confined to poorly exposed inliers occupying low lying land.

74. The Fig-tree Series facies of the Swaziland System includes phyllites, shales, shaly sandstones, cherts, banded ironstones, mica schists and quartz-biotite schists. The Jasper Marker, a dull red jasper rock containing specularite, two beds of shaly sandstone, a narrow shale band and a conglomeratic phase, originally included with the Moodies Series, are now considered to be part of the Fig-tree Series and are correlated as such by the writer. Due to lack of exposures no accurate estimate of the thickness of the Fig-tree Series in the area can be made.

75. In order to determine the geological structure of the area, it was necessary to divide the Moodies Series into a number of zones on a lithological basis. Thus the Moodies Series which is represented by 5,130 feet of sediments in the area, is divided as follows.

Zone	General Description	Approx. Thickness ft.
M7	Medium-coarse grained quartzites with massive, ill-sorted conglomerate bands. The pebbles and matrix of the conglomerates are often replaced by limonite and haematite.	1,380
M6	Shaly sandstones, and indurated shales tending to be ferruginous in some localities.	±280
M5	Fine grained micaceous quartzites, brown and purple shales, slates and mudstones.	230-650
M4	Medium grained gritty quartzite with scattered rounded pebbles.	120-420
M3	Coarse grained grit with scattered subangular pebbles and loosely packed ill-sorted conglomerates sometimes containing abundant chert pebbles.	500-1,200
M2	Medium grained gritty quartzite with occasional scattered pebbles.	400-600
M1	Fine grained shaly, micaceous quartzites.	450-600

Each zone tends to show rapid lateral changes, the variations being included in the above general descriptions.

76. The stratigraphical relationship of the Moodies Series to the Fig-tree Series is markedly unconformable. Overlapping by the Moodies Series is pronounced between the eastern and western parts of the area. In the vicinity of Mbutu hills, the M1 zone of the Moodies Series lies unconformably on the Fig-tree Series, whereas in the Masali peak area, M3 zone constitutes the base of the Moodies Series. Intraformational unconformities within the Moodies Series itself are also prevalent such as the wedging out of the M4 zone north of Silotwane Peak and the M6 zone north-east of Masali peak. The overlapping and intraformational unconformities within the Series would suggest periods of isostatic readjustment during the period of deposition.

77. Metamorphosed ultrabasic rocks of the Jamestown Complex are represented by talc schists, talc-tremolite schists, talc-carbonate schists, amphibolites, pyroxenites and serpentinites. These rocks occur in long lens-shaped bodies often having been intruded along lines of structural weakness both in the Moodies and Fig-tree Series.

78. The granite, which constitutes the eastern-most boundary of the area is typically G.4 granite as classified by D. R. Hunter (1957). Only its contact was mapped during the survey but it was observed to be coarse grained, grey coloured and locally displaying porphyritic or foliated phases. Microscopically its composition is quartz, orthoclase, plagioclase, microcline and biotite with occasional hornblende.

79. Post-granite intrusions include irregular-shaped stocks of granodiorite together with dykes of basic composition. Insufficient work has been

done to determine the various ages of the dykes but it is likely that the majority are of pre-Karroo age.

(iii) *Structure*

80. The geological structure is essentially that of a complexly folded synclinorium which has been subjected to intensive faulting. At least three stages of folding and faulting have occurred:—

(a) Folding and faulting that puckered and fractured the Fig-tree Series prior to the deposition of the Moodies Series. It is impossible to correlate the details of these structures due to insufficient exposures.

(b) Post-Swaziland System tectonism causing the formation of the synclinorium and compact overfolding with intensive faulting. the axes of the major folds in the synclinorium are generally orientated along north-east to south-west aligned axes. The faulting is usually of the high-angle, thrust-wrench type resulting in very complicated geological structures. This tectonic period is closely associated with the emplacement of the G.4 granite, but whether the emplacement of the granite was the result of the tectonism or the instigator is controversial.

(c) A period during which the area was gently flexured along north-west to south-east striking axes followed the major faulting and folding of the area. Consequently the keels of many of the major folds are buckled and the pre-existing faults subjected to warping. The degree of faulting accompanying this rippling was not ascertained.

(d) Faulting of post-granite age has further complicated the geological structure of the area. They are commonly normal tension faults frequently occupied by dykes which strike in a north-west to south-east trend.

(iv) *Economic Geology*

(a) *Gold*

81. All quartz veins and mineralized rocks in the area were sampled and assayed for their gold content with negative results. In addition, all streams and rivers in the area were systematically panned, but with the exception of traces of gold in the alluvium in the lower reaches of the Malolotsha river results were negative.

(b) *Tin*

82. A number of old alluvial tin workings were located along the Malolotsha river between the old Forbes Reef mine and the northern limit of Ekwayini gorge.

(c) *Iron*

83. A broad zone of banded ironstones in the Fig-tree Series occurs adjacent to the G.4 granite contact one and a half miles north-east of Forbes Reef store. The banded ironstones are traceable for 9,500 feet along a north-east south-west strike and have an average thickness of about 500 feet. The beds are poorly exposed, except in some old surface workings and consequently it was not possible to sample them in any detail. It is doubtful, however, whether the ironstones have any economic significance.

84. The Jasper Marker, which is prominently exposed north of Masali peak for some 9,500 feet before swinging away over the Transvaal border, is a ferruginous horizon. It is estimated that the Jasper Marker has a thickness of about 400 feet. Its characteristic red colour may be due to

finely disseminated iron particles, but the majority of its iron content occurs as specularite. The specularite is associated with veinlets of white quartz, tending to be concentrated along their contacts. When the veinlets occur parallel to one another the rock takes on a banded appearance. The Jasper Marker was sampled at strategic points but no assay results are at hand at the time of submitting this report. Pretorius (1947) reports that the Jasper Marker north of the Lily Valley averages 43.43% iron and 33.05% silica.

85. Ferruginous patches occur in indurated shale of the Moodies Series (M6 zone) on the western slopes of the Silotwane peak in the Mhlangampepa valley. The iron content in these patches is entirely in the form of limonite which occupies fractures and bedding planes in the shale and also as a gossan capping to the rock. Some of the mineralized portion may contain 49% iron and 10% silica, but they do not have any economic potential since their distribution is of a limited extent. The conglomerate bands of the overlying M1 zone of the Moodies Series in the same vicinity and also on the northern and north-eastern flanks of Silotwane peak are periodically ferruginous. Pebbles of limonitic material occur, the matrix and pebbles of the conglomerate being frequently replaced by limonite and haematite. Rich portions may assay 57% iron and 3% silica, but again mineralization is patchy with limited extent.

(d) *Asbestos*

86. A number of serpentinite bodies intruded into the Moodies Series with other Jamestown Complex rocks occurring in the area. The serpentinite bodies are lens-shaped with their long axes generally orientated along a north-east to south-west direction. They attain an average length of 3,000 feet and the largest body being 500 feet across at its maximum width. The serpentinites are generally of the apple-green variety, though some small isolated occurrences of blue-green serpentinite are present. One small lens of apple-green coloured serpentinite, lying on the western bank of the Malolotsha river 10,500 feet east of Silotwane peak, carries quantities of brittle slip fibre. No other indications of asbestos were observed, but as the serpentinite bodies are not well exposed a trenching programme would have to be instigated to prospect them thoroughly.

(b) *Economic Geology of the Mahlangatsha Area (Mankaiana District)*

87. A number of occurrences of minerals with economic potential were examined. All the deposits lie on lapsed mineral concession No. 50.

(1) *Alumina and Pyrophyllite*

88. Four deposits of alumina and pyrophyllite occur within an area of 7 square miles towards the centre of the concession. The four deposits, namely the Bikini, Atoll, Brickworks and Eslindini deposits occur in a phyllitic band of the Insuzi Series.

89. The generalized stratigraphical succession of the area is as follows:—

Type	Thickness (ft.)
Andesitic lava	?
Felsitic lava, sometimes amydgaloidal near its base	?
Upper phyllite	90-130
Felsitic lava	±350
Lower phyllite	?

90. The deposits of alumina and pyrophyllite are confined to the lower phyllite horizon. The rocks of the Insuzi Series have been subjected to folding and the genesis of the deposits is attributable to dynamic and thermal metamorphism, each deposit occurring near the crest of an overfold.

(a) *The Bikini deposit*

91. The deposit is situated in the hilly country one and three-quarter miles south-east of Mahlangatsha clinic. The deposit is lens-shaped and dips to the south-east at 16 to 30 degrees. It is essentially a pyrophyllitic schist with augen and veins containing mica and small quantities of muscovite. The pyrophyllite is characterized by a pale-greyish colour and a soft talcose feel. The harder and more compact augen of mica (muscovite) and diaspore are pale-grey almost white in colour. The veins of mica and diaspore which lace the deposit attain a maximum width of 3 inches and vary in length from 6 inches to several feet. They are generally aligned parallel to the long axis of the lens-shaped deposit.

92. Systematic sampling shows the deposit to have the following grade:—

	Alumina	*Silica*	*Titania*
Pyrophyllitic schist ..	35.53%	54.10%	1.04%
Mica-diaspore rock ..	31.43%	57.13%	0.94%

93. It is conservatively estimated that 21,000 tons of good quality pyrophyllite and 1,600 tons of mica-diaspore rock can be yielded by the deposit.

(b) *The Atoll deposit*

94. The Atoll deposit is situated just over half a mile to the north-east of the Bikini deposit and is prominently exposed on a steeply inclined hill slope. The deposit is primarily a quartz-andalusite-pyrophyllite schist which dips at 21 degrees to the north-west with a roughly lenticular shape. The rock is finely laced with veinlets of pyrophyllite which become increasingly abundant near the uppermost contact of the deposit, so that the andalusite remains only as scattered "islands" in a pyrophyllitic schist. Muscovite and lesser quantities of diaspore occur both as a constituent of the schist and in veinlets lacing the deposit. In the former case, the muscovite and diaspore occupy cleavage planes which are at variance with the schistosity of the rock.

95. The average grade of the deposit estimated from representative sampling is as follows:—

Alumina	*Silica*	*Titania*
36.32%	54.67%	1.19%

96. The deposit has a strike length of 1,220 feet and an average width of 100 feet. Assuming a down dip persistency of 150 feet, some 1,220,000 tons of rock, at the above grade, are available.

(c) *The Brickworks deposit*

97. The Brickworks deposit occurs on the bank of the Mozane river three quarters of a mile east of the Atoll deposit. The deposit dips north-east between 21 and 38 degrees and is primarily a quartz-andalusite-pyrophyllite schist. The sections show the rock to have a matrix of microcrystalline quartz, andalusite and small quantities of cordierite. Porphyroblasts of andalusite are also present being aligned parallel with the schistosity. Both the andalusite in the matrix and the porphyroblasts are replaced by pyrophyllite, sometimes entirely, so that the rock grades into a poor quality pyrophyllitic schist. Muscovite and diaspore occur both as constituents of the schist and in narrow veins dissecting the deposit. In the former case, the diaspore and muscovite lie in cleavage planes which are discordant to schistosity of the matrix.

98. The average grade of the deposit estimated from sampling results, is as follows:—

Alumina	*Silica*	*Titania*
27.10%	62.45%	0.95%

99. The tonnage available, estimated on a down dip persistency of 40 feet, is approximately 103,400 tons of rock at the above grade.

(d) *The Eslindini deposit*

100. The Eslindini deposit is situated on the northern-most bank of the Mfunzi river on the periphery of Rampur Estate. The deposit gives rise to two prominent outcrops, which have been duplicated by faulting. The rock is similar to that of the Brickworks deposit being a quartz-andalusite pyrophyllite schist. Porphyroblasts of andalusite are set in a fine-grained matrix of quartz and andalusite which displays a schistose texture. Pyrophyllite occurs at the expense of the andalusite so that the rock may grade into a pryophyllitic schist with scattered remnants of andalusite. The muscovite and diaspore are set in a crude schistose texture discordant with the schistosity of the rock suggesting mineralization along cleavage planes. The deposit is extensively laced with veins containing muscovite and lesser quantities of diaspore.

101. From the samples taken it is estimated that the overall grade of the deposit is as follows:—

Alumina	*Silica*	*Titania*
31.27%	59.33%	0.99%

102. Calculating on a down dip persistency of 30 feet, it is conservatively estimated that the deposit will yield 99,800 tons of rock at the above grade.

(2) *Kaolin*

103. A deposit of kaolin occurs one and three-quarter miles south-east of Eslindini store in the rugged Mahlangatsha hills. It occurs in quartzites of the Mozaan Series, the kaolin occupying a fault plane which strikes

obliquely to the general strike of the strata. The deposit was prospected by means of auger drilling, pitting and trenching, since it is overlain by about six feet of soil overburden. The kaolin appears to be of good quality but is generally stained a bright orange-brown colour. The deposit was proven over a strike length of 740 feet, but its continuity is likely over a much greater distance. It has a width of 30 feet but its depth was not proven, though several holes drilled to a depth of 40 feet were still in clay. To an average depth of 20 feet a tonnage of 29,600 tons of kaolin is available. No information is available to date regarding the quality and physical properties of the kaolin.

(3) *Sillimanite*

104. Two deposits of sillimanite occur within an area of 1/6 square mile in the Mahlangatsha hills one and a half miles from the kaolin deposit being worked by Kaolin (S.D.) (Pty.) Limited. The sillimanite-bearing quartzites occur as lens-shaped bodies in the Mozaan Series. The lenses are elongated with their long axes parallel to the bedding of the over and underlying quartzites. Their genesis can be attributed to dynamo-thermal metamorphism due to the combined agencies of regional folding and the intrusion of G.5 granite immediately east of the vicinity. The sillimanite-bearing quartzites are distinguished by subdued outcrops which are soft, powdery and almost white in colour with a finely striated or rugose appearance. The latter is due to the differential weathering of quartz and sillimanite which are the main constituents of the rock. The sillimanite is intimately associated with dickite and kaolinite, especially at depth, as proved by a series of diamond drill boreholes drilled on the deposits. Finely scattered small garnets and re-crystallized detrital allanite are accessory minerals.

105. The grade of the two deposits was established by representative grab sampling over the width and length of each deposit. The overall grade for each deposit is as follows:—

	$\%Al_2O_3$	$\%SiO_2$
Western deposit..	21.48	73.54
Eastern deposit ..	19.47	74.76

Experiments carried out in the Geological Survey's laboratory show that the deposit can be upgraded. A partial beneficiation by elutriation with bromoform gave the following results:—

	%
Total loss of ignition ..	4.94
Silica	47.78
Alumina	43.48
Ferric oxide	0.42
Calcium oxide	0.24
Sodium oxide	0.91
Potassium oxide ..	0.35

Almost certainly further upgrading could be achieved by a more efficient means of beneficiation.

106. Estimating on a strike length of 1,050 feet, an average width of 60 feet and a proven down dip length of 260 feet, then some 1,092,000 tons of sillimanite-bearing rock are available from the eastern deposit. The western deposit, which has a strike length of 1,050 feet, a proven down dip persistency of 200 feet and an average width of 56 feet, should yield 784,000 tons of sillimanite-bearing rock.

(4) *Manganiferous Iron*

107. A deposit of manganiferous iron occurs in highly dissected

and somewhat inaccessible country, 4 miles south-east of Mantola beacon in the Mahlangatsha mountains. The deposit is intimately associated with a band of amphibole schist which occurs in meta-quartzites of the Mozaan Series.

108. The manganiferous iron mineralization occurs as a series of rudely lens-shaped bodies within the schist which may be followed on strike for three and a half miles. The zones of mineralization vary considerably in thickness, pinching to less than two feet or swelling to over 70 feet. The overall iron content of the deposit averages at 34.97 per cent. whereas the average content of the richer portion is as follows:—

	%	
Iron	35.74	Average from 7 samples
Manganese	3.57	
Silica	35.07	
Titania	0.11	
Phosphorus	0.05	Average from 5 samples
Sulphur	0.03	
Vanadium pentoxide ..	0.10	Average from 2 samples

(c) *The Horo District Survey* (*Pigg's Peak District*)

109. The detailed mapping of likely auriferous zones in lapsed mineral concession No. 33 has not been completed. The area, which is underlain by rocks of the Swaziland System and metamorphosed equivalents of ultrabasic rocks of the Jamestown Complex, will require a great deal of thorough investigation before any comments can be made on its economic potential.

(D) By P. E. Winter—Geologist.

110. During the period January to March frequent trips were made to Forbes Reef in connexion with the systematic cleaning and sampling of trenches and old workings. These are in Fig-tree sediments and Jamestown schists, on Crown mineral area No. 7, Mbabane district. Economic gold mineralization was encountered in one quarry only.

111. During the field season March to September an area of 167 square miles between the Ngwempisi and Mkondo rivers in the Mankaiana district was mapped on a scale of 1:50,000. Mapping was done on aerial photographs on a scale of 1:30,000 and re-plotted on base maps on a scale of 1:50,000. The area mapped overlaps portions of lapsed mineral concession Nos. 42, 47 and 50. Mineral rights are vested in the Swazi Nation. Surface rights are owned by local Swazi inhabitants (Swazi Nation Land Nos. 17, 18 and 19) and sheep farmers who own land mainly on the Makumula and Mahlangatsha plateaux.

112. The rock-types consist of rocks of the Insuzi Series, composed essentially of felsic and andesitic lavas, with interlayered phyllites, and the Mozaan Series consisting essentially of conglomerate, quartzite and alumina-rich shales. During this survey three new deposits of diaspore, pyrophyllite and andalusite were located in phyllites of the Insuzi Series. Further occurrences of kaolin were located in the Mozaan beds, as well as a horizon of low grade manganiferous iron ore. Three horizons of sillimanite-bearing quartzites which could have economic possibilities were located near the eastern G.4 granite-Mozaan contact.

113. During September the writer conducted Mr. D. A. Pretorius of the Economic Research Unit of the University of the Witwatersrand and a geologist from a mining company over the area underlain by the Insuzi and Mozaan Series, Mankaiana district, and a portion of the Usushwana Complex, Mbabane district.

114. At the invitation of a mining company, a visit was paid to the Barberton area, to examine surface geology and gold-bearing rock-types similar to those found in Swaziland.

115. During the last week in September and the first week in October a camp was established on the Mgubudla river in the Horo area, Pigg's Peak district, from where detailed mapping of the surrounding country on a scale of 1:10,000 was commenced. The area mapped is underlain by talc-schist and amphibolite of the Jamestown Igneous Complex and chert bars with various sedimentary schists of the Fig-tree Series. Three square miles were mapped. Stream panning and loam sampling was also undertaken. The area overlaps portions of Swazi Nation Land No. 2 and mineral concession No. 5

Prospecting in the Forbes Reef Area, Crown Mineral Area No. 7

Mbabane District

116. Work was commenced in this area with the view to demarcating areas of gold mineralization. A search was made for an alleged auriferous stibnite reef 30 feet wide.

117. In an area east of the Mbabane-Pigg's Peak main road, on the banks of the Black Mbuluzi river, two reefs, the Belmont reef and Red reef, were investigated for gold mineralization. Both these reefs occur near the G.4 granite contact. Gold is concentrated in altered Fig-tree sediments associated with talc-schist of the Jamestown Igneous Complex. Trenches on the Albino Reef further east were cleaned out and panned without success. Three adits on these reefs were flooded and inaccessible.

Belmont Reef

118. *Locality*. Situated on the east bank of the Black Mbuluzi river, approximately one and a half miles south of the Forbes Reef store.

119. *Geology*. The ore-body of amphibolite enclosed by talc-schist has an eliptical shape with a maximum width of 17 feet tapering at both ends. The amphibolite is exposed over a strike length of 100 feet striking north-south and has a 55 degree dip eastwards. A number of quartz veins and stringers cut accross the amphibolite. The northern end of the amphibolite body is an anticlinal nose pitching to the north. A short adit and vertical shaft were sunk by early prospectors.

120. *Mineralization*. Gold mineralization is confined to the amphibolite. Samples taken from the hanging and footwall talc-schists assayed 0.06 dwts. gold/ton. Samples taken across the widest part of the ore-body assayed 2.5 dwts. gold/ton over a width of 12 feet. A grab sample of amphibolite with visible specks of arsenopyrite, taken near the hanging wall of the ore-body in the deepest part of an old excavation, assayed 18.78 dwts. gold per ton. The average grade across the ore-body in the vicinity of the grab sample is 1.48 dwts. gold per ton over 7 feet. These samples were taken in oxidized ore near the surface. Amphibolite veined by quartz stringers carries higher gold values than amphibolite barren of quartz stringers.

Red Reefs

121. *Locality*. Situated on the west bank of the Black Mbuluzi river two miles south of the Forbes Reef store.

122. *Geology*. Gold mineralization was encountered in sediments of the Fig-tree Series. The sediments occur in talc-schist of the Jamestown Igneous Complex, which forms the hanging and footwall of the ore-body. At the southern end, the ore-body resembles a anticlinal nose pitching to the south at 50 degrees.

123. The ore-body is exposed in a quarry and two trenches 130 feet apart and has a strike length of 440 feet in a north-easterly direction

with a dip of 55 degrees to the south-east. Sediments are exposed over an average width of 130 feet. Further along strike to the north-east, no trenching was done due to marshy conditions along the banks of the Mbuluzi river.

124. The sediments contain stockworks of narrow quartz veins aligned parallel to the bedding or axial-plane foliation. Above the water-table the sediments are weathered and oxidized. Much limonitic material accounts for the yellow-brown to brown colour of the weathered sediments.

125. *Mineralization.* High gold values usually occur in sediments, associated with the stockwork of narrow white quartz veins. A prominent quartz vein 12 inches wide, exposed in the quarry, striking obliquely to the foliation of the sediments, on assay showed very low gold value which rules out the possiblity of the large quartz veins being feeders for gold-bearing solutions in this area.

126. The highest values, along two roughly-defined pay-shoots 20 feet apart in the quarry and trenches were: 4.43 dwts. over 21 feet, 5.10 dwts. over 9 feet, 4.95 dwts. over 9 feet, 3.28 dwts. over 18 feet and 4.30 dwts. over 6 feet. An isolated value near the talc-schist contact on the west side of the quarry gave 22.51 dwts. over 3 feet.

Prospecting along the Moodies-Fig-tree Contact, Crown Mineral Area No. 7

127. *Trenching.* Old trenches were cleaned out and panned for gold. Between the Primrose and Art Union gold mines, the trenches are in highly weathered talc-carbonate-schists of the Jamestown Igneous Complex. Narrow bands of gritty sedimentary material with intrusions of quartz veins and stringers, represent remnants of sediments caught up in the talc-schist. A number of trenches were also located on narrow brecciated quartz blows. No gold values were found on panning these trenches. Between the Art Union gold mine and an area south of Millers trees, trenching was confined to sedimentary beds, west of the talc-schist contact. Regionally, the sediments dip steeply to the east.

128. *The Emerald mine.* An adit situated in the bed of a stream was driven underneath a green sheared quartz chlorite or quartz sericite chert bar. Two sixty feet deep vertical shafts, link underground workings with the surface. No samples were taken underground. Assay values on the green chert bar taken on surface were negligible. No gold values were encountered in the pan along a trench just north of the workings. North of the Primrose gold mine, however, gold occurs in the footwall of a sheared chloritic chert bar close to the Moodies quartzites. South of the Emerald mine close to the Moodies quartzites a number of old shafts were sunk on this chloritic chert. This points to the possibility that prospectors in the past followed this horizon as a possible gold bearer.

129. *The Art Union mine.* This dormant mine is situated half a mile south of the Emerald mine. Old workings close to the talc-schist Fig-tree contact are on brecciated chert and quartz veins. Sedimentary material in talc-schist is exposed on a footpath above the main caved adit. A vertical shaft on sheared green chert was located close to the Moodies quartzite in this area. It is not certain if the shaft is connected with the main adit which is inaccessible due to caving of the adit portal. No gold values were found on surface in this area.

130. *The Art Union Extension.* This dormant prospect is situated half a mile to the south-west of the Art Union. Old workings, which are caved, are situated in sediments of the Fig-tree Series near the talc-schist contact. An adit started in talc-schist aligned in the direction of the old workings was stopped before it reached the sediments. A number of old broken cyanide tanks between the old workings and the incomplete adit indicate some early gold production from this area.

131. Several small trenches were located on brecciated chert bars and quartz veins in talc-schist and on a sheared green chert bar close to the Moodies quartzites. No values were found on surface in this area. A limonitic siderite gossan in Moodies quartzites assayed 49.67% Fe and 0.11 dwts. gold over 21 feet.

132. *South of Miller's trees.* A number of trenches were cleaned out and systematically sampled over a strike of 380 feet. The trenches are in Fig-tree sediments on the hanging wall side of a steeply, easterly dipping, brecciated chert bar. A value of 3.12 dwts. gold per ton over 6 feet was found in the southernmost trench. Isolated values of 1.51 dwts. per ton over 3 feet and 5.96 dwts. per ton over 3 feet were found in trenches 195 feet and 375 feet further north respectively.

133. *Ferruginous Capping.* A ferruginous capping 200 feet wide, striking 3,000 feet north-west was found to the west of the Mhlangampepa river in the Moodies quartzite and conglomerate. The occurrence is one and a half miles north-west of the Avalanche gold mine. The iron capping is a massive dark brown to black limonite. A more porous grey variety has a metallic lustre. One prospecting pit 4 feet deep exposed a purple grit 2½ feet below the surface underneath the ferruginous capping. The grit contains veins of limonitic material, which, when leached, produced the iron capping.

Mahlangatsha Area

134. *Physical features.* A highveld peneplain, which lies at a mean elevation of 4,250 feet above sea level is deeply dissected by three main rivers, the Ngwempisi, Mkondo and Mozane, draining through valleys from 700 feet to 2,250 feet below the level of the peneplain.

135. The Mozane valley, midway between the Ngwempisi and Mkondo rivers is wide, well watered and has a deep soil covering, overlying andesitic lavas of the Insuzi Series, while outcrops of harder felsite build a range of conical hills along the eastern flank of the valley.

136. The remnant of the peneplain between the Ngwempisi and Mozane rivers forms the Makumula plateau, formed by a broad curved belt of granophyre and underlying gabbro, dipping regionally to the south-east.

137. The Mahlangatsha plateau between the Mozane and Mkondo rivers is built of sediments of the Mozaan Series. Weathering of the alternating hard and soft strata has produced a rugged topography of ridges and valleys. Tributaries of the Mkondo and Nwempisi rivers cut a number of deep gorges transversely across the strike of the conglomerates and quartzites of the Mozaan Series.

138. *General Geology.* The rock-types are listed in chronological order, the oldest rock types being mentioned first.

(1) *Gneisses*

139. Pegmatized gneisses underly an area south of the Ngwempisi river. Small areas of migmatitic granite are exposed in river beds only, as outcrops are poor due to thick soil and grass cover. Pegmatites and quartz veins are abundant in the gneiss. Many large irregular xenoliths of amphibolite and smaller talc-schist and serpentinite xenoliths are scattered throughout the gneiss. The xenoliths represent altered rocks of the Jamestown Igneous Complex. Outcrops of homogenous granite occur sporadically in the gneiss. The granite-gneiss contacts are not well defined but gradational.

140. The gneiss is a light grey rock with distinct foliation. The rock type is medium-grained with an allotriomorphic granular texture. Felspars are mainly saussuritized plagioclase and microcline-microperthite, with plagioclase as the most abundant felspar. Quartz grains have serrated interlocking boundaries and wavy extinction. Accessory minerals are apatite, sphene, epidote, zircon, and irregular flakes and clusters of biotite. Pink peg-

matitic veins and bodies of granite occur in the gneiss. The pink pegmatite has similar mineral constituents to the gneiss, but with microcline as the most abundant felspar.

141. Xenoliths of amphibolite contain ragged flakes and needles of green pleochroic amphibole in a turbid fine-grained groundmass of felspar, quartz and some micropegmatite. Grains of ore mineral scattered throughout the groundmass are altered to leucoxene. Xenoliths of pyroxenite are coarse-grained melanocratic rock-types containing pyroxene altered to amphibole and chlorite. Some saussuritized plagioclase and quartz grains are interstitial.

142. Serpentinite xenoliths contain mainly serpentine with some talc, antigorite, carbonate and secondary magnetite. Talc-schist and talc-carbonate-schist xenoliths, composed essentially of talc, often contain needles of tremolite, patches of serpentine and occasionally some carbonate grains.

(2) *Insuzi Series*

143. The Insuzi Series consists of andesitic and felsitic lavas with two interstratified phyllite horizons. The lavas, striking north-east to north, form a broad, curved belt three miles wide. The lava is separated from the gneiss in the west and north-west by a two-mile wide sill-like body of gabbro and granophyre, with the result that no contacts between the gneiss and overlying lava were seen in this area.

144. The andesitic lava is a aphanitic greenish-grey coloured rock, occasionally containing amygdales of quartz and felspar. A medium-grained variety contains ragged crystals of hornblende altered to chlorite. Ore minerals, altered to leucoxene and associated with the femic minerals, are surrounded by biotite aggregates. The groundmass is composed of granular scintillating quartz and anhedral remnants of saussuritized plagioclase. Rounded amygdales are composed of crystals of saussuritized plagioclase or interlocking quartz grains.

145. The fine-grained variety has a felted mass of amphibole needles in a groundmass of granular quartz grains with aggregates of epidote. Amygdales composed of penninite and a mozaic of quartz grains are common. Some thin sections exhibit microcline in amygdales with flakes of carbonate. The amphibole resembles antigorite and occurs as aggregates with a fibro-lamellar structure and wavy extinction giving a spherulitic texture.

146. The felsite is a hard compact, fine-grained, light-grey to greenish dark grey coloured rock. The outer shell is usually weathered light grey to white. The presence of iron oxide may account for a pinkish colour of the rock in some areas. The texture is felsitic. Femic minerals are green amphibole altered to chlorite and pleochroic dark brown to yellow biotite. The groundmass is cryptocrystalline composed essentially of a mozaic of quartz with some plagioclase. Biotite, in wisp-like flakes, is scattered throughout the groundmass or concentrated in elongated streaks aligned parallel to the strike of the lava. Occasionally spherulites and slender needles of quartz were noted in the matrix as well as small crystals of muscovite and scale-like individuals of calcite. A groundmass of sericite often exhibits helicitic flow structure around insets of albite. These phenocrysts, which are common and partly altered, are rounded and surrounded by flakes of biotite and chlorite.

147. Associated with the felsite are bands of vesicular lava. The lava is weathered to a ferruginous brown colour with amygdales often elongated and weathered out, leaving a pockmarked surface. Amygdales of mozaic quartz grains are set in a near isotropic groundmass of amphibole, chlorite, biotite and ore. The phyllites vary from true, purple coloured phyllite to a dark-brown, well-foliated shale. The phyllitic horizons in the upper Mozane

valley are soft with a fine-grained compact texture and poorly-developed cleavage, closely resembling altered lava in certain areas. The phyllites are derived from argillaceous sedimentary material. Metamorphism of these produced lenses of pyrophyllite with augen of diaspore and andalusite in the matrix. Under the microscope the phyllite has a goundmass of fine-grained mozaic quartz, veined by limonitic material or is composed of large rounded quartz grains with wavy extinction in a sericitic groundmass.

(3) *Mozaan Series*

148. The Mozaan Series overlies the lava discomformably and is composed essentially of re-crystallized medium- to coarse-grained quartzites, various conglomerate horizons and altered aluminous and ferruginous shale horizons. The actual contact between the sediment and lava was not seen.

149. The Mozaan Series outcrops over a 2-3 mile wide curved belt, in the mapped area. The sediments strike north-east for 6 miles, then swing north for another 8 miles where they terminate abruptly against G.5 granite, forming steep cliffs 2,000 feet above the Ngwempisi river. From a point five and a half miles south of the Ngwempisi river the outcrop width decreases in successive steps northwards, due to the intrusive nature of the G.5 granite.

150. The intrusive nature of the G.5 granite into sediments of the Mozaan Series is clearly indicated in the Tsitsin river gorge, where angular xenoliths of white medium-grained glassy quartzites were found in the granite. Re-crystallization of quartzite along the western G.5 granite quartzite contact is not severe. Along the G.4 granite-quartzite contact the quartzites are intensely re-crystallized for a distance of two miles from the contact. Xenoliths of quartzite along the latter contact are also composed of a coarse-grained grey grit.

151. The formation of high temperature metamorphic minerals, e.g., sillimanite and garnet, in sediments on the eastern G.4 granite contact also indicates a higher degree of metamorphism by the G.4 granite.

152. Along the western lava contact individual quartz grains can be recognized in the quartzite, the mozaic textures being absent. Shale horizons are metamorphosed to phyllite, with the development of andalusite as the main metamorphic mineral. The presence of micaceous quartzite, along this contact, with flakes of muscovite and sericite surrounding quartz grains, producing helicitic textures, can be ascribed to regional dynamic metamorphism.

153. Correlation of the sediments in the Mahlangatsha area with other areas of Mozaan Series is rendered difficult by the incomplete development of the succession.

MOZAAN SERIES

Lithology	Estimated thickness in feet	Remarks
7th Quartzite	±1,010	Medium- to fine-grained white to pink quartzite. Two well-developed 5 foot thick ferruginous conglomerate bands near the base, separated by white gritty quartzite 150 feet thick.
6th Shale	90-120	Ferruginous shale, with magnetite and haematite bands. Ancient Bantu iron workings on surface.

Lithology	Estimated thickness in feet	Remarks
6th Quartzite	230	Bluish-grey to white medium-grained quartzite, with little grit, and two well-developed, highly ferruginous 3 foot conglomerate bands near the base. In the Kukwane syncline only one ferruginous grit occurs. This is the type area for upper 5 zones, south of Ngwempisi river.
5th Shale	80	Purple grit, equivalent to ferruginous purple to brown coloured quartz mica schist surrounding the Kukwane Syncline.
5th Quartzite	185-215	Coarse gritty quartzite with a 4 foot conglomerate near the base. Two 6 foot thick conglomerates, highly ferruginous, occur near the top of the succession. The basal conglomerate of this zone is exposed south of the Ngwempisi river up to the Tsitsin river. The lower half of this zone forms dip-slopes north of the Tsitsin river. The two upper conglomerates are developed north of Ntungulu beacon only.
4th Shale	0-30	Only outcrops north of the Tsitsin river, over a short strike length, where the shale is slightly ferruginous. This horizon ties in with the zone of kaolinization in the Mahlangatsha hills. In the Gege area this zone locally contains pyrophyllitic schist.
4th Quartzite	475-500	Gritty white to pinkish-orange coloured highly sheared quartzite south of the Tsitsin river. Becomes micaceous south of Eslindini store. Four conglomerate bands, with the upper conglomerate containing pebbles and boulders up to 7 inches in size. Current-bedded grits between the 2nd and 3rd conglomerates. The lower three conglomerates grade into one, south of Eslindini while the fourth becomes a gritty quartzite with occasional pebbles. Conglomerates badly sorted.
Ferruginous Quartzite	20	Ferruginous quartzite marker between the Ntungulu and Mantola beacons on the west flank. Badly sorted pinkish ferruginous quartzite at the base.
Quartzite	70	Medium-grained white to purple coloured gritty quartzite often current-bedded.

Lithology	Estimated thickness in feet	Remarks
3rd Shale	10-40	Ferruginous sandy shale with andalusite schist at the base. Highly sheared north of Eslindini. South of Mantola beacon it becomes quartzitic. Good marker horizon. Reverse dip.
3rd Quartzite	90	Medium-grained gritty white-grey quartzite with occasional small pebbles at the top. Usually micaceous in the south. Veined by blue quartz.
2nd Shale	50	Purple shale to phyllite with 10 foot dark grey andalusite schist on top.
2nd Quartzite	35	Fine-grained white sericitic quartzite with a 5 foot thick big-pebble conglomerate at the base. Boulders up to one and a half feet in length. Reverse dip.
1st Shale	0-10	Ferruginous shale and phyllite with bands of limonite pseudomorphic to pyrite. Only developed at Mozane river gorge.
1st Quartzite	0-30	Fine-grained white, sericitic sheared quartzite with veins of blue quartz.
Total max. Thickness	2,540	

(4) *G.4 Granite*

154. A medium- to coarse-grained grey granite is intrusive into the Mozane and Mkondo rivers. The relationship between the Insuzi lavas and G.4 granite is not clear in this area. In other regions of Swaziland lava occurs intrusive contact with the Mozaan sediments north of the confluence of the Mozane and Mkondo rivers. The relationship between the Insuzi lava and G.4 granite is not clear in this area. In other regions of Swaziland lava occurs as xenoliths in the G.4 granite. Intrusion of the G.4 granite must have taken place under high temperature conditions judging from the presence of the mineral, sillimanite, in sediments intruded by this granite.

(5) *Gabbro-granophyre Complex*

155. A differentiated sill-like intrusion of gabbro and granophyre forms a two mile wide curved belt to the west and north-west of the Insuzi lavas. Gabbro occurs at the base and is mainly developed on the western and north-western flanks of the Makumula plateau which is built by granophyre.

156. Outcrops of gabbro also occur in the Insuzi Series on the south-eastern side of the granophyre. Smaller outcrops of gabbro are abundant along the eastern flank, where assimilation of Insuzi lava has produced a rock-type of hybrid character.

157. Correlation of this complex with the Usushwana Complex six miles to the north is fairly certain. Both have identical sulphide mineralization near the base of the gabbro and titaniferous magnetite horizons near the gabbro-granophyre contact. The latter is also gradational with the formation of a melanocratic hybrid gabbro containing abundant micropegmatite and pyroxenes altered to amphiboles. Microgranite is intimately associated with granophyre, the amount of microgranite relative to granophyre increasing southwards.

158. The granophyre is typically medium-grained grey to slightly pink in colour, with micropegmatite as the major constituent. Saussuritized plagioclase crystals form the core of micropegmatite patches, where quartz-felspar intergrowth is incomplete. Yellowish-brown to dark-brown pleochroic biotite crystals are associated with ore minerals. A finer-grained variety usually light grey in colour, has a more granular texture resembling microgranite. The bulk of the groundmass is composed of granular quartz and felspar grains, with some plagioclase crystals surrounded by micropegmatite. Femic minerals are represented by flakes of biotite and large anhedral crystals of pleochroic green hornblende.

159. The microgranite is a fine-grained compact rock composed entirely of granular quartz and felspar grains. Epidote, hornblende and magnetite are the main accessory minerals.

160. Gabbro is hypidiomorphic granular and usually highly uralitized. Plagioclase, usually saussuritized, has the composition of andesine-labradorite. Anhedral crystals of amphibole are interstitial to plagioclase. Ore minerals are associated with epidote and fibrous laths of amphibole. Minor amounts of quartz occur in the groundmass.

161. The age of the gabbro and granophyre in relation to the G.4 granite in this area is not known. The G.5 granite, however, is definitely intrusive into both the gabbro and granophyre. The Usushwana Complex, which is correlated with this intrusion, is without doubt post-G.4 in age, but pre-G.5 granite.

(6) *G.5 Granite*

162. The granite intrudes all the older rock-types. Two large plutons of coarse-grained grey porphyritic G.5 granite occur in this area. The largest pluton occupies an area of 20 square miles, intruding a large portion of Mozaan Series in the north. The mode of intrusion was magmatic stoping and assimilation under relatively cool conditions.

163. A smaller pluton forms the south-western extension of the Makumula plateau.

(7) *Dykes and sheets of various ages*

164. Diabase dykes occur mostly in the gneiss, striking north-west. A diabase sheet occurs in the north where the lava and granophyre wedge out against the G.5 granite.

165. Numerous dolerite dykes are intruded into all the formations with sheets believed to be of Karroo age common in the Mozaan quartzites especially in the area north-west of the Mozane-Mkondo river confluence.

(8) *Quartz veins*

166. Quartz veins are not common in the Mozaan except along granite contacts. Abundant veins in the gneisses and the Insuzi Series strike north-east and east-west. In the Insuzi Series they are generally narrow but obtain widths of 50 feet in the gneisses. The veins consist of glassy or milky white quartz which have suffered granulation to a large extent, often resembling quartzite.

167. *Structure.* The rock formations of the Mahlangatsha area have regional dips of 20 to 60 degrees to the east and north-east.

168. The Insuzi and Mozaan Series occupy a narrow 3 to 6 mile wide geosynclinal basin, striking north-east and north. The Insuzi Series only occupies the western flank of the geosynclinal basin in the Mahlangatsha area, probably having foundered in the intrusive G.4 granite on the eastern flank of the geosyncline.

169. The Insuzi and Mozaan Series were effected by at least two periods of similar folding. The earlier folding was along north-east to north striking fold axes. A series of younger north-west striking fold axes caused the earlier fold axes to lie on a zig-zag pattern, forming pitching synclines and centroclinal basins. Both these periods of folding affected the Insuzi and Mozaan Series, while only the younger fold period affected the gabbro-granophyre sill to the west and north-west of the Insuzi and Mozaan Series. The phyllites in the Insuzi lava were folded before the deposition of the Mozaan Series.

170. The earlier folding (affecting the Insuzi and Mozaan Series), caused by pressure from the east and south-east, was contemporaneous with the intrusion of G.4 granite. The gneisses in the north-west formed a stable buffer against which the sediments and lava were folded. Folding was severe enough to produce overfolding or even thrusting in the sedimentary horizons of the Insuzi and Mozaan Series.

171. The younger period of folding affecting the gabbro-granophyre complex, the Insuzi and Mozaan Series was caused by pressure from the north-east and south-west, probably contemporaneously with the intrusion of G.5 granite.

172. Faulting along a north-east to south-west direction, caused by the earlier period of folding duplicated the phyllitic horizons in the Insuzi Series. Faulting in the Mozaan Series shows a preference for direction striking obliquely to the bedding. One of these faults is five miles long. These faults are wrench-faults with a relatively small shift. Steep angle normal faults branch off these wrench faults near their extremities. The normal faults striking north have dips of up to 70 degrees to the west.

173. Blue quartz veins in the basal members of the Mozaan Series were followed almost along the entire outcrop. These quartz veins could represent the continuation of a large fault striking south-east across the Ngwempisi river. This fault affected the gabbro-granophyre sill and, therefore, post-dates the first period of folding. This could account for the reversed dip of some of the lower members of the Mozaan Series on the west flank.

174. The Kukwane syncline is accompanied by two small normal flank faults and one longitudinal fault.

175. Original structures, e.g., bedding and current-bedding are difficult to distinguish in the Mozaan sediments. Current-bedding of the festoon variety is found in grits on the west flank of the Mozaan Series. Jointing in an east-west direction is well developed and represents tension joints perpendicular to the bedding and cleavage in the quartzites. These features are well exposed in the quartzite between the 3rd and 4th conglomerate bands in the 4th quartzite zone.

Economic Geology

176. *Alumina.* The Mahlangatsha area is a rich aluminous province. Various deposits of diaspore, pyrophyllite and andalusite occur in the sedimentary horizons of the Insuzi lavas.

177. *Kaolin.* Deposits of good quality kaolin occur in quartzites of the Mozaan Series, associated with faults in and above the 4th quartzite zone. Andalusite schists at the base of the Mozaan Series contain up to 32% Al_2O_3.

178. *Sillimanite.* This mineral occurs near the western quartzite-G.4 granite contact. Four horizons of sillimanite-bearing quartzites were mapped. One of these horizons of hard sillimanite, two miles long and 15 feet wide with an average alumina content of 17% Al_2O_3, has a possible economic potential if the sillimanite does not alter to clay minerals in depth.

179. *Iron.* An iron ore horizon, situated three miles south-west of Mantola beacon in meta-sediments of the Mozaan Series, has a strike length of over 4 miles and an average thickness of 30 feet. A grab sample taken from this horizon showed the magnetic portion to contain 40.85 per cent. Fe, 17.52 per cent. SiO_2 and 14.91 per cent. Mn with the non-magnetic portion giving 32.35 per cent. Fe, 41.11 per cent. SiO_2 and 1.9 per cent. Mn.

180. *Titaniferous magnetite.* Horizons near the gabbro-granophyre contact are sporadic and non-economic.

181. *Copper and Nickel.* Mineralization occurs in minor quantities along the base of the gabbro in a few areas.

182. The largest occurrence of disseminated pyrrhotite and chalcopyrite in gabbro is 3 miles north of Lapanda beacon. The mineralized gabbro is 20 feet wide with a strike length of half a mile.

183. *Gold.* Three conglomerate bands in the Mozaan Series were assayed for gold, with poor results. One of the conglomerates contained much visible pyrite.

184. Four of the largest quartz veins in the gneisses were assayed. The highest value obtained was 0.33 dwts. gold per ton over 60 feet.

185. One quartz vein in Insuzi lava near the granophyre contact at Makubulando assayed 1.55 dwts. gold per ton. Five other grab samples taken in the same area on this blue quartz vein contained only negligible amounts of gold.

(E) Diamond Drilling

186. A new diamond drill BBS 20 was purchased under C.D. & W. Scheme D 4918. With the appointment of Mr. I. L. H. Smith as driller in April, this rig was placed in operation.

187. A total of 41 holes were drilled during the period under review with a total footage of 8,200 feet. Of these, 20 short holes were drilled on engineering projects and 21 holes varying in depth from 55 feet to 745 feet were drilled in the course of mineral exploration. Several months work was lost due to the drillers working off a backlog of accumulated leave.

188. The full details of the year's drilling programme are given in Appendix IV.

IV. MINERAL DEVELOPMENT

189. Operations at the Havelock asbestos mine have been conducted in the usual exemplary manner. At the year's end the modernizing and improvements to the mill were nearing completion. The production and sale figures for asbestos are given elsewhere in this report.

190. Mineral Holdings Limited have been engaged in prospecting operations throughout the year on the western extension of the Havelock mine serpentinite. This work entailed the sinking of an incline shaft with underground development supplemented by an underground diamond drilling programme. These prospecting operations were still in progress at the year's end.

191. One borehole was drilled on the Pigg's Peak serpentinite, which contains small seams of incipient chrysotile fibre, with negative results. This serpentinite has considerable extent and it is planned to explore the body along the strike elsewhere when drilling rigs become available.

192. The barytes mine has operated in a very small way indeed as will be seen from the production returns. This is most disappointing as the mine ore reserves exceed one million tons. Several boreholes were drilled on the barytes deposit on mineral concession No. 25, which is situated within a quarter of a mile of the railhead at Ngwenya. The encouraging surface indications were not confirmed at depth, only very narrow veinlets of barytes were intersected.

193. Beryl is still being collected by the Swazis in a small way but due to the depletion of easily won beryl, production will cease in all probability in 1963. The production for 1962 which is estimated at only about 2 tons, will be despatched for shipment in the coming year.

194. The interest in clays by various concerns has been maintained during the year. The clay at the Mtendekwa river which has been opened up in a borrow pit for road metal has been categorized as a ball clay suitable for the ceramic industry.

195. The shafts at both the Central Mining Finance Limited and Johannesburg Consolidated Investment Company colliery blocks have remained closed during the year. It now seems certain that the Mpaka colliery owned by Central Mining Finance Limited will re-open during the coming year to supply the Swaziland railway, both the sugar mills and sundry consumers in the Territory. Several bulk samples of coal were obtained from Mpaka colliery for testing purposes by various possible consumers. This coal with its relatively high calorific value of 13.4 lbs./lb. and reasonably low ash content of 12.3% taken in conjunction with its almost smokeless and other qualities should command an export market.

196. Diaspore, pyrophyllite and andalusite, which are intimately associated in the same deposit, were mined throughout the year. This deposit has now been taken over by G. & W. Base and Industrial Minerals (Pty.) Limited. In addition to the deposits of pyrophyllite discovered last year further new pyrophyllite discoveries were made. It is interesting to record that on the flat slabs of pyrophyllite at one of the new discoveries, numerous petroglyphs were found. These petroglyphs showed a marked similarity to those known from Katanga and are given an age of 1,600 years. Efforts are being made to preserve these historic rocks which may have some ethnological significance.

197. It is gratifying to record that another, the third gold mine in the Territory, commenced production during the year. This is the Waterfall mine at Forbes Reef which, since it commenced operations, has consistently produced over a hundred ounces of fine gold per month with an average grade of 14 dwts. per ton.

198. The mine originally commenced work on a quartz vein, averaging about 7 dwts., which also carried some scheelite. The talc-schist which formed the country rock to the vein was also mined. Today the ore bearer is an almost pure talc schist containing much visible gold, the quartz vein having disappeared.

199. The She mine produced consistently throughout the year with a recovery grade of 4 dwts. At this mine the ore-body is a phyllitic rock, presumably an engulfed sediment, with talc and talc-carbonate foot and hanging walls. In the Pigg's Peak district the Wyldsdale mine has been a smaller but nevertheless regular producer, the ore carrier being a narrow but rich quartz vein in talc-carbonate schists.

200. The investigation of the dormant gold mines has continued throughout the review period. Two boreholes sited at the Kobolondo gold mine intersected the ore zone which did not contain payable values. At the Daisy mine in the Horo area boreholes yielded most encouraging results. The first two boreholes gave 16.61 dwts. over 72 inches and 12.3 dwts. over

50 inches respectively. Very considerable interest has been shown by mining companies in this property which was worked by underground and open cast methods in the past over a strike length of 1,000 feet. An intensive exploration programme incorporating surface work, diamond drilling and geophysical prospecting is planned for 1963.

201. More detailed grid drilling is being undertaken on the Main Block (Castle Block) at Ngwenya (Bomvu Ridge) haematite deposit. Mining and access roads have been cut and are nearing completion. Plans for mining the deposit are well advanced. It is confidently anticipated that full scale mining operations will commence on schedule. The contract call for the first full year of production is 800,000 tons which is to be stepped up to 1.2 million tons per annum for the subsequent nine years.

202. Further vast deposits of low grade sedimentary iron ore were discovered during the course of the mapping in the Mahlangatsha mountains. Grab samples reflect an average grade of 34.7% Fe with low phosphorus, titania and sulphur.

203. The kaolin deposit in the Mahlangatsha mountains has been worked on an ever increasing scale throughout the year. It is confidently expected that production and sales will increase considerably in the years ahead particularly if an export market can be established. Two further kaolin deposits were found in the same area during the Department's regional mapping programme. All these kaolin deposits occur on the same alumina-rich stratigraphic horizon which is intercalated between two quartzites. Detailed prospecting along this zone possibly will reveal further ore-bodies. The area suffers from the disadvantage in being somewhat distant, some forty miles from the railhead at Piet Retief. This possibly is off-set by the quality of the kaolin which is classed as one of the finest in Southern Africa.

204. Considerable tonnages of low grade sillimanite ore capable of being mined by open cast methods were discovered in the Mozaan Series in the Mahlangatsha mountains. The ore consists essentially of sillimanite as soft rosette-like crystals in a fairly pure quartzite. Garnets are a very minor constituent of the quartzite. There seems very little doubt that the sillimanite ore can be up-graded to the requisite quality but the question of selling sillimanite in a powdered form presents a problem.

205. The Department advised on engineering problems in connexion with the foundations for the railway bridges and also advised on the railway tunnel sites. Drilling was also undertaken on behalf of the Public Works Department to test the foundations for the road bridge over the Mzimene river at Manzini. Boreholes were also drilled to test the weir and power station sites for the Edwaleni hydro-electric scheme on the Little Usutu river.

206. Water borehole sites were located for interested parties at Matsapa, the Territorial airport, housing sites at the Edwaleni hydro-electric scheme, the cannery at Malkerns and at the Gollel cattle holding ground in the Lowveld. In the latter instance good supplies were obtained from zones of decomposition in the basalts.

207. Central Mining Finance Limited have successfully applied geophysical methods for the location of water boreholes to supply domestic and industrial water to the Mpaka colliery. The water intersected in the boreholes was of high purity in contradistinction to the normal brackish, sulphurous waters intersected in boreholes traversing the Ecca Series. It would now appear that the chances of locating supplies of potable water are good in the semi-arid regions of the Middleveld and along the granite-Ecca Series contact in the Lowveld. Funds are being sought to establish a geophysical unit to undertake this work in the coming year.

208. Examination of the new railway cuttings in the Mbuluzi gorge through the Lebombo range revealed the presence of breccias which are possibly aquifers.

V. MINES DEPARTMENT

(A) Mineral Statistics and Exports

209. The mineral production figures for the year ending 31st December, 1962, are given in the table (Appendix I) on page 00 of this report together with those for 1961 for comparison purposes.

210. Asbestos again has had a difficult year and, except for the shorter grades, has suffered considerable price decreases. Therefore, despite an increase in the tonnage of fibre sold, the value of production has fallen by some R130,000. Exports increased by 2,037 short tons to 32,830 short tons valued at R4,939,675.

211. With the opening up of a new mine in March the small resurgent gold mining industry has now firmly established itself in second place behind asbestos in its value of production, which increased by 889 fine ounces to 2,214 fine ounces valued at R55,231.

212. Two other minerals are running neck and neck with each other, namely pyrophyllite and kaolin. Pyrophyllite production, which has been steadily increasing year by year, reached a total of 3,902 short tons valued at R21,410. Kaolin, of which there was a small production during the last month of 1961, has found a steady market in South Africa and production is expected to increase considerably. Sales of this mineral increased to 2,743 short tons valued at R20,569.

213. Barytes has had a very disappointing year and sales have plummeted to an all-time low of 68 short tons valued at R973.

214. Sales of diaspore have fallen also but the demand is a fluctuating one and production is expected to rise again in the coming year. Production of 224 short tons was valued at R3,276.

215. The tin mining industry struggles on in a small way. Production for the year amounted to just under 8 short tons of tin concentrates, equivalent to 5.10 short tons of metallic tin valued at R9,116.

216. Some beryl was collected by Swazis in the Sinceni area during the year but none had been sent off for sale at the year's end, so a "nil" production has been recorded.

217. A table (Appendix II) on page 00 shows the countries to which the various minerals have been exported and the amounts and values of each.

(B) Inspections

218. The Inspector of Mines was on overseas leave from the beginning of the year until 9th July.

219. Routine inspection of mines and quarries was carried out during the year and calls for no comment. A large number of explosives magazines were established in the Territory during the year mainly because of the interest shown in hail prevention by means of anti-hail rockets. A majority of the farmers in the Ezulwini and Malkerns valley have now rocket storage magazines on their farms, as have other farming and forestry interests in the Territory. This has meant a considerable increase over normal in the number of inspections carried out by the Inspector of Mines (as Inspector of Explosives).

(C) Accidents

220. To avoid duplication mine accidents have been classified with machinery accidents in the "Machinery Department" section of this report.

(D) Labour

221. A summary of the labour employed in the mining industry in Swaziland is given in the table (Appendix III) on page 00 of this report.

222. Total earnings for the year have increased considerably by almost R300,000 to R896,035. Average earnings for Europeans rose slightly to R211.80 per month. Those for Africans showed a 37 per cent. increase to R16.42 per month and a slight increase in the value of food provided to R5.56 per month.

VI. MACHINERY DEPARTMENT

(A) General

223. During 1962 a general register of accidents investigated by the Inspector of Mines and by the Inspector of Machinery was kept, and are given as a collective figure for the year.

224. During October, 1962, the Inspector of Machinery was nominated as a delegate to a Labour Administration Seminar for English-speaking Participants from African Countries. This Seminar was sponsored by the International Labour Office and held in Freetown, Sierre Leone from 2nd to 15th November, 1962.

225. Four working groups were formed to study various aspects of Labour Administtation. The fourth group of which the Inspector of Machinery was a member, made a detailed study of "The role of Labour Inspection Services in the Field of Occupational Safety and Health."

226. The main conclusions made were (a) Existing Factory and Safety legislation was considered to be inadequate, especially in regard to future developments. Work was, however, proceeding with revision of legislation; (b) Agricultural activities were not covered by legislation as such, but, where specified machinery was used, this could be covered by some of the legislation in force; (c) Legislation did not make provision for specific inspection by medical personnel on a national scale; (d) Due to lack of finance and adequate qualified staff, the field of occupational safety and health was not receiving the full attention it deserved, and the standards required were considerably lowered as a result; (e) In one particular country due to lack of staff, legislation requiring inspection of boilers, pressure vessels, etc., had been repealed; (f) Legislation should be introduced to prohibit the importation, sale, or hire of inadequately guarded machinery; (g) The main causes of accidents were found to include overcrowding, bad lighting, poor housekeeping and piece rates, lack of supervision and long working hours. Other factors which affected health were nutrition habits, lack of meal facilities and distances to be travelled by workers.

227. A great deal was gained from the discussions and experience of the I.L.O personnel and other delegates and it is hoped that the legislation now under review and in process of being drafted will form a firm foundation for future industry in the Territory.

(B) Remarks on Machinery Inspections and Tests

Boilers

228. Certificates of Permission were granted unprovisionally to:— Manzini Dry Cleaners.

Winding Plant

229. Certificates of Permission were granted as follows:—

Havelock mine:

Central Ventilation Shaft	: Central Compartment
Main Vertical Shaft (kibble winder)	: West and East Compartments
Main Vertical Shaft (stage winder)	: Whole Shaft

Elevators

230. Certificates of Permission were issued as follows:—

Miller's Mansions	9 persons or 1,350 lbs. material
Parkview Heights	8 persons or 1,200 lbs. material

(C) Accidents

231. The following accidents were reported during the year.

	Fatal		Non-Fatal		Non-Casualty		Total	
	1961	1962	1961	1962	1961	1962	1961	1962
Mines and quarries ..	Nil	4	33	147	Nil	1	33	152
Industries (works) ..	8	8	203	422	3	2	214	432

(D) Remarks on Accidents

(i) *Fatal Accidents*

232. There were 12 fatalities. An elderly missionary was killed whilst operating a saw bench at the Mbuluzi Mission Saw mill.

233. A person was killed at Crofthead Quarry when a tractor which he was driving overturned and crushed him.

234. A person was killed at Point "A" during construction of the Railway when he was run over by an Eimco shovel loader.

235. A person was killed at Ubombo Ranches when a Michigan shovel got out of control and overturned.

236. Two persons were killed at Havelock mine, one was struck by a kibble after the rope had been severed by a falling crosshead and the other was killed by a fall of ground.

237. Two persons were killed at Usutu Pulp Company Limited, one was struck by a falling tree and the other was killed when illegally driving a tractor.

238. A person was killed at Ngonini Estates in a tractor accident.

239. A policeman on duty was killed when he ran across a race track.

240. A person was killed at Rush & Tomkins Quarry when he illegally entered a stone bin and was suffocated.

241. A person was killed at Peak Timbers when involved in a motor accident.

(ii) *Non-Fatal Accidents*

242. The following table shows the type of non-fatal accidents which occurred:—

Classification (Cause)	Mines and Quarries	Industries	Total
Fall of Ground	13	Nil	13
Machinery, Trucks and Trams ..	11	47	58
Fall of Material	6	6	12
(a) On Surface	5	53	58
(b) Underground	5	Nil	5
Falling in Shafts, Excavations, etc. ..	Nil	1	1
Struck by Cage, Skip, etc.	4	Nil	4
Miscellaneous:			
Burning and Scalding	2	15	17
Falling and Slipping	20	61	81
Splinters	3	5	8
Sundry	71	234	305
Explosives:			
Due to Fumes	3	Nil	3
During Blasting Operations ..	3	Nil	3
Sundry	1	Nil	1
TOTALS	147	422	569

243. The following table gives the location of the various injuries inflicted, and:—

(a) is loss of member
(b) is injury to member
(c) is loss of use of member

Location of Injury	Mines and Quarries (a)	(b)	(c)	Industries (a)	(b)	(c)	Total (a)	(b)	(c)
Arms, hands or fingers ..	2	59	—	14	153	—	16	212	—
Legs, feet or toes	—	44	—	2	179	—	2	223	—
Eyes	—	9	1	—	14	—	—	23	1
Body or Head	—	32	—	—	60	—	—	92	—
TOTAL	2	144	1	16	406	—	18	550	1

244. The total time, in days, lost as a result of accidents is given below with the average time lost per accident:—

	Total number of shifts lost (returned to duty)	Number of accidents in respect of which persons have returned to work	Average shifts lost per accident	Loss outstanding
Mines and Quarries	2,534	143	17.7	4
Industries	7,234	406	17.8	16
TOTAL	9,768	549	17.8	20

245. It is significant to note that in 1961, 236 non-fatal accidents were reported and the average time lost per accident was 24.8 shifts per accident (Mines and Quarries 23.06, Industries 28.85). The drop has been due largely to increased pressure being brought to bear for a higher standard of first-aid treatment and a better standard of investigation into the causes of accidents and their removal. The increase in reportable accidents is due to more industries starting up and increased mining activities.

246. The most significant feature about these lost-time accidents is that, allowing 280 shifts per year per man, the total time lost in accidents is equivalent to one man not working for 34.81 years and represents a total financial loss to employers of approximately R18,000 in wages alone and does not include compensation paid, medical expenses or the cost of replacements or loss of production due to change of staff.

247. One company has benefitted by employing a full-time safety officer and his work has made a large contribution to our efforts in the field of Occupational Safety and Health.

(E) Prosecutions

248. Four prosecutions were instituted during the year, two of which resulted from fatal accidents. In one case, the accused was charged with culpable homicide but was found not guilty.

249. One person was prosecuted for failing to comply with Regulation 117(1), i.e., operating a boiler without a certificate of permission. The case was heard in court and the accused was found guilty and sentenced to a fine of R30 or 3 months imprisonment.

250. Arising out of a fatal accident which occurred in December, 1961, and which was not reported to this office or to the police, two persons were charged with contravening Section 2(1)(c) of the Inquests Proclamation. They pleaded guilty and were sentenced to pay a fine of R20 or imprisonment for 2 months. One of the accused, the manager, was also charged with contravening Regulation 142 (reporting of accidents) Section 19(a) of the Mines, Works and Machinery Proclamation (endangering the Safety of Workmen) and Section 17 of the Proclamation (failing to attend an enquiry). He was found guilty on all three charges and sentenced as follows. R30 or 3 months, R30 or 3 months and a caution and discharge on the third count.

251. As the result of a series of inspections and letters to the manager of a quarry, two directors were charged with contravening Section 19(a) of the Proclamation by failing to ensure that efficient guards were provided to moving machinery (Regulation 102) and also failing to ensure that the air receivers were tested (Regulation 119(2)(a). They were also charged with contravening Regulation 159, failing to appoint a manager and Regulation 98 failing to appoint a competent person in charge of machinery. They each paid admissions of guilt on all three charges of R20, R10 and R10. The total fines levied in these cases amounted to R210.

(F) New Construction

Swaziland Railway

252. Work commenced on the earthworks for the Swaziland Railway and is being carried out by R.M.R. (Swaziland) Contractors.

Swaziland Electricity Board

253. Work commenced on the Edwaleni Scheme for the Swaziland Electricity Board.

(G) Electric Power

254. There was no increase in generating capacities of sets installed in the Territory.

(H) Inspections

255. The following is a summary of the official duties performed by the Inspector of Machinery during 1962:—

Boiler Inspections

External	44
Internal	40
Hydraulic Test	12

Machinery Inspections

Surface—Satisfactory	13
Unsatisfactory	11
Underground—Satisfactory	1

Winding Plant

Inspections	3
Tests	3

Elevators

Inspections	4
Attendance at Law Courts	3
Number of trips in connection with accidents	54

VII. HEADQUARTERS

(A) Administration

256. Except for C.D. & W. Scheme D 4918, the running of the Department has been financed by Territorial funds.

257. With the entry into the Territory of the railway contractors, the staff at Headquarters have been kept exceptionally busy on the variety of tasks associated with such a large novel undertaking. The initiation of the railway construction programme has brought about a keen renewal of interest in the geology and mineral resources of the Territory. The fact that Swaziland will now be linked with a major seaport with very adequate ore loading facilities has stimulated very considerable interest in the lower priced base metals about which very numerous enquiries were received.

258. Two more mobile receiving-transmitting sets were purchased. These will enable the staff at Headquarters to keep in touch daily with the geologists engaged in mapping and similar field work.

259. Work on the Bulletin No. 2, "The Mineral Resources of Swaziland" occupied a considerable amount of the time of the senior members of the staff. The co-operation of the Director and staff of the Overseas Surveys is gratefully acknowledged for their assistance in the preparation and printing of the new mineral map of Swaziland and list of the geological formations both of which are to accompany Bulletin No. 2.

260. I gratefully record my deepest appreciation of the work of the professional, technical and administrative staff who through their wholehearted endeavours have enabled the Department to operate at its full capacity in all spheres at all times.

(B) Drawing Office

261. The draughting staff, most regrettably, have continued to work under most difficult conditions. With the trend of increasing work, the situation is rapidly reaching the stage when conditions will become completely untenable unless some immediate action is taken to alleviate the position particularly in regard to extensions of the draughting office and increasing the filing facilities.

262. A list of the plans drawn during the year is enumerated in Appendix VI. Special plans, to a very much smaller scale, were also prepared for reproduction in Bulletin No. 2. A total of 2,197 sunprints were made during the year. This reflects an increase of almost 30% on the number produced last year. This figure also may be regarded as about average for for the general increase in the quantity of work produced by the draughting section.

263. The sunprints are produced by the simple but slow ammonia process. A faster, more modern reproducing unit must be acquired in the overall interests of efficiency and expediency.

(C) Library

264. The library was used constantly throughout the year by the professional and technical staff in addition to members of the mining fraternity and the public.

265. In addition to the regular geological and mining periodicals and magazines, the more important, recently published textbooks on geology and the various aspects of mining were also purchased in order to keep pace with the modern advances in these sciences.

266. Unfortunately the congestion mentioned in last year's report has not been alleviated, in fact, the situation has become increasingly worse.

267. The lady stenographer undertakes the duties of classifying and cataloguing the various publications in additions to her other duties.

(D) Laboratory

268. During the year 592 samples, which reflects a 10% increase on last year's figure, were prepared for assay or analysis.

269. Many of these being borehole cores required to be split or crushed and quartered. These samples were assayed and/or analysed as follows:—

Alumina	78
Calcium	2
Carbon dioxide	1
Cobalt	2
Copper	1
Gold	457
Iron	42
Magnesium	2
Manganese	7
Nickel	14
Platinoids	5
Phosphorus	8
Potash	1
Silica	82
Sulphur	5
Titanium	71
Tungsten	1
Vanadium	38
TOTAL	817

270. In addition, in the field, the geological mapping and prospecting parties crushed and panned many hundreds of samples in the course of their routine operations.

(E) Publications

271. The following published reports were produced during the year:

(1) The Annual Report of the Geological Survey and Mines Department for the year ended 31st December, 1961.
(2) Bulletin No. 1 of the Geological Survey and Mines Department.
(3) "The Geology of Swaziland."
(4) "Rb-Sr Age Measurements in Various Swaziland Granites," by D. R. Hunter jointly with H. L. Allsopp, U. R. Roberts and G. D. L. Schreiner. Published in *The Journal of Geophysical Research.*

272. A list of the unpublished reports produced by the professional staff is to be found in Appendix V. The list of plans, maps, etc., produced, most of which accompany the above-mentioned reports, is contained in Appendix VI. These reports, maps, plans, etc., are available on sale at a small charge.

(F) Visitors

273. The Department was responsible for the guidance of numerous professional and technical officers of the various mining companies over the mineral deposits of the Territory. The technical officers of the Department advised members of the public in a variety of spheres.

(G) Acknowledgments

274. The Department gratefully acknowledges its indebtedness and thanks to the following for their co-operation and assistance in a variety of ways.

The staff of the secretariat, Mbabane.
The Director and staff of the Republic of South Africa Geological Survey.
The Director and staff of the Geological Survey of Mocambique.
The Director and staff of the Bernard Price Institute, Johannesburg.
District Commissioners and Police Force of the Territory.
The Manager and staff of the Havelock mine.
The Manager and staff of Peak Timbers Limited.
The Manager and staff of the Usutu Pulp Company.
The Manager and staff of the Ubombo Ranches Limited, Swaziland.
The Manager and staff of the Mhlume (Swaziland) Sugar Company.
The many members of mining companies operating in the Territory for their assistance and freely-given hospitality.
To members of the public for their co-operation with the Department.

D. N. DAVIES,
Director of Geological Survey
and Commissioner of Mines.

MBABANE,
20th March, 1963.

APPENDIX I

MINERAL PRODUCTION FOR 1962

	1961		1962		Increase		Decrease		Price Range
	Short tons	R	Short tons	R	Short tons	R	Short tons	R	
Chrysotile Asbestos	30,792.62	5,070,321	32,829.81	4,939,675	2,037.19	—	—	130,646	R25—R316
Metallic Tin ..	6.12	9,864	5.10	9,116	—	—	1.02	748	R1,701—R1,913
Coal	1,079.62	3,272	—	—	—	—	1,079.62	3,272	—
Barytes	453.65	7,041	67.87	973	—	—	385.78	6,068	R14—R30
Diaspore	491.68	5,137	224.00	3,276	—	—	267.68	1,861	R14—R60
Pyrophyllite ..	2,955.00	13,904	3,902.00	21,410	947.00	7,506	—	—	R5—R50
Beryl	7.14	1,652	—	—	—	—	7.14	1,652	—
Kaolin	58.13	439	2,743.00	20,569	2,684.87	20,130	—	—	R7—R50
	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R	Fine ozs.	R	
Gold	1,325.19	33,130	2,214.16	55,231	888.97	22,101	—	—	R24.88—R24.95
Silver	103.34	66	132.11	95	28.77	29	—	—	R0.67—R0.84
Total ..		R5,144,826		R5,050,345		R49,766		R144,247	

APPENDIX II

MINERAL EXPORTS, 1962

Minerals	Country to which Exported	Short tons	Value R
Chrysotile Asbestos	United Kingdom	21,288	3,426,108
	Republic of South Africa	7,894	996,564
	Spain	2,819	406,864
	Belgium	500	64,800
	France	217	29,633
	Holland	30	4,083
	Nigeria	75	11,267
	Australia	2	231
	Mocambique	5	125
Tin Concentrates	Republic of South Africa	7.86	9,116
Barytes	Republic of South Africa	67.87	973
Diaspore	Japan	224.00	3,276
Pyrophyllite	Republic of South Africa	3,902.00	21,410
Kaolin	Republic of South Africa	2,742.79	20,569
		Fine ozs.,	Value R
Gold	Republic of South Africa	2,214.16	55,231
Silver	Republic of South Africa	132.11	95

APPENDIX III

LABOUR STATISTICS

Month	Skilled				Unskilled						
	Below Surface	On Surface	Total	Earnings R	Below Surface	On Surface	Total	Earnings R	Value of of food	Labour	Earnings and food
January ..	37	119	156	27,019	498	1,241	1,739	22,785	9,031	1,895	58,835
February ..	44	122	166	31,676	530	1,304	1,834	23,752	9,142	2,000	64,570
March ..	44	123	167	31,616	530	1,226	1,756	23,338	8,745	1,923	63,699
April ..	45	127	172	33,481	551	1,155	1,706	24,785	9,850	1,878	68,116
May ..	45	130	175	34,061	603	1,117	1,720	26,187	10,224	1,895	70,472
June ..	50	124	174	34,015	595	1,153	1,748	28,245	9,871	1,922	72,131
July ..	50	126	176	41,215	600	1,146	1,746	29,537	9,594	1,922	80,346
August ..	50	129	178	41,950	631	1,176	1,807	30,679	9,930	1,985	82,559
September..	49	132	181	39,528	628	1,168	1,796	30,576	10,056	1,977	80,160
October ..	47	131	178	42,072	634	1,130	1,765	33,170	9,289	1,943	84,531
November..	50	115	165	39,577	633	1,147	1,780	38,670	9,957	1,945	88,204
December..	52	127	179	41,604	589	858	1,447	30,478	10,330	1,626	82,412
Total ..				R437,814				R342,202	R116,019		R896,035

APPENDIX IV

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDING 31st DECEMBER, 1962

B.H. No.	Depth	Size	Cost per ft.	Formation	Remarks
147	745	NX	R2.80	Gabbro	Magnetite bands, Usushwana Complex
148	491	NX	R3.92	Gabbro	Magnetite bands, Usushwana Complex
149	651	NX	R3.30	Gabbro	Magnetite bands, Usushwana Complex
150	363	NX	R3.00	Gabbro	Usushwana Copper Prospect, min. con. No. 24
151	55	EX	R3.00	Gabbro	Magnetite Wyndham
152	671	BX	R0.34	Kaolin	
153	476	NX	R3.53	Siliceous gneisses	Daisy mine
154	315	NX	R1.20	Sandstone and dolerite	Daisy mine
155	260	NX	R3.40	Siliceous gneisses	Daisy mine
156	226	NX	R1.54	Granite	Kobolondo mine
157	300	NX	R0.70	Talc schist	Ruby Tin
158	219	NX	R1.07	Talc schists phyllites	She Gold mine
159	299	NX	R1.58	Granite	Kobolondo mine
160	336	NX	R1.57	Quartzite	Sillimanite prospect
161	258	NX	R2.18	Siliceous gneisses	Daisy mine
162	396	NX	R2.28	Siliceous gneisses and talc schist	Daisy mine
163	232	NX	R1.54	Siliceous gneisses	Daisy mine
164	389	BX	R1.84	Serpentinite	Pigg's Peak Gold mine
165	439	NX	R1.89	Quartzite	Sillimanite prospect
166	241	NX	R3.00	Siliceous gneisses	Droxford Barytes prospect
109	218	NX	R2.79	Siliceous gneisses	Droxford Barytes prospect
Engineering Projects	620			Granite	Total of 20 holes drilled on bridge and hydro-electric foundations.
	8,200				

APPENDIX V

Report by Professional Staff

by D. N. Davies — Director

(1) Report for the European Advisory Council — Period September, 1961 — February, 1962.
(2) Report for the European Advisory Council — Period March, 1962 — August, 1962.
(3) Overseas Geological Surveys Report for the period 1st January, 1962 — 31st December, 1962.

by D. R. Hunter — Geologist

(1) Age determinations from Swaziland.
(2) The Swaziland Mining Industry.
(3) Résumé of results obtained from the Usushwana Complex.
(4) Report on the drilling of the Kaolin Deposit, Mahlangatsha, Mankaiana district.
(5) Note on the drilling on Farm F69/13/5 and Magomba Ranch, mineral concession No. 2, Stegi district.
(6) Supplementary note on the results of the diamond drilling in the Maloya area.
(7) Note on the drilling of the south-west flank of the Usushwana Complex Buhlungu valley. Lapsed mineral concession No. 24, Mbabane-Manzini districts.

by D. H. Jones — Geologist

(1) Report on the geology of the Kobolondo Area with reference to the Kobolondo and Black Diamond Creek mines (mineral concession N. 32A and Crown mineral area No. 1, Pigg's Peak district).
(2) Report on the occurrence of two Sillimanite Deposits in lapsed mineral concession No. 50 (Mahlangatsha area, Mankaiana district).
(3) Report of the Alumina and Pyrophyllite Deposits of the Mahlangatsha area (lapsed mineral concession No. 50, Mankaiana district).

APPENDIX VI

MAPS AND DIAGRAMS PRODUCED DURING 1962 IN THE DRAWING OFFICE

No.	Date	Init.	Title	Scale
493 MD	6.2.62	J.G.U.	Lightning Conductors	No scale
495 MD	6.3.62	J.G.U.	Diagram showing extent of E.P.L. No. 3/1959. She Syndicate ..	1:25,000
494 P	14.2.62	D.H.J.	Geological plan of the Horo Area	1:10,000
496 P	6.3.62	D.H.J.	Plan of geology at the Gordon and Daisy mines	1:10,000
497 Misc.	8.3.62	D.N.D.	Plan of current mineral investigation (under P.L. No. 3/1962) ..	1:250,000
498 MD	16.3.62	J.G.U.	Plan showing extent of area held by R. J. Solé	1"-0.94 miles
499 Misc.	4.4.62	D.R.H.	Locations of rocks and minerals of which age determination has been made	1:500,000
500 MD	—	J.G.U.	Hail Rocket Magazines	
501 Misc.	—	D.N.D.	Fig. "A" Basutoland. Conditions in the Kimberley and O.F.S. Diamond Fields	
502 P	29.3.62	P.E.W.	Assay plan of Red Reefs ..	1:250
503 P	13.4.62	P.E.W.	Plan showing geology and position of magnetometer traverses on C.M.A. 7	1:10,000
504 P	15.5.62	J.G.U.	Plan showing geology of a serpentinite body on mineral concession No. 32C	1:10,000
505 P	28.5.62	D.H.J.	Assay plan of Daisy mine	1:1,000
506 MD	28.6.62	J.G.U.	Hail Rocket magazine 1,500 x 2,000 metres 160 x 15,000 metres —60 x 1,500	¼"-1'
507 MD	3.7.62	J.G.U.	Hail Rocket Magazine 120 x 2,000 metres—60 x 2,000	¼"-1'
508 MD	17.7.62	J.G.U.	Portable explosives magazine ..	
509 P	24.7.62	D.R.H.	Plan and section of boreholes, Kaolin deposit, Mahlangatsha..	1:2,000
510 P	7.8.62	D.R.H.	Location of Boreholes drilled by Geological Survey M.C.2, Stegi District	1:5,000
511 P	15.8.62	D.R.H.	Section through BHs 147-148-149 S.W. Flank of Usushwana Complex	
512 Misc.	22.8.62	C.G.M.	New design for Borehole Log sheet	
513 MD	27.8.62		Safety Dugout for launching Hail Rockets	
514 Misc.	29.8.62	C.G.M.	Standard Geological Symbols	
515 Misc.	28.9.62	C.G.M.	Mineral Tonnage and Values graph	

No.	Date	Init.	Title	Scale
516 P	30.9.62	D.H.J.	Field plans of Horo Area ..	1:10,000
517 P	15.10.62	D.H.J.	Plan of geology of Black Diamond Creek gold mines	1:1,000
518 P	18.10.62	D.H.J.	Plan showing geology of Diaspore-Pyrophyllite deposits in the Mahlangatsha area	1:5,000
519 P	23.10.62	D.H.J.	Mahlangatsha sillimanite deposits L.M.C. 50	1:2,500
520 P	6.11.62	D.H.J.	Bikini Diaspore-Pyrophyllite deposit L.M.C. 50	1:200
521 P	14.11.62	D.H.J.	Brickworks Diaspore-Pyrophyllite deposit L.M.C. 50	1:1,000
522 P	19.11.62	D.H.J.	Plan showing distribution of sillimanitic quartzite and sillimanite bearing rock in Mahalangatsha area	1:10,000
523 P	20.11.62	D.H.J.	Atoll Diaspore deposit	1:1,000
524 P	21.11.62	D.H.J.	Eslindini Diaspore deposit ..	1:1,000
525 P	29.11.62	D.H.J.	Section showing sillimanite-bearing zone in Boreholes 160A, 160B and 160C	1:500
526 P	4.12.62	D.H.J.	Bikini Diaspore-Pyrophyllite deposit	1:1,000
527 MD	12.12.62	D.A.C.P.	Diagram showing various mining locations held by Swaziland Barytes Limited	1:5,000
531 P	Jan. 62	D.H.J.	Geological plan of Jackal mine	1:500
532 P	Jan. 62	D.H.J.	Geological plan of Kobolondo mine	1:12,000
533 P	Jan. 62	D.H.J.	Geological and Assay Plan of Gordon mine	1:200
534 P	Jan. 62	D.H.J.	Geological Section of the Daisy mine	1:1,000

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CONTENTS

I. INTRODUCTION

(A) General

The vacant post of geologist authorized by the Secretary of State last year was filled by the appointment of Mr. D. H. Jones, B.Sc. (Hons.) (Wales), F.G.S. (Lond.) M.G.S. who assumed duty in March.

2. The present staff position is given below:—

Director and Commissioner of Mines	D. N. Davies, M.Sc. (Rand), B.Sc. (Stell.), M.G.S.
Geologist	D. R. Hunter, M.Sc. (Lond.), F.G.S., M.G.S.
Geologist	J. G. Urie, M.Sc. (Rand), B.Sc. (Hons.), (Rhodes) M.G.S.
Geologist	D. H. Jones, B.Sc. (Hons.) (Wales), F.G.S. (Lond.) M.G.S.
Geologist	P. E. Winter, B.Sc. (Hons.) (Rand), B.Sc. (Pret.).
Mineral Development Officer and Inspector of Mines ...	D. A. C. Purser, A.C.S.M., A.M.I.M.M.
Inspector of Machinery	J. S. Houston, B.Sc. (Elect. Eng.) (Rand) A.M.I.E.E., A.M. (S.A.) I.E.E., A.M.S.A.I. Mech. E., A.M.I. Cert. M.E.E.
Drilling Superintendent	D. Horn.
Diamond Driller	R. A. M. Myburgh.
Diamond Driller	J. S. McCall.
Draughtsman	C. G. Matthews.
Senior Lady Clerk	Mrs. A. W. Girdwood.
Senior Lady Clerk	Miss J. White.
Lady Clerk	Miss V. M. Slatem.
Grade I Clerk	M. D. Msibi.

3. The annual report for this year will take a slightly amended form with the deletion of the geological papers which formed Part II of the Report in previous years. The reason is that the first Bulletin of the Department is at present in the press and will be available in the first quarter of next year. In addition, the explanation of the 1:125,000 geological map of Swaziland is also in the press and will be published at approximately the same time. Where possible in future, it is the Departmental policy to publish at least one bulletin annually. It may be mentioned in this connexion that work has already started on a publication to be entitled "The Mineral Resources of Swaziland". It is anticipated that this work will be completed and published before the end of 1962.

4. As stated in last year's annual report, the full running costs of the Department have been borne by Territorial revenue. Late this year finance was provided from Colonial Development and Welfare

funds for a C.D. and W. Scheme No.D.4918 which makes provision for an additional diamond driller and diamond drilling unit together with ancillary equipment and transport. The provision of an extra diamond drill will assist most materially in the acceleration of the prospecting and exploration programmes, its advent being particularly timely as it is foreseen that one or other of the existing drilling units will be committed at various times to drilling engineering projects associated with the rapid tempo of development in the Territory.

5. Dr. S. H. Shaw O.B.E., M.Sc. Ph.D., Director of Overseas Geological Surveys, visited the Territory at the end of March and early in April. In addition to discusssions with His Honour, the Resident Commissioner and the Government Secretary, Dr. Shaw visited the Ngwenya haematite deposit (previously known as the Bomvu Ridge deposit), the Havelock asbestos mine, the Usushwana Complex and the anthracite and low volatile bituminous coal collieries at Maloma and Mpaka respectively. Dr. Shaw also had discussions with the Director in regard to future work and the policy of the Department.

(B) Research Projects

6. Further research into the origin of the Stormberg volcanic rocks continued with a visit to the proposed Pongola dam site in Northern Zululand. The Director, at the invitation of Dr. F. C. Truter, Director of the Geological Survey of the Republic of South Africa, accompanied by Drs. de Villiers and van Wyk of his staff, had the opportunity of traversing the gorge of the Pongola river where diamond drilling of the proposed and alternative dam sites, was in progress.

7. An interesting point arising from this research project is the fact that, originally initiated as an academic study, the project has now assumed considerable significance both from the engineering and economic viewpoint. There is no question that the siting of the dam wall is controlled by the geological formations necessitating a most detailed geological mapping programme of the Pongola gorge and environs.

8. Furthermore detailed mapping was undertaken in the Stegi district to determine the prevalence of the rhyolitic breccias which however are far less widely distributed in relation to the Northern Zululand area.

9. The location of these breccias is important economically as they are permeable and therefore a potential aquifer in areas where the location of good water supplies is a noted problem.

II. GEOLOGICAL SURVEY

(A) Geological Mapping

10. During February and March Mr. Hunter mapped the surface and underground geology of the She mine in the Forbes Reef district on scales of 1:2,500 and 1:500 respectively.

11. Mr. Urie spent several weeks investigating and mapping a large body of serpentinite in which incipient chrysotile asbestos mineralization is known to occur at several localities on lapsed mineral concession No. 32C in the Pigg's Peak District. The area mapped was two square miles. As previously mentioned under "Research Projects", mapping was also undertaken in the Stegi district in connexion with the location of the breccia horizons in the acid volcanics of the Storm-

berg Series of the Karroo System.

12. The mapping of the Usushwana Complex by Mr. Winter on a scale of 1:25,000 was completed. This comprised an area of 58 square miles ranging from the Usushwana river to Makwanakop and from Mhlambanyati to the Great Usutu river.

13. Mr. Winter also mapped the surface geology of the Albino and Red Reefs gold prospects on a scale of 1:100. He made a detailed geological survey of the phyllitic zone of the Insuzi Series of the Pongola System during which 9 square miles were mapped on a scale of 1:25,000. It is gratifying to record that during this survey six further occurrences of pyrophyllite, several of which are of economic importance, were discovered.

14. The geology of several selected areas on Crown mineral area No. 7, Forbes Reef area was mapped on a scale of 1:10,000, in connexion with magnetometer traverses.

15. Except when he mapped 1½ square miles of the environs of the She mine in the Forbes Reef area, Mr. Jones was mapping for the whole of the period under review in the Pigg's Peak district. This work included the mapping of the surface and underground workings of the dormant Kobolondo and Black Diamond Creek gold mines on a scale of 1:1,000. A further area of 18½ square miles linking the two above mentioned mines was mapped on a scale of 1:12,000.

16. On lapsed mineral concession No. 33, the surface and underground geology of the dormant Daisy, Gordon and Jackal gold mines was mapped on a scale of 1:1,000. A further area of 10 square miles encircling these mines was mapped on the scale of 1:10,000.

17. At the Devil's Reef mine, the surface and underground geology was mapped on a scale of 1:500.

18. The results of this detailed mapping of potentially economic areas will be discussed later in this report.

(B) Field Work.

(1) By D. N. Davies — Director.

19. During February, both the diamond drilling sites in the environs of the Havelock mine were visited. Discussions were also held in Manzini with Mr. Cawood in connexion with his prospecting activities on the Komati river west of Balegane. An examination was made of the basal conglomerate of the Molteno Beds of the Stormberg Series in the Maloma area in regard to the possibility of gold mineralization.

20. A visit was made in the company of members of the Natural Resources Board in March to the Komati river where Mr. Cawood was investigating the terrace gravels for their gold content. The diaspore deposit in the Sicunusa area was also visited in an investigation into possible extensions of the ore-body.

21. In April, the Departmental drilling rigs operating in the vicinity of the Havelock mine were visited to note progress and log the cores. Discussions were also held with the District Commissioner, Pigg's Peak in connexion with the prospecting and mining activity in the district. New road cuttings in the Oshoek area were also visited to determine the extent of the chrysotile fibre occurrences exposed during the excavations. A further visit was made to the Havelock mine during the month for discussions with the Management in regard to the visit to the mine by delegates to the Seventh Commonwealth Mining and Metalurgical Congress.

22. Dr. Shaw, Director of Overseas Geological Surveys visited the Territory in May. Visits were made to Ngwenya haematite deposit, the Havelock Mine, Johannesburg Consolidated Investment anthracite colliery and the copper-nickel and titaniferous magnetite deposits in the Usushwana Complex. Later in the month the south eastern end of the Complex was visited with Mr. Winter in connexion with geological and structural problems. The Johannesburg Consolidated Investment borehole cores were examined at their camp on the Ingwavuma river to collect specimens for heavy mineral determinations.

23. An examination was made of the large pyroxenite body in the Usushwana Complex in June. During the month in the company of the Inspector of Mines, an inspection was made of the Havelock mine mill. A visit was paid to the drilling site on mineral concession No. 41 to examine borehole cores. An opportunity was taken to sample freshly exposed road cuttings for gold in the Pigg's Peak District. Discussions were held in Mankaiana with the District Commissioner in connexion with the improvement of the road to the kaolin deposit on lapsed mineral concession No. 50.

24. During July, the titaniferous magnetite horizons in the Usushwana Complex were examined and their mode of occurrence studied in a fresh road cutting on the Usutu Pulp Mill — Malkerns road. At the request of the Director of Land Utilization officers from his Department were shown the magnesite deposit below the Ngwenya haematite deposit and arrangements made for taking bulk samples for use on the experimental farm at Malkerns. A visit was paid to the Tung Oils property to examine brick-making clays. A meeting was held in Gollel with the Director and Assistant Director of the Geological Survey of the Republic of South Africa in connexion with arrangements for the C.C.T.A. excursion to Zululand and Swaziland. This was followed by a visit to the Pongola poort dam site and Ubombo where the volcanic rocks of the Stormberg Series were examined as part of the joint research project into the origin of these rocks by the geological surveys of South Africa, Mocambique and Swaziland. The red granite and occurrences of amythystine quartz were examined in an area west of the pulp mill site during the month.

25. A talk on the mineral potential of Swaziland was given in August in Manzini to the newly formed Swaziland Agricultural Union. A visit was also made to the new drill site near the Havelock mine to note progress. Bald Hill — a hill formed of pyroxenite on which the growth of the pine trees is retarded to a remarkable degree — was sampled in an effort to determine whether an unusually high concentration of copper and/or nickel or other minerals was present to cause the stunted growth. A further visit was paid to the brick-making clay deposit at Tung Oils. An inspection of the sugar mill at Ubombo Ranches was carried out in the company of the Inspector of Machinery.

26. In September, the G.4 granites in an area south of Mbabane were examined for molybdenum mineralization. An occurrence of molybdenum in the Rocklands quarry of Peak Timbers Ltd. was examined also during the month. The Director and Mr. J. G. Urie attended the C.C.T.A. Southern Regional Committee for Geology Conference in Pretoria. Papers were read by the Director and Mr. Urie who presented Mr. Hunter's paper. Following the conference, the Director took part in the Richtersveld, Namaqualand, excursion which included a visit to the State Alluvial Diamond Diggings at Alexander Bay. On the outward flight, the Lichtenburg alluvial diamond diggings, the Black Rock manganese mine and the Fish river canyon were viewed from the air.

The return flight was made over the Aughrabie Falls and the Kimberley diamond pipes.

27. During October, another visit was made to the Rocklands quarry at night when the quarry faces were examined with the ultra-violet lamp as powellite was found to be associated with the molybdenite. Mhlumeni Customs Post on the Mocambique border was visited to site water boreholes to augment the present supply. Bald Hill, where magnetic anomalies were discovered, was again visited. Samples of ilmenite-rich gravel and sand were collected from the Ingwavuma river for examination for possible diagnostic kimberlite minerals. A deposit of brick clay in the vicinity was also sampled. A visit was made to the Windy Ridge area adjacent to the Havelock mine where an alleged galena occurrence, which turned out to be massive specular haematite, was examined.

28. The water drilling sites at Mhlumeni were again visited in November and a visit was made to the Havelock mine for discussions with the Manager. The environs of the diaspore mine were visited also to note the progress of mapping and prospecting for pyrophyllite. A visit was paid to the Msauli asbestos mine for confidential talks with the mine management and the Mhlume Sugar Company was visited in connexion with the possible use of Swaziland coal in the sugar mill.

29. In December, the Director went to Bulawayo for technical discussions with the management of New Amianthus Mines Ltd.

(2) By D. R. Hunter, Geologist.

30. During the year the activities of the diamond drilling programmes at the Pigg's Peak mine, in the Havelock area, and on the Usushwana Complex were supervised, and the cores logged. The results are summarized under the Mineral Development section of this report.

(i) Visits to Mines

31. In January the diaspore-pyrophyllite mine was visited at Sicunusa and geological advice was given to the mine operator. During February and March the surface and underground geology at the She mine was mapped on scales of 1:2,500 and 1:500 respectively.

32. In May a visit was paid to the Mahlangatsha area with the Director to investigate the re-mapping of this area in view of the possible exploitation of the kaolin deposit occuring there.

33. In November the Wyldsdale mine was visited with the Director to note the progress of underground development and sample newly discovered auriferous reefs and horizons.

(ii) Geological Mapping

34. Throughout the year the mapping parties operating on the Usushwana Complex and in the vicinity of the Kobolondo, Black Diamond Creek, Daisy, Gordon and Devil's Reef mines were supervised. The results of this work are given in the reports by Messrs. Winter and Jones.

(iii) Water Supply

35. Advice was given in connexion with the drilling and siting of boreholes to supply water on farms in the Peebles Block South and Ezulweni areas. A borehole was sited for the Department of Land Utilization near Gollel. At the year's end no results of these boreholes had been received.

(iv) General

36. In April the Annual Congress of the Geological Society of

South Africa was attended with the Director. This was followed immediately by the Commonwealth Mining and Metallurgical Congress at which the writer was also present. Both these congresses were held in Johannesburg. In May, the writer accompanied a tour arranged by the organisers of the later congress to the Bushveld Igneous Complex north and west of Pretoria.

37. Throughout the year visiting consultant engineers and geologists were accompanied on tours of deposits of potential economic importance in the Territory. These included visits to the Usushwana Complex, Ngwenya and the Komati valley molybdenum occurrence. In view of the re-investigation of the Kobolondo mine, Mr. D. L. Martyn, a former tributor in that area, accompanied the writer on a visit there to point out salient features of interest.

38. In January, the dumps at the colliery prospect near Maloma were examined in an endeavour to find suitable plant fossil remains for submission to the British Museum in London. Although many fragmentary remains were found none were considered to be worthy of despatch to the Museum.

39. Dr. Darnley of the United Kingdom Geological Survey, who was visiting South Africa in connexion with the Commonwealth Mining and Metallurgical Congress, spent a week-end in Swaziland during which time he was shown examples of various granites on which age determination measurements had been carried out.

40. Several samples of rhyolite tuff were collected from the Ngwavuma gorge in the Lebombo mountain. These samples were submitted to the office of the United Kingdom Atomic Energy Authority in Salisbury for testing as a possible source of beryllium. The results of this work were still awaited at the year's end.

41. Evidence was given in three illicit gold cases heard before magistrates at Mbabane and Emlembe.

42. In September the delegates attending the meeting of the Southern Regional Committee for Geology of the Council for Technical Co-operation South of the Sahara were conducted through Swaziland from Gollel to Havelock mine. At the same time the opportunity was taken to visit localities of interest in the Lebombo mountains mapped by the Republic's Geological Survey, immediately to the south of the Swaziland border.

43. The compilation of the explanation to accompany the geological map of Swaziland was completed during the year, the preliminary proofs of which were corrected at the year's end. Work started on the memoir on the mineral resources of Swaziland and had reached an advanced stage in December.

44. The Department's first bulletin was edited for publication and submitted to the publishers early in December.

45. A paper entitled "The Role of a Geological Survey in Mineral Exploration" was prepared for the meeting of the Southern Regional Committee for Geology held in Pretoria. It was read, on the writer's behalf, by Mr. Urie. A short note was also prepared for inclusion in a paper on the age determinations of various Swaziland granites to be published by members of the staff of the Bernard Price Institute, University of the Witwatersrand.

(3) By J. G. Urie — Geologist

46. The mapping and investigation of a large body of serpentinite occurring on lapsed mineral concession No. 32C in the Pigg's Peak district was undertaken. This body of serpentinite differs from the typical ser-

pentinites of the area in that it is appreciably paler green in colour and fairly coarse textured.

47. The body was pitted and trenched and all exposures were closely examined. Extremely brittle slip-fibre is developed in places and veinlets of brittle cross-fibre were occasionally observed. In no instance was the fibre of sufficiently good quality or sufficiently well-developed to be of economic interest.

48. An investigation of a lead-antimony prospect on Crown mineral area No. 7 Mbabane district was completed. The lead and antimony is present as encrustations of the mineral bindheimite in siliceous shear zones. Original sampling results were encouraging but subsequent detailed investigation showed that taken overall the mineralization is poor and rather patchy. Numerous channel samples reveal that the metal content ranges from trace amounts up to 0.15% Pb and 0.60% Sb over a width of one foot.

49. The Stormberg volcanics of the Lebombo mountain, Stegi district were briefly re-examined during November. A number of detailed traverses were made across the Lebombo range in order to ascertain roughly what proportion of the volcanics is made up of pyroclastic material.

50. Agglomerates composed of fragments of devitrified glass and/or porphyritic lava set in a stony matrix are present as narrow and generally impersistent bodies. Horizons of vesicular rocks are encountered occasionally. Quite commonly agglomerates and vesicular rocks occur in association. Interbedded tuffs varying from compact fine-grained to friable sandy-textured types are present.

51. These pyroclastic rocks although fairly common only constitute a small proportion of the mass of volcanic material. The presence of these rocks is not only of academic interest, but of considerable importance in that by virtue of their porosity and their tendency to weather to appreciable depths they quite frequently yield good supplies of ground water.

52. In addition to the above, boreholes for water supplies were sited near Mbabane and at the Mhlumeni Customs post in the Stegi district. Several boreholes were sited on an asbestos prospect in the Piggs Peak district. Work was also undertaken on the old gold prospects at Forbes Reef. The writer was an official delegate at the C.C.T.A. Congress in Pretoria where a paper was presented on behalf of Mr. Hunter. Following the Congress, the writer participated in the geological excursion through Northern Natal and Swaziland.

(4) By D. H. Jones — Geologist

53. The first week was spent accompanying various members of staff to places of geological interest in the Territory including Havelock, Forbes Reef and part of the Usushwana Complex.

54. During the period March to September the economic geology of seven gold mines was carefully studied in the following mineral concession areas.

(a) Crown mineral area No. 7 (Mbabane district); a detailed geological map was prepared of the She gold mine area. Prospect trenches and underground workings were examined to gain more pertinent information regarding the mineralization and structural relationship of the gold-bearing phyllitic horizon of the She mine.

(b) Mineral concession No. 32A (Pigg's Peak district); an examination of the old Kobolondo gold mine was completed. A plan was produced showing the surface and underground workings of the

mine and details of the geological setting. Sixty nine trenches, cuttings, surface workings, adits and stopes were studied and 960 feet of underground workings logged and sampled. The gold-bearing quartz vein on the periphery of a small granite boss, that constitutes the Kobolondo "lode", was examined carefully with a view to future prospecting by means of diamond drill boreholes.

(c) Crown mineral area No. 1 (Pigg's Peak district); the old Black Diamond Creek gold mine was examined and the mine area was surveyed by plane table showing the geological features and surface and underground workings. Some 757 feet of underground workings were logged and samples taken of gold-bearing quartz veins and siliceous shear zones.

(d) In addition to examining the Black Diamond Creek and Kobolondo gold mines, an area encompassing the two mines was geologically mapped.

(e) Lapsed mineral concession No. 33 Portion A (Pigg's Peak district); the derelict Daisy, Gordon and Jackal mines included in this concession were examined. The area was surveyed geologically to show the positions of surface and underground workings together with relevant details. The Daisy mine was thoroughly examined, 1460 feet of surface workings and 1028 feet of underground workings being logged and sampled. The auriferous lode of quartz-biotite gneiss was studied with the aim of future prospecting by means of diamond drill boreholes. In addition, 262 feet of underground workings of the Gordon mine were logged and sampled together with 637 feet of the Jackal mine workings. The area encompassing the three mines was carefully mapped and a geological plan produced.

(f) Mineral concession No. 32B (Pigg's Peak district); A plan of the old Devil's Reef gold mine underground workings and geology was completed. A plan was prepared showing details of the surface geology in the area surrounding the mine. Some 4,845 feet of underground workings were examined and all occurrences of ferruginous wad and breccia systematically sampled for gold. Only low gold and manganese values were obtained. The wad may find some application as an umber in the paint industry.

54. Since September, the writer has been engaged in the examination of rock slides and preparing plans for reports on the above mentioned mines.

55. In addition during the course of the year. An occurrence of molybdenite was examined and the Daisy and Gordon gold mines were revisited for further sampling.

(5) By P. E. Winter — Geologist

56. During the period January-March, mapping of the Usushwana Complex was completed. The Usushwana Complex is a composite dyke-like intrusion of pyroxenite, gabbro and granophyre, aligned in a north-west south-east direction. The rock-types are exposed over an area of 96 square miles. The area mapped included parts of lapsed mineral concession Nos. 3 and 24, Crown mineral area No. 14 and mineral concession Nos. 25, 44 and 45. Surface rights are owned by the Usutu Pulp Company, a few private farmers and the Swazi Nation (Swazi Nation land Nos. 9, 10 and 14).

57. During April and May, trenching of an upper mineralized horizon and magnetite bands in the Buhlungu valley was completed, while the examination of thin sections in connexion with the mapping

of the Usushwana Complex was undertaken at Headquarters.

58. During the period August-October, maps and diagrams of the Usushwana Complex were completed and a report on the Usushwana Complex prepared. Prospecting and systematic sampling of trenches and old workings in sediments of the Fig-tree Series and altered ultrabasics of the Jamestown Igneous Complex on Crown mineral area No. 7, Mbabane district, was commenced.

59. Sketch plans showing the geology and assay values of the Albino reefs and Red reef were prepared.

60. During the period October-December, the following tasks were undertaken:—

(a) **Mbabane District** Magnetometer traverses over a pyroxenite outcrop of the Usushwana Complex in an area known for stunted growth of pine trees. The reason for this abnormal growth has still to be determined.

(b) **Mankaiana District** Mkopeleli area: Prospecting for further deposits of pyrophyllite in phyllites of the Insuzi Series of the Pongola System. An area of 9 square miles was mapped in detail at a scale of 1:25,000 showing the location of pyrophyllite deposits. The area covered, included lapsed mineral concession No. 50 and lapsed mineral concession No. 47. Mineral rights are vested in the Swazi Nation. Surface rights are owned by the Swazi Nation (Swazi Nation land Nos. 17 and 19) and by private farm F14.

(c) **Mbabane District** Magnetometer traverses over a portion of Crown mineral area No. 7 with an accompanying diagram showing geology and positions of magnetometer traverses, at a scale of 1:10,000.

(d) Logging of boreholes on the lower mineralized zone of the Usushwana Complex at Maloya was completed during the absence of Mr. Hunter on leave.

(C) Diamond Drilling

61. During the year twelve holes were drilled, with a total footage of 5978. Although this reflects a considerable decrease in footage compared with 1960, it is satisfactory, as three working months were lost due to leave being taken by the drillers.

62. Of this total footage, 2980 feet were drilled on behalf of Mineral Holdings on the cost plus 15% basis. This included one NX hole of 1861 feet using the BBS 2 which has a rated capacity of 1750 feet only.

63. The remaining 2998 feet were drilled in connexion with Departmental investigations, which were with one exception concentrated on the Usutu copper-nickel prospect on mineral concessions Nos. 24 and 44.

64. Approval was granted late in the year for the purchase of a further drill, and the appointment of another driller. Most of the equipment is now to hand and it is expected that this rig will be operational early in March 1962.

65. Three short boreholes were drilled on the western extension of the Havelock mine serpentinite and these boreholes provided further positive information confirming the indications obtained from the surface prospecting. The company is now following this up with underground development.

66. In the Havelock area 2980 feet were drilled by the Departmental drill on behalf of Mineral Holdings to investigate another serpentinite body.

III. MINERAL DEVELOPMENT

General

67. By far the most important event of the year, both as far as the Territory and the Department is concerned, was the announcement in September of this year that a decision had been taken to build a railway from the Ngwenya (Bomvu Ridge) haematite deposits to Goba in Mocambique, the primary function of the railway being the transportation of the iron ore.

68. The Department was responsible for the initial prospecting of this deposit when some 32 million tons of high grade iron ore were proved. Following the publication of the Department's Special Report No. 2 entitled "The Bomvu Ridge Haematite Deposits" in 1957, the Anglo-American Corporation acquired a prospecting licence and have since proved further ore reserves. During this year, they entered into a contract to supply Japanese purchasers over a period of ten years with 12 million tons of ore from this deposit. Mining, probably will commence in 1963, with the first shipments scheduled for 1964.

69. Another result of the announcement about the railway, which will, in all probability, operate steam locomotives will be the opening up of a colliery in the Bushveld to supply, inter alia, the Railway with coal.

70. In the statistics of mineral production it will be noted that the value is given in rand. Two rand equal one pound sterling. From the statistics of mineral production and sales it will be observed that a very considerable decrease of R502,637 occurred. This fall is due to a lesser quantity of asbestos being sold and a drop in the price for the various grades of chrysotile fibre, and in particular the lack of demand for the larger grades of fibre.

71. A decrease in the sales of diaspore is also reflected but as the demand for the mineral is sporadic this is not unusual. Barytes and beryl show a reasonable increase with a marked increase in the tonnage of pyrophyllite sold. The She gold mine at Forbes Reef was in production for a full year for the first occasion with an increase of 519 fine ounces over last year's production. Work at the Wyldsdale gold mine was conducted in a small way. The mining of the main Ridge section has not been attempted to date.

72. Work at the Havelock asbestos mine has been conducted in a most satisfactory manner throughout the year. Work on modernising and improving the mill has been in progress throughout the review period. Preparations were being made for the sinking of a new 1200 foot vertical shaft early in 1962. Exploration of the various serpentinite bodies in the Pigg's Peak district continued throughout the year. Three boreholes were drilled on the western extension of the Havelock mine serpentinite. These boreholes provided further positive information confirming the indications obtained from the surface prospecting. The company is now following this up with underground development.

73. In the Havelock mine area 2980 feet were drilled by the Department on behalf of Mineral Holdings during the investigation of other serpentinite bodies.

74. Efforts are continually being made to find further markets for barytes. The decision to build a railway has altered the market position radically, particularly if freight rates are favourable, with the Middle East market now becoming a definite possibility. The mine has continued to operate in a small way.

75. Beryl was produced by the Swazi in the Sinceni area as a

village industry, the Department being responsible for the collection, weighing, bagging and sale on their behalf. It is not anticipated that the production of the mineral will continue for much longer unless new deposits are discovered as most of the easily won beryl, which is shed from pegmatites, has been collected already.

76. Considerable interest has been shown in brick-making clays during the year. Suitable clays for the brick-making industry are known to occur on the Ingwavuma and Mtendekwa rivers and also near the Mpaka colliery on the Manzini-Stegi road. The Ingwavuma river deposit, however, is far too inaccessible to be of economic interest at this stage.

77. There were no new developments in the coal mining industry. The shafts at the Johannesburg Consolidated Investment Company's anthracite colliery at Maloma and Central Mining Finance Ltd. colliery at Mpaka remained sealed during the year. It is hoped, however, that the Mpaka colliery will re-open towards the end of 1962 or early in 1963 to provided coal for the Swaziland Railway, the sugar mills and other sundry consumers.

78. Diaspore, with which is associated pyrophyllite and andalusite, was mined continuously during the year. Sales, however, as previously recorded, were not as high as in previous years. Several new pyrophyllite deposits containing some diaspore were discovered by the Department. This search for new pyrophyllite deposits arose from the fact that the present deposit producing pyrophyllite, andalusite and diaspore has had ever increasing orders for the mineral the production of which has now reached a new high figure of 500 tons per month.

79. Considerable time was spent on re-opening the dormant gold mines, some of which have been closed for over 50 years, for mapping and sampling purposes. The underground workings of the Pigg's Peak, Kobolondo and Daisy mines, all in the Pigg's Peak district, were mapped and sampled in detail as far as the accessibility of the underground workings allowed. All three mines warrant further work preferably by diamond drilling.

80. In the Forbes Reef area, two dormant prospects were cleaned out, re-mapped and sampled. At both these prospects, encouraging economic gold values were obtained.

81. It is hoped to commence mining for gold and scheelite early in the New Year near the Forbes Reef waterfall on the Malolotsha river. The reef consists of white quartz with scheelite intruded into talc-schists. The schists also carry appreciable quantities of gold on the contact with the quartz vein.

82. The She gold mine and environs is to be prospected in the coming year by a Rand mining group who have an option over the mine. At the Wyldsdale gold mine, a new larger mill has been erected and driving towards the rich "B" reef, in which visible gold was discovered in three borehole cores, was in progress. The intersection of the "B" reef is expected early in 1962.

83. A manganiferous iron deposit at the dormant Devil's Reef gold mine was also investigated. The ore-body is contained in the banded ironstone horizon of the Fig-tree Series. The deposit which has reserves of several million tons is also a possible source of umber for the paint industry. The ore, being a very soft manganiferous ferruginous wad, could be worked very cheaply by open cast methods. The average grade of the wad is SiO_2 — 21.29% Fe — 44.01% and Mn. 6.16%.

84. Further bodies of siderite were discovered in the Moodies sediments in the Forbes Reef area. These are being investigated at pre-

sent. Large bodies of haematite were also found in the Malanganpeppa valley in the Ngwenya mountains. Although on surface fairly rich in iron, it was found as a result of pitting, that these bodies were surface enrichment ore of a ferruginous shale and of purely superficial significance.

85. Exports of kaolin figure for the first time in the Territorial statistics of mineral production. Samples of kaolin from the deposit in the Mankaiana district, including bulk samples of 40 ton lots were forwarded to interested parties. As a result of tests by a major producer of ceramics in South Africa, it has been shown that the material is suitable for the production of first grade glazed tiles and other allied ceramic products. It is hoped that production at an initial rate of several thousand tons per annum will commence early in the coming year. Potential consumers on the Continent have also shown an interest in the deposit.

86. One of the Department's main tasks in the period under review was the investigation into the copper-nickel and titaniferous-vanadinferous-magnetite mineralization in the Usushwana Complex. At the year end the diamond drilling and trenching programmes were nearing completion and it is hoped to invite tenders for detailed prospection of the Complex early in the coming year.

87. Two zones of copper-nickel mineralization with strike lengths of 3½ and 2 miles respectively have been discovered together with other areas of intermittent mineralized outcrops, the continuity of which could not be traced owing to the afforestation and scree cover. The ore minerals are chalcopyrite, pyrrhotite and pentlandite, with traces of the rare metals platinum, gold, silver and a minor amount of cobalt. The results of this work are contained in Special Report No. 4 — "The Usushwana Igneous Complex" by P. E. Winter, Geologist.

88. Very large bodies of titaniferous iron ore were discovered in the Usushwana Complex during the mapping. In addition to the titanium content which varies between 2.94 and 15.64% the magnetites also have proved to be vanadiniferous, the magnetites forming part of the xenolithic body on the farm Wyndham averaging 1.73% V_2O_5. The fact that the magnetites of the Complex tend to be vanadiniferous is borne out by the fact that a magnetite-rich gabbro assayed 0.96% V_2O_5.

89. On the south-western flank of the Complex three horizons of magnetite have been located and these can be traced at intervals over a strike length of about 1¾ miles. A similar body is found on the southern-eastern flank near Qwabiti, the house of the Manager of the Usutu Pulp Company. These various bodies are being investigated by diamond drilling at the moment.

90. Molybdenite was reported from the Rocklands quarry on the property of Peak Timbers Ltd. Examination of the specimen submitted disclosed the presence of powellite also. The quarry was examined by day and again by night with the aid of a Mineralight but no further occurrences either of molybdenite or powellite were found.

91. The Department also undertook drilling tasks for the Public Works Department at a quarry site and sited boreholes to augment the supply of water at the Mhlumeni Customs Post on the Mocambique border. Water borehole sites were indicated to private persons at Peebles Block South, Badlana and on various farms in the Ezulwini valley

92. Numerous magnetometer traverses were undertaken in the Usushwana Complex in connexion with the tracing of the various zones of mineralization.

IV. MINES DEPARTMENT

(A) Mineral Statistics and Exports

93. The mineral production figures for the year ending 31st. December 1961 are given in the table (Appendix I) in this report together with those for 1960 for comparative purposes.

94. By comparison with 1960,which was a record year, the year has seen a decrease in the value of mineral production. This was largely due to a weakening demand for higher grade asbestos fibre combined with the closing down of two coal prospects at the end of the previous year.

95. Despite the drop in production, chrysotile asbestos remains the most valuable export commodity of the Territory. Exports decreased by 1234 short tons to 30,793 short tons valued at R5,070,321.

96. Coal sales from the Johannesburg Consolidated Investment Company's colliery prospect near Maloma and the Central Mining Finance colliery prospect near Mpaka amounted to 1,080 short tons valued at R3,272 — a very appreciable decrease when compared with the figure of 12,845 short tons for 1960. This large decrease was due to the fact that no coal was mined at either of these prospects during the year for both had closed down pending more favourable marketing and transport conditions.. Sales were entirely of dumped coal won during the previous year.

97. Gold mining at two mines, the She mine near Forbes Reef and the Wyldsdale mine north of Pigg's Peak, continued throughout the year. Production, mainly from the She mine, showed a increase of 519.43 fine ounces bringing the year's total to 1,325.19 fine ounces valued at R33,130. Silver, occurring in association with the gold, likewise showed an increase of 45.46 fine ounces to 103.34 fine ounces valued at R67.

98. Sale of diaspore was limited and exports decreased by 335 short tons to 492 short tons valued at R5,137. This reduction was, however, more than offset by an increasing demand for pyrophyllite and production of this mineral rose by 1,241 short tons to an all time high of 2,955 short tons valued at R13,904.

99. Production of kaolin commenced in a small way towards the end of the year. Sales amounted to 58 short tons valued at R439.

100. Barytes had a satisfactory year and exports more than doubled those for the previous year. Production rose by 254 short tons to 454 short tons valued at R7,041.

101. The tin mining industry continued to operate in a small way. Production decreased by 0.85 short tons to 6.12 short tons valued at R9,864.

102. Swazi prospectors collecting beryl in the Sinceni area showed even greater interest. Production rose by 1.62 short tons and this small village industry produced a total of 7.14 short tons valued at R1,652.

103. A table (Appendix II) in this report shows the countries to which the various minerals have been exported and the amounts and values of each.

(B) Mineral rights granted.

104. Mining rights were granted over only one area during the course of the year.

(C) Inspections

105. Regular inspections of all mines and quarries have been

carried out during the year. Particular attention paid to safety matters has kept the accident rate relatively low and no accidents were reported from the quarries during the year.

106. Inspections have been facilitated by suitable modern legislation in the form of the Mines, Works and Machinery Proclamation promulgated towards the end of 1960 and the new Mines, Works and Machinery Regulations which came into force early in 1961.

(D) Accidents

107. There were 19 reportable accidents during the year, one of which was fatal, and the remainder involved various injuries which resulted in the injured person being absent from work for periods of three days or longer.

108. All but one of the accidents occurred underground. One accident was due to disobedience to orders and was thus the fault of the injured person himself. The remaining accidents were due to dangers inherent in the work being done.

(E) Labour

109. A summary of the labour employed in the mining industry in Swaziland is given in the table (Appendix III) in this report.

110. Total earnings for the year have increased slightly by R7,633 to R696,238. Average monthly earnings for Europeans were R204.73 while those of Africans were R11.98; in addition, each African, on average, received food to the value of R5.12 each month.

V. MACHINERY DEPARTMENT

(A) General

111. 1961 is the first year in which an Inspector of Machinery has been on full time duty. The accident statistics are, however, by no means complete, as several concerns only started reporting accidents during the last quarter of the year.

112. The major portion of the work of this Department was concerned with testing of the plant erected at the Usutu Pulp Co., Ltd.

113. Welding tests and the radiographic examination of welds in boilers and pressure vessels, including welded, high pressure, steam pipe lines, occupied a considerable amount of time.

(B) Remarks on Machinery Inspections and Tests

Boilers

114. Certificates of Permission were granted unprovisionally to:—

Cramond Earth Movers	(1)
Hi-Ho Vulcanising (Swaziland) Ltd.	(1)
Mbabane Hospital	(2)
Mhlume (Swaziland) Sugar Co., Ltd.	(4)
Ngonini Estates	(1)
Peak Timbers Ltd.	(7)
Swaziland Bone Meal & Soap Factory (Pty.) Ltd.	(1)
Swaziland Co-Op Tobacco Co., Ltd.	(1)
Ubombo Ranches Ltd.	(2)
Usutu Pulp Co., Ltd.	(2)
Williamson & Paterson	(1)

Certificates of Permission were refused in the following cases:—

Swaziland Bone Meal & Soap Factory (Pty.) Ltd. (1) (Discarded)

Tung Oils Ltd. (1) (Pending repairs)

Certificates of Permission were cancelled in the following cases:—

Havelock mine (2) (Boilers not in use)

Swaziland Co-Op Tobacco Co., Ltd. (1) (Boiler requires extensive repairs)

Ubombo Ranches Ltd. (3) (Boilers not in use)

Wayne Tyre & Rubber Co. (1) (Boiler not in use)

Winding Plant

115. Three Certificates of Permission were issued to Havelock mine as follows:—

Main Incline Shaft	:	East and Centre Compartments
Sub-Vertical Shaft	:	East and West Compartments
Point Four Winze	:	Centre Compartment

Elevators

116. Certificates of Permission were issued to:—

Mhlume (Swaziland) Sugar Co. Ltd. — 5 persons or 750 lbs material

Usutu Pulp Co. Ltd. — 33 persons or 5,000 lbs. material

(C) Accidents

117. The following accident reports were received for investigation during the year.

	Fatal		Non-Fatal		Non-Casualty		Total	
	*1960	1961	*1960	1961	*1960	1961	*1960	1961
Mines	Nil	Nil	Nil	33	Nil	Nil	Nil	33
Works	4	8	33	203	Nil	3	37	214
Total	4	8	33	236	0	3	37	247

*1960 — for last quarter of 1960 only.

(D) Remarks on accidents

(i) Fatal Accidents

118. Seven of the fatalities were African employees, of which two were killed at Usutu Pulp Co. Ltd., three at Ubombo Ranches and two at Mhlume (Swaziland) Sugar Co. Ltd.

119. A European plasterer, employed by Veloso Construction Co. Ltd., was fatally injured when he fell from a scaffold.

120. At Usutu Pulp Co. Ltd., one fatality occurred when a pipe which was being off-loaded, swung and struck an employee. The other fatality occurred when a member of a rigger's gang fell 92 feet from the crown plate of an erection mast to the ground.

121. The remaining five fatalities were all due to the victims being involved in road transport accidents.

(ii) Non-Fatal Accidents

122. The reporting of accidents has been standardised by the introduction of specially printed Accident Report Books which enable the responsible persons to make identical and simultaneous reports to:—

(1) The Inspector of Machinery or Mines (as the case may be).

(2) The Labour Commissioner.

(3) The District Commissioner of the district concerned.

123. Compliance with the Mines, Works and Machinery Proclamation, the Workmen's Compensation Proclamation and the Inquest Proclamation is now ensured by the completion and dispatch of the report forms.

124. The International Labour Organisation recommendation that an accident involving the injured person in absence from work for more than three days is compensatable has been adopted and such accidents are therefore reportable.

125. The following table shows the type of non-fatal accidents which occurred:—

	Mines	Works	Total
Machinery	2	16	18
Trucks and Trams			
(a) Loco.	1	—	1
(c) Winch	—	3	3
(d) Hand	—	3	3
(e) Scraper	—	1	1
(f) Animal Drawn	—	1	1
Fall of Material			
(a) On Surface	—	23	23
(b) Below Surface	2	—	2
Boilers or Steampipes			
(b) Personal Misadventure	—	2	2
Miscellaneous			
(c) Burning and Scalding	1	8	9
(d) Falling and Slipping	8	47	55
(e) Splinters	2	5	7
(h) Sundry	17	94	111
TOTALS	33	203	236

	Mines			Works			Total		
Location of Injury	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Arms, Hands or Fingers	3	12	—	6	56	—	9	68	—
Legs, Feet or Toes	—	13	—	3	80	2	3	93	2
Eyes	—	3	—	—	10	2	—	13	2
Body or Head	—	2	—	—	44	—	—	46	—
TOTAL	3	29	—	9	190	4	12	220	4

(a) Loss of —
(b) Injury to —
(c) Loss of use of —

126. The total number of shifts lost as a result of accidents is as follows, with the average time lost per accident.

	Total Shifts lost	Average Shifts lost/accident
Mines	761	23.06
Works	5,857	28.85
Total	6,618	23.80

127. 1961 was the first full year of operation of the Machinery Department and there are no comparative figures available from previous years. The figures stated are not a complete reflection of the accident rate in the Territory as not all industrial concerns are reporting their accidents. This problem is being tackled as each case arises.

128. The significant feature about these lost-time accidents is firstly the total time lost. Allowing 280 shifts per year, this time lost is equivalent to one man not working 23.65 years.

129. Of this time 690 shifts or nearly 2 years were lost due to accidents to Europeans. The average value of wages paid out, and for which no return was received by the employer amounts to the following.

2 years @ R240/month	=	R5,760
21.65 years @ R25/month	=	R6,495
Total		R12,255

130. This is over and above any compensation, medical expenses or replacement cost paid by employers for incapacity as a result of any accident.

131. Greater care is needed in the training of unskilled workers, particularly where contract work is involved as the desire on the part of the employer tends to push the job at the expense of safe methods.

132. Training within industry and induction training coupled with more widespread first aid knowledge will reduce the accident rate and also the severity rate. It should be understood that no scheme will work unless top management gives the lead.

133. One company has already appointed a safety officer who is doing sterling work and the incidence of lost time accidents has dropped appreciably since his appointment.

134. With the trend of present development in the Territory the incidence of reportable accidents is expected to rise unless the contractors and industrialists embark on a safety programme immediately.

(D) Prosecutions

135 Five prosecutions were instituted during the year, two of which resulted from fatal accidents. In these cases the accused were charged with culpable homicide but were found not guilty. In the first case the Crown failed to establish the identity of the deceased due to burial before identification. In the second case, the wrong particulars of the negligence involved were given.

136. Two persons were prosecuted for failing to comply with Regulation 117(1), i.e. operating a boiler without a certificate of permission and in each case, paid an admission of guilt of R10.00 each.

137. The fifth case was against a Section Manager for a contravention of Section **twenty-three** of the Inquests Proclamation for the illegal burial of a body. He pleaded not guilty but was found guilty and fined R60.00.

138. The total fines in these cases amounted to R80.00.

(F) New Construction

Usutu Pulp Co. Ltd.

139. The construction was behind schedule but by October, 1961,

most of the contractors had left the site. Preliminary running operations were started and the training of staff started simultaneously.

(G) Electric Power

140. The following table gives the major industries in the Territory which generate electric power. The total installed capacity is given.

Havelock mine	8600 kw.
Usutu Pulp Co. Ltd.	9620
Ubombo Ranches Ltd.	4375
Mhlume (Swaziland) Sugar Co. Ltd.	1865
Peak Timbers	1750
Swaziland Plantations	720
Government Schemes. Mbabane and Manzini	1387
Ngonini Estates	430
Swaziland Crushers	160
Swaziland Canners	75
Total	28,982 kw.

(H) Inspections

141. The following duties were performed during the year.

Boilers	
External Inspections	70
Internal Inspections	37
Hydraulic Tests	38
Inspections — Machinery	
Surface — Satisfactory	33
Unsatisfactory	24
Underground — Satisfactory	1
Unsatisfactory	Nil
Attendances of Law Courts	4
Winding Plants Inspections Satisfactory	5
Tests Satisfactory	4
Elevators Inspections and tests Satisfactory	2
Mileage Travelled	9,581
As Passenger	316
Total	9,897
No. of trips in connexion with accidents	34
Official Visits within Territory	12
No. of days absent from office on official duty	112

VI. HEADQUARTERS

(A) Administration

142. The financing of the work of the Department has been borne entirely by Territorial funds. Late in the year funds were made available under the Colonial Development and Welfare Scheme to provide for an additional diamond driller, diamond drilling rig and ancilliary equipment.

143. Particularly since the announcement of the decision to build a railway and to exploit the Ngwenya haematite deposit, members of the staff have given information and advice on the variety of subjects allied thereto. Numerous enquiries were received during the year in regard

to the geology, mineral resources, and development of new projects in the Territory.

144. Considerable time was spent by the senior members of the staff on the editing and preparation for publication of the Bulletin No. 1 and the explanation to accompany the 1:125,000 Geological Map of Swaziland. A start also was made on the publication entitled "The Mineral Resources of Swaziland" which is scheduled for release in 1962.

145. Closer daily liaison was maintained between Headquarters in Mbabane and the diamond drilling rigs as a result of the purchase of three receiving and transmitting wireless sets.

146. I wish to place on record my sincere appreciation of the very high standard of work and loyal co-operation of all members of the Department who at all times have devoted themselves whole heartedly to the efficient runnning of the Department.

(B) Drawing Office

147. During the period April to November when the Department operated without the services of a qualified draughtsman, the work of more immediate importance was undertaken by the Geological staff.

148. The resignation of the draughtsman came at a most unfortunate period when the important plans and sections of the Usushwana Complex report were being prepared with the result that this publication was delayed considerably.

149. The draughting section continues to work under the considerable difficulties of space shortage and lack of filing facilities for the plans, sections etc., the number of which are increasing at considerable rate in keeping with the general tempo of development within the Territory. In the interests of the efficient organization of this section of the Department's work, a formula will have to be found soon to alleviate the difficulties. A list of the plans drawn during the year is enumerated in Appendix VI. In addition to the plans a total of 1,535 sunprints were made which include plans, borehole logs, sections of boreholes and formations and hatchured and hand-coloured maps which were drawn or reproduced during the year, it was found that many of the plans to accompany the reports published in Bulletin No. 1 required to be redrawn to the specifications of the printers.

(C) Library

150. Numerous publications continued to be received from official geological surveys and other allied sources on the reciprocal basis. Enquiries were also received from newly created geological surveys, university and commercial institutions for publications on an exchange system.

151. Conditions in the library, which as mentioned last year also is combined with a small museum, are becoming increasingly congested. It will soon become necessary to remove most of the periodical publications, except for the more recent issues, for storage in an archive.

152. The lady clerk-typist undertakes the work of librarian in addition to her other duties.

(D) Laboratory

153. Some 534 samples were prepared for assay or analysis during the year. As a great number of these samples were of boreholes cores, the samples prior to dispatch were logged, split and/or crushed and

quartered. The samples were assayed and/or analysed as follows.

Alumina	88
Antimony	19
Beryllium	1
Bismuth	3
Chrome	2
Cobalt	116
Copper	34
Germanium	2
Gold	437
Iron	129
Lead	16
Manganese	111
Nickel	37
Platinoids	7
Silica	89
Silver	2
Tin	1
Titanium	7
Uranium	1
Vanadium	92
Partial Chemical analysis	1
Complete Chemical analysis	2
Spectropraphic analysis	2
Total	1,202

154. These figures reflected an increase of roughly 50% over those for the preceeding year.

155. Many hundreds of samples were crushed and panned in the field both by the prospector and the geological field parties. Fourteen samples were treated by heavy liquid and magnetic separation methods and one sample subjected to chemical tests on behalf of the Police Department.

(E) Publications

156. The list of roneod reports prepared by the technical staff during the year is given in Appendix V. The majority of the reports are accompanied by the relevant diagrams and plans listed in Appendix VI and, except where of a confidential nature, are available to the public at a modest charge.

157. The following published reports were produced by members of the Department during the year.

A. (1) The Annual Report of the Geological Survey and Mines Department for the year ending 31st. December, 1960.
(2) "Bulletin No. 1 of the Geological Survey and Mines Department" — In the press.
(3) "The Geology of Swaziland" — In the press.

B. By D. N. Davies — Director
(1) "The Tin Deposits of Swaziland" published in the Special Economic Volume of the Transactions of the Geological Society of South Africa.
(2) "The Sedimentation Features of the Karroo System in Swaziland" read at the C.C.T.A. Congress, Pretoria, September 1961.

C. By D. R. Hunter — Geologist

(1) "The Role of a Geological Survey in Mineral Exploration" read at the C.C.T.A. Congress, Pretoria, September 1961.
(2) "Preliminary report on the copper-nickel-cobalt mineralization in the Usushwana Complex, Mbabane District" — unpublished.

D. By J. G. Urie — Geologist

"The Bomvu Ridge Iron Ore Deposit" joint author with C. Bursill and J. F. M. Luyt, published in the Special Economic Volume of the Transactions of the Geological Society of South Africa.

E. By P. E. Winter — Geologist

Special Report No. 4 — "The Usushwana Igneous Complex"

(F) Visitors

158. Constant visitors to the Department included many members of the technical and administrative staffs of the major Rand mining groups and many members of the mining fraternity and the public of Swaziland who consulted the Department on a variety of subjects.

(G) Acknowledgements

159. The Department gratefully acknowledges its indebtedness and thanks to the following for their co-operation and assistance in a variety of ways.

The Staff of the Secretariat, Mbabane,
The Director and staff of the Republic of South Africa Geological Survey,
The Director and staff of the Geological Survey of Mocambique,
The Director and staff of the Bernard Price Institute, Johannesburg
District Commissioners and Police force of the Territory,
The Manager and staff of the Havelock mine,
The Manager and staff of Peak Timbers Ltd.,
The Manager and staff of the Usutu Pulp Co.,
The Manager and staff of Ubombo Ranches Ltd., Swaziland,
The Manager and staff of the Mhlume (Swaziland) Sugar Co.,
The many members of mining companies operating in the Territory for their assistance and freely given hospitality.
To members of the public for their co-operation with the Department.

D. N. DAVIES,
Director of Geological Survey
and Commissioner of Mines.

MBABANE.
13th. March, 1962.

APPENDIX I

MINERAL PRODUCTION FOR 1961

	1960		1961		Increase		Decrease		Price Range
	Short tons	R	Short tons	R	Short tons	R	Short tons	R	
Chrysotile Asbestos	32,026.25	5,572.958	30,792.62	5,070,321	—	—	1,233.62	502,637	R25 — R319
Metallic Tin	7.07	9,982	6.12	9,864	—	—	0.85	118	R1401 — R1757
Coal	12,845.56	39,130	1,079.62	3,272	—	—	11,765.94	35,858	R1.30* — R3.00
Barytes	200.00	3,450	453.65	7,041	253.65	3,591	—	—	R15 — R16
Diaspore	826.56	8,312	491.68	5,137	—	—	334.88	3,175	R10
Pyrophyllite	1,713.60	5,200	2,955.00	13,904	1,241.40	8,704	—	—	R4
Beryl	5.52	1,420	7.14	1,652	1.62	232	—	—	R230
Kaolin	Nil	Nil	58.13	439	58.13	439			R7.5
Gold	Fine ozs. 805.76	R 20,280	Fine ozs. 1,325.19	R 33,130	Fine ozs. 519.43	R 2,850	Fine ozs. —	R —	R24.80
Silver	57.88	36	103.34	66	45.46	31	—	—	R0.63 — R0.70
TOTAL		R5,660,766		R5,144,827		R15,847		R541,788	

APPENDIX II

MINERAL EXPORTS 1961

Minerals	Country to which Exported	Quantity short tons	Value R
Chrysotile Asbestos	Australia	.1250	
	Britain	20,852.5000	3,634,769
	Denmark	3.0000	408
	Finland	5.0000	780
	France	280.0000	43,316
	Holland	15.0000	2,042
	Mexico	110.0000	17,160
	Republic of South Africa	7,257.0000	982,047
	Spain	2,270.0000	389,799
Tin Concentrates	Republic of South Africa	8.64	9,864
Barytes	Republic of South Africa	453.65	7,041
Diaspore	Western Germany	215.04	1,920
	Japan	276.64	3,217
Pyrophyllite	Republic of South Africa	2,955.00	13,904
Beryl	United States of America	7.14	1,652
Kaolin	Republic of South Africa	58.13	439
		Fine oz.	
Gold	Republic of South Africa	1,325.19	33,130
Silver	Republic of South Africa	103.34	66

APPENDIX III

LABOUR STATISTICS

	Europeans				Africans					Total	
Month	Below Surface	On Surface	Total	Earnings	Below Surface	On Surface	Total	Earnings	Value of food	Total Labour	Earnings and food
								R c	R c		R c
January	28	99	127	27,201.78	524	1,143	1,667	18,951.59	9,116.67	1,794	55,270.04
February	27	106	133	28,221.81	508	1,211	1,719	18,957.91	9,459.35	1,852	56,639.07
March	28	106	134	30,063.99	528	1,220	1,748	19,752.16	8,900.41	1,882	58,716.56
April	28	102	130	31,147.81	532	1,212	1,744	20,375.39	8,914.91	1,874	60,438.11
May	27	105	132	29,302.87	507	1,282	1,789	19,985.24	7,356.58	1,921	56,644.69
June	29	112	141	29,618.49	493	1,183	1,676	19,548.95	9,135.89	1,817	58,303.33
July	31	103	134	27,185.55	499	1,234	1,733	19,281.68	8,935.83	1,867	55,403.06
August	33	115	148	27,923.02	500	1,249	1,749	20,199.06	8,718.33	1,897	56,840.41
September	35	117	152	27,325.01	449	1,276	1,725	22,043.37	8,875.84	1,877	58,244.22
October	36	117	153	28,933.76	474	1,163	1,637	22,487.19	9,273.23	1,790	60,694.18
November	34	113	147	27,037.72	482	1,156	1,638	22,103.13	8,521.73	1,785	57,662.58
December	36	115	151	30,231.93	491	1,259	1,750	22,867.61	8,282.20	1,901	61,381.74
Total	372	1,310	1,682	R344,193.74	5,987	14,588	20,575	R246,553.28	R105,490.97	22,257	R696,237.99

APPENDIX IV

SUMMARY OF DIAMOND DRILLING FOR YEAR ENDING 31st DECEMBER 1961

BH. NO.	Depth	Size	Cost Per Ft.	FORMATION	REMARKS
135	86	BX	R3-10	Talc schist & amphibolite	Pigg's Peak gold mine, mineral concession No. 32B.
136	1,861	NX	R2-43	Chert & serpentinite	Asbestos, mineral concession No. 41.
137	351	NX	R1-92	Talc schist & serpentinite	Asbestos, mineral concession No. 41.
138	320	NX	R1-70	Talc schist & serpentinite	Asbestos, mineral concession No. 41.
139	448	NX	R0-94	Talc schist & serpentinite	Asbestos, mineral concession No. 41.
140	716	NX	R1-66	Gabbro	Usushwana copper prospect, mineral concession No. 24
141	186	NX	R2-18	Gabbro	Usushwana copper prospect, mineral concession No. 24
142	447	NX	R1-99	Gabbro	Usushwana copper prospect, mineral concession No. 24
143	467	NX	R1-88	Gabbro	Usushwana copper prospect, mineral concession No. 24
144	322	NX	R1-82	Gabbro	Usushwana copper prospect, mineral concession No. 44
145	322	NX	R1-90	Gabbro	Usushwana copper prospect, mineral concession No. 44
146	452	NX	R1-90	Gabbro	Usushwana copper prospect, mineral concession No. 44
12	5,978				

APPENDIX V.

REPORTS PRODUCED BY PROFESSIONAL STAFF

By D. N. Davies — Director

(1) Report for the European Advisory Council — Period October 1960 — March 1961.
(2) Report for the European Advisory Council — Period April 1961 — August 1961.
(3) Overseas Geological Surveys Report for the period September 1960 — December 1961.

By D. R. Hunter — Geologist

(1) Swaziland mineral development 1960.
(2) The development of mineral industries in Swaziland.
(3) Contribution to joint paper with officers of Bernard Price Institute on age determinations of Swaziland granites.
(4) Economic geology section of Usushwana Complex. Special Report No. 4.
(5) Preliminary report on the copper-cobalt-nickel mineralization in the Usushwana Complex, Mbabane District.

By J. G. Urie — Geologist

(1) Report on an investigation of a serpentinite body in north-western Swaziland. Lapsed mineral concession No. 32C, Pigg's Peak District.
(2) Note on a brief re-examination of acid volcanics in the Stegi District.
(3) Lead-Antimony prospect. Forbes Reef area — Crown mineral area No. 7 — Mbabane District.

By D. H. Jones — Geologist.

(1) Some observations on the preliminary detailed mapping of the She mine area.
(2) Report on the geology of the Horo district with reference to the Daisy, Jackal and Gordon gold mines.
(3) Report on the Devil's Reef gold mine area.
(4) The Report on the geology of the Kobolondo area with reference to the Kobolondo and Black Diamond Creek gold mines is in the process of being compiled at the time of submitting these details of work accomplished in 1961.

By P. E. Winter — Geologist

(1) Pyrophyllite deposits in the Mkopoleli area, Mankaiana District, Swaziland.

APPENDIX VI.

MAPS AND DIAGRAMS PRODUCED DURING 1961 IN DRAWING OFFICE

No.	Title	Scale	Init.
460	Plan showing the locality of the Embo & Mhlambanyati copper occurences	1:50,000	DRH.
461	Embo copper occurrence	1:2,500	DRH.
462	Mhlambanyati copper occurrence	1:2,500	DRH.
463	Section through boreholes 125 & 126	1:500	DRH.
464	Section through borehole 127	1:500	DRH.
465	Section through borehole 130	1:500	DRH.
466	Section through boreholes 131 & 132	1.250	DRH.
467	Section through borehole 133	1:250	DRH.
468	Tentative cross-section of BH.136 Havelock	1:5,000	JGU.
469	Tentative section through proposed borehole 137 Western Extension Havelock Serpentinite	1:1,000	JGU.
470	Chart of Department Organisation		B.C.
471a	Table of Swaziland Rock Analyses		DRH.
471b	Table of Swaziland Ore Analyses		DRH.
471c	Table of Swaziland Mineral Analyses		DRH.
471d	Table of Swaziland Coal Analyses		DRH.
472	Antimony-lead occurrence — Forbes Reef Area C.M.A. 7 Mbabane District	1:1,000	JGU.
473	Geology of the Havelock Asbestos Mine as from W. J. van Biljon	1:5,000	
474	Havelock Mine — Section through main shaft from W. J.. van Biljon	1:1,000	
475	Havelock Mine — Underground plan of portion of 3 Level from W. J. van Biljon	1:1,000	
476	Plan of She mine underground workings ...	1:500	DRH.
477	Plan of She mine underground geology ...	1:500	DRH.
478	Generalized Geological Assay Plan of the Usushwana Complex	1:50,000	PEW.
479	Geological plan of the Usushwana Igneous Complex	1:25,000	PEW.
480	Map of coal deposit in Swaziland	1:500,000	DRH.
481	Tectonic Map of Swaziland	1:2,000,000	DRH.
483	Plan of Underground Geology-Devil's Reef Mine	1:500	DHJ.
484	Assay plan of Devil's Reef mine	1:500	DHJ.
485	Surface geology Devil's Reef mine	1:500	DHJ.
486	Borehole Sites — Embo Maloya Area	1:25,000	DRH.
487	Geological Plan of the Devil's Reef Area M. C. No. 32B Pigg's Peak District	1:500	DHJ.
488	Map of Mineral Concession 25	1:59,500	JGU.
489	Map showing position of Pyrophyllite occurrences on Swazi Nation Lands 17 and 19	1:25,000	PEW.
490	Locality Plan Devil's Reef mine M.C.32B		DHJ.
491	Geological Sections of the Devil's Reef gold mine M. C. 32B	1:500	DHJ.
492	Appendix A Usushwana Report		PEW.

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The Kaolin deposit at Mahlangatsha showing the quarry and the dumps of kaolin awaiting transport to railhead. The ore-body is vertical and is between 25 and 30 feet. wide.

(Photo: D. N. Davies).

The three stamp mill at the Waterfall gold mine, Forbes Reef.

(Photo: D. N. Davies).