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GEOLOGICAL SURVEY
GEOLOGIESE OPNAME

THE GEOLOGY OF THE AREA AROUND SCHWEIZER-RENEKE

AN EXPLANATION OF SHEETS 2724B (PUDIMOE)
AND 2725A (SCHWEIZER-RENEKE)

by

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Geological map in colour on a scale of 1:125,000 obtainable separately at 60c.

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Geologiese kaart in kleur op 'n skaal van 1:125,000 apart verkrygbaar teen 60c.

CONTENTS

I. INTRODUCTION

A. Location and Extent of Area

The greater part of the area lies in the District of Schweizer-Reneke, Transvaal, but some farms are situated within the Bloemhof and Christiana Districts of the Transvaal and approximately a third of the area is situated in the northern part of the Cape Province and forms a portion of what was known as British Bechuanaland which falls here within the Divisions of Vryburg and Taung.

The area as a whole has an extent of 2118·41 square miles (5465·49 sq. m) and is bounded by lines of east longitude 24° 30′ and 25° 30′ and south latitude 27° 00′ and 27° 30′. Portions of the Bantu Reserves of Taung (B. 1–2)* and Takwanen (A. 1) fall within the western portion of the area. Cattle-ranching in the Cape, combined with the raising of maize and other crops in the Transvaal, form the major farming activities.

Two towns, Schweizer-Reneke having a European population of 1658 (1960) and Amalia with a White population of 183, are situated within the area.

B. Means of Communication

Owing to its topography the area is well furnished with communications, every part of it being accessible either by road or by rail. It is traversed by the main road from Johannesburg to Vryburg, which passes through Schweizer-Reneke. Well-constructed gravel roads branch out from the latter to towns and villages in the surrounding areas. The Cape area is well served with main roads leading from Vryburg, situated just off the northern boundary of the map, to Kuruman in the west, Reivilo in the southwest and Kimberley in the south. In addition the area is covered by a network of district and farm roads in all directions.

The main railway line from Rhodesia to Cape Town passes from north to south through the western portion of the area. Another main railway line from Welverdiend crosses the area in a southwesterly direction and passes through Schweizer-Reneke and Amalia to join the Rhodesia line at Pudimoe.

C. Previous Work

The area west of the Transvaal boundary was mapped and described by A. L. du Toit (1905 and 1907)† and A. W. Rogers (1907). The geological map of this area forms the southeastern portion of Cape Geological Commission Sheet 52, published in 1908. In a series of papers R. B. Young (1906–1940) described certain characteristic features of the dolomite.

The relationship existing in the Vryburg area between the underlying geology and the flora of the region was described in 1930 by A. O. D. Mogg.

The Transvaal portion also received early attention and descriptions of the geology by E. Jorissen and G. G. Holmes appeared in 1904 and 1906 respectively.

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* These numerals indicate the portion on the accompanying geological map within which the place named is situated.

† Figures in parentheses refer to the bibliography at the end of this explanation.

In spite of the number of papers dealing with certain aspects and portions of the area, the general geology remained largely unknown. The present explanation deviates from the geological classification of Rogers and Du Toit in so far that no volcanic rocks are incorporated with the Dolomite or Campbell Rand Series. The lava flow, therefore, which occurs immediately below the dolomitic limestone has now been grouped with the Black Reef Series.

D. Present Investigation

1. Distribution of Work

The mapping of the portion falling in the Transvaal was undertaken by O. R. van Eeden in 1934 and 1935. He also completed the small portion in the Cape Province between the Transvaal border and 24° 45′ east longitude, but due to inaccuracies in the field-sheet this portion was remapped by S. J. van Graan in 1946.

In response to repeated requests for geological advice in connection with underground water supplies from farmers and other local authorities from this part of the country, it was decided to complete the rest of the area falling within the Cape Province. This was undertaken during 1938 by N. P. de Wet, who completed portion (A. 1), and C. A. Strauss who was responsible for portion (B. 1) and that part of (B. 2) which falls within the Cape Province. This work was done under the supervision of F. C. Truter.

In addition the problem of the location of underground water supplies throughout the area was further investigated during 1938 by B. D. Maree, using a magnetometer and electric resistivity apparatus. Some results of his investigations are given in a subsequent chapter.

Each geologist is responsible for the portion of the map and the facts and deductions relating to his area, but no initials are given in the text to indicate each one's responsibility.

2. Base Maps

The mapping was done on plain-table sheets on a scale of 500 Cape roods to the inch for the Cape and (A. 4) and (B. 4) portions, and on a scale of 1 inch equals one mile for the rest of the area. The plain-table sheets were supplied by the Drawing Office of the Geological Survey and were prepared by enlarging photostatically the degree sheets of the Transvaal and Cape Province to the required scale.

3. Acknowledgments

The two authors who mapped the Cape portion desire to express their sincere gratitude to F. C. Truter, then Principal Geologist in charge of the Regional Geology Branch, for his useful advice and constructive criticism in the course of the mapping of the area and of compiling reports in regard to it. They also wish to express their appreciation of the work of A. L. du Toit, A. W. Rogers and R. B. Young to whose publications frequent reference is made in this report. Lastly all the authors are indebted to the inhabitants of the area for the valuable assistance rendered and for their friendliness and hospitality.

II. PHYSICAL FEATURES

A. Relief

There is quite a marked difference topographically between the Transvaal and Cape Province portions of the area and a clear relationship is discerned between the relief and the formations from which it has developed. So, for instance, we find in the Cape in the Dolomite Series the deep glacial valley down which the Dry Harts River meanders to its confluence with the Harts River. The upper portion of the Dry Harts River is also known as the Leeuw River. On the west the Dry Harts Valley is bounded by the escarpment of the Ghaap Plateau, which runs north–south, and from the margin of which the Ghaap Plateau rises in gentle undulations westwards. On the eastern side the Dry Harts Valley is bounded by the Langerand, as far as Dry Harts Siding, and from there southwards by the hills built by the Pniel lava.

The Langerand is a narrow, tapering little plateau, bounded by convergent escarpments on its west and east sides, so that it forms the watershed between the Dry Harts Valley and the broad valley of the Donkerpoort Spruit. At Dry Harts Siding the Langerand is abruptly terminated where the Donkerpoort Spruit cuts its way through into the Dry Harts Valley to join the Dry Harts River.

From Dry Harts Siding southwards and eastwards there lies the rugged hilly country which stretches away to the Transvaal border in the east, and down to and across the Harts River in the south. These hilly highlands, the Langerand and Ghaap Plateau, must have been part of a continuous plateau before it was dissected first as a result of glacial action and post-glacial elevation, and later by pluvial action.

This plateau is well developed immediately to the south and west of Tierkloof Siding (A. 2). Occasionally a few low ridges and kopjes are seen at places where rocks were able to offer a greater resistance to destructive agencies of weathering. The altitude above sea-level on the Ghaap Plateau hardly ever exceeds 4000 feet (1219 m). This portion of the plateau has the form of a very flat monocline, the axis of which runs north–south, so that there is a hardly perceptible rise from east to west. The monotony of this flat country is broken by the previously mentioned Dry Harts River, which flows in a deep canyon, seldom more than 200 yards (182 m) wide on Rosendal (A. 1–2), Waterloo (A. 1–2), Tierkloof (A. 2) and Champions Kloof (A. 2), but further south on Zwartkrans (A. 2), the river widens out to a broad fertile valley fully 2 miles (3·2 km) in width.

Another striking feature of the dolomite region is the occurrence of dykes of dolerite and diabase, locally known as "aars". They form narrow parallel ridges which rise slightly above the general level of the country and extend in straight lines for miles. Calcareous tufa and a dense covering of thorn-trees are invariably associated with these "aars", which consequently form prominent features as the surrounding country generally lack a dense vegetation.

From the Transvaal border the Harts River flows in deep meanders incised in the Ventersdorp lava. The vertical lava cliffs rise to 80 feet (24·4 m) in height, while the surrounding country is extremely dissected by the tributaries which all have precipitous gradients.

In contrast the Transvaal area is characterised by the absence of any marked physiographic features, except for the Marokane Hills along the border. In general, it may be described as a great, undulating plain diversified with low rounded hills or rises and hollows which differ little from one another and from the general plain in height. This area lies at an altitude of 4000 feet (1219·2 m) to 4500 feet (1371·6 m) above sea-level except for the divide northwest and southeast of the Harts River which lies at an altitude of 4500 feet (1371·6 m) to 4600 feet (1402 m). The highest point in the area is the Morgenzon trigonometrical beacon which stands at 4651 feet (1417·6 m) above sea-level. Even in this monotonous landscape a clear relationship between the topography and the formations from which it has developed may be discerned.

The area occupied by the Archaean granite southwest of Schweizer-Reneke is in the main devoid of physiographic features; but the sediments of the Ventersdorp System form low ridges and hills which may have fairly steep slopes, e.g. Rooikop (B. 4) and the hill immediately northeast of Schweizer-Reneke.

The few prominent landmarks on the undulating plain consist generally of harder, more weathering-resistant rocks such as the banded ironstone which builds Abelskop (B. 3), the quartz forming Witkop (B. 3) and the Ventersdorp sediments and quartz porphyries of Uitvalskop (B. 2).

The Transvaal–Cape Province boundary northeast of Myra Siding follows the foot of the low escarpment traced approximately by the 4000 feet (1219·2 m) contour-line. The escarpment known as the Marokane Hills is a few hundred feet high and consists mainly of Ventersdorp lava with subsidiary sediments projecting through the former along a monoclinal fold. Between these hills and the previously described ranges east of the Dry Harts River, there is a broad flat plain with very few outcrops (A. 2), the underlying formation being chiefly the Dwyka Series of the Karroo System.

Although it would appear that selective erosion of the different formations constituting the area largely contributed to the differences in topography, it must also be borne in mind that the glaciers responsible for the deposition of the Dwyka tillite played a large part in the carving out of the broad Dry Harts Valley, as well as many of the broad valleys striking west, such as the valley now occupied by the Donkerpoort Spruit. Relics of Dwyka tillite are abundant throughout the northwestern portion of the area (A. 1–2), and occur as far east as Amalia (A–B. 3). It is well developed outside the confines of the area east of Schweizer-Reneke and it is very probable that it may have covered the whole of the area originally. The question arises to what extent the present landscape represents the Pre-Karroo peneplain. The Marokane Hills were formed by monoclinal folding, the Cape terrain having sagged relative to the Transvaal area. This folding is almost certainly Pre-Dwyka in age and the present peneplain thus largely represents a slightly modified Pre-Dwyka feature.

B. Climate and Drainage

The area has a typically continental climate with very cold winters and excessively hot summers. The mean maximum temperature for January is 91° F (32·8° C) and the mean minimum temperature for the same month 63° F (17·2° C); for July, the coldest month, the temperatures are respectively 67° F (19·4° C) and 31° F (—0·6° C). The mean annual temperatures are 80·7° F (27° C) and 48·2° F (9° C) respectively. All these readings were taken over a period of 20 years at Vryburg, the only temperature recording station for the area. The above figures show that the variation between day and night temperatures is of considerable magnitude. Frost is of common occurrence between the end of May and the middle of September.

The prevailing winds blow from the west and northwest. The former, which traverses the Kalahari Desert, is a hot, dry wind which often carries a lot of dust and even sand. The moisture-bearing wind from the north is generally regarded as the rain bearer.

Rain is mostly precipitated in the form of local thunder storms, which mainly occur during the months of summer. The average yearly rainfall for the area as a whole amounts approximately to 17·56 inches (446 mm), varying from one locality to another but increasing slightly towards the east as appears from the following table:—

Stations	Latitude	Longitude	Number of years observed	Average rainfall	
				Inches	Millimetres
Lansdowne	27° 22′	24° 35′	10	18·73	475
Waterlea	27° 18′	24° 36′	5	19·14	486
Kameelfontein	27° 02′	24° 37′	15	16·02	407
Retreat	27° 01′	24° 40′	15	18·16	461
Naples	27° 10′	24° 40′	6	13·18	335
Madrid	27° 14′	24° 40′	27	17·70	449
Verona	27° 20′	24° 43′	21	16·43	417
Tierkloof	27° 04′	24° 46′	30	15·96	405
Queensbury	27° 06′	24° 53′	5	13·74	349
Gouda	27° 10′	24° 55′	18	12·57	319
Leliefontein	27° 03′	24° 58′	27	15·66	398
Spreeuwfontein	27° 13′	24° 59′	30	19·54	496
Italie	27° 26′	25° 03′	15	17·80	452
Lot 15 44 HO (Schweizer-Reneke)	27° 08′	25° 15′	16	19·96	507
Schweizer-Reneke I	27° 11′	25° 20′	14	20·17	512
Schweizer-Reneke II	27° 11′	25° 20′	40	18·93	481
Zandfontein	27° 18′	25° 20′	35	18·98	482
Houtvolop	27° 22′	25° 22′	15	19·89	505
Holpan	27° 14′	25° 24′	24	20·74	527
Mooifontein	27° 29′	25° 24′	23	15·51	394
Koppiesvley	27° 04′	25° 27′	11	20·05	509
			Average	17·56	446

Although at first glance the rainfall appears to be adequate, it is unfortunately very irregularly distributed over the years as the records, some of which date back to 1897, show. Often a high rainfall period, which may exceed an average of 25 inches (635 mm) per annum for periods up to three years, is succeeded by a period of drought in which the annual rainfall may not even reach 7 inches (178 mm). This has a crippling effect on crop-farming and can also be fatal for stock-farming.

The main watershed in the Cape Province between the Molopo and the Dry Harts Rivers is situated outside the confines of the area, namely to the north, northwest and west of Vryburg, with the result that the principal drainage directions in this area of the Cape is to the southeast and east, via the Takwanen Spruit, the Dwars River and the Sterkfontein Spruit which all join the south-flowing Dry Harts River. The latter has its origin northeast of Vryburg where it is known as Leeuw Spruit. It enters the area on the farm Rosendal (A. 1–2) in the north, where it has cut a deep narrow gorge through hard rocks of the Transvaal System and admirably exposes various rocks belonging to the Black Reef and Dolomite Series. On entering Zwartkrans (A. 2) it is joined by the large Losasa Spruit from the east and from here on it constitutes a broad valley which bears abundant evidence of having been formed by glaciation. At its confluence on Uitenhage (A. 1–2) with another tributary from the east, the Dry Harts River turns west and now continues its course west of the Cape–Rhodesia railway line down to its confluence with the Harts River to the southwest of Taung Station.

When torrential summer rains have fallen in its drainage-area the Dry Harts River comes down in flood and, overflowing its shallow banks in places, it inundates large portions of its broad valley. It only runs for a short time after rains, and for the rest of the year is a dry tract.

The chronology of the development of the Dry Harts Valley appears to have been as follows:—

During the Karroo glacial period there probably existed a small drainage-line; this was deepened and widened by the abrasive action of the glaciers. When they retreated tillite and shale were deposited in the newly excavated valley. This was followed by some elevation of the country and consequent renewal of erosion. The Harts River and the small tributaries running into the Dry Harts Valley, were hanging and thus they deepened their channels and increased their gradients. At the same time most of the glacial deposits were removed by erosion. There came a lull in the elevation, and deposition of alluvium and the formation of soil proceeded. During this period calcrete was formed. Further elevation took place, which resulted in removal of post-glacial deposits, erosion of calcrete and a further increase in gradient of the tributaries.

The Ghaap Plateau is very badly drained. As will be seen on the map there are no definite watercourses draining the southwestern part of the plateau. The water is dammed up by the long limestone ridges or " aars " which occur above dykes. In this way fairly large areas are inundated for weeks during heavy rains. Along the eastern edge of the plateau various minor streams descend the escarpment from the west, but the water is absorbed into the soil in the valley before it reaches the actual course of the river.

In the Transvaal the Harts River and its tributaries drain the eastern portion of the area, the former flowing in a southwesterly direction. Owing to its flat nature and the extensive cover of superficial deposits the run-off throughout the area is small, so that there are very few large tributaries joining the Harts River. The latter having a much longer course and bigger catchment area, carries much more water than the Dry Harts River and thus also runs more frequently and for longer periods. From the Transvaal border its banks and beds are rocky. It is fed by numerous springs along this stretch, so that it perennially contains pools and long tracts of water. None of the streams, however, are perennial, although waterholes occur along some of the major drainage-courses throughout the area.

The area west of 25°00′ east longitude as far as the Cape–Rhodesia railway line is drained by a number of tributaries of the Dry Harts River, which all flow towards the southwest. From north to south they are respectively the Losasa Spruit, the tributary which enters the Dry Harts on Uitenhage, the Markani Spruit, the Pudimoe Spruit and the tributary which has its confluence with the Dry Harts River just northwest of Magopela Siding.

There are numerous small pans on the Dolomite, especially at its contact with the Black Reef Series. East of 25°00′ east longitude there are about 80 pans, some fairly large as for example on De Park 87 HO (B. 4), on the Ventersdorp lava and sediments, on the granite and Karroo. On similar rocks west of this line there are just a few pans. The most important single factor responsible for the formation of these pans is wind-erosion (Van Eeden, 1955).

C. Vegetation

There are indications that the portion of the area which falls within the Cape Province previously supported an extensive arboreal vegetation. The advance of civilisation created a demand for timber both for domestic use and for use in the diamond-mines at Kimberley. This, together with the practice of veldburning, brought about deforestation in this part of the area.

Some of the flora show a preference for certain geological formations as was first pointed out by Mogg (1930). He expressed the view that where the cover of soil exceeded four feet in depth the influence of the underlying geological formation was negligible, except perhaps in the case of a soft, easily weatherable rock in a moist climate. The relationship is well illustrated in the Transvaal portion of the area where on Marokane (A. 2–3) and Zoet en Smart 31 HO (A. 3) a luxurious growth of vaalbos (*Tarchonanthus camphoratus*) is found on the shallow soil covering the Ventersdorp lava, whilst it is sparse and often entirely absent on Weltevreden 28 HO (A. 3) and Welgevonden 3 HO (A. 3) where there is a thick cover of soil. Vaalbos also shows a preference for areas occupied by surface-limestone and occurs together with raisin-bush (*Grewia* spp.) in clumps in portions of the granite area and especially on rocks of the Swaziland System.

Over large areas grass is the predominating form of vegetation, especially on the more level stretches such as portions of the Ghaap Plateau and the eastern portion of the area where bush and shrub are very scarce and occur only in isolated patches. Bushman grass (*Aristida ciliata*) prefers the sandy stretches but several other coarse grasses are also found.

On the eastern side of the Cape–Rhodesia railway line on the Langerand and in the hills along the Transvaal border, bush is fairly abundant but the alluvium-filled valleys are mostly covered with grass only. The bush consists of members of the Acacia family amongst which camel-thorn (*Acacia giraffae*), swarthaak (*Acacia detinens*) and haak-en-steek (*Acacia spirocarpoides*) predominate, together with vaalbos (*Tarchonanthus camphoratus*) and other less abundantly represented trees such as shepherd's tree (*Boschia albitrunca*), wild pomegranate (*Rhigozum trichotomum*), buffalo-thorn (*Ziziphus mucronata*), karree (*Rhus lancea*) and wild olive (*Olea africana*). Along the Harts River in the Cape bush is thick, willow (*Salisi woodii*) and karree being abundant and shepherd's and wild olive-trees grow out of the vertical cliffs along the river.

Where the valleys are sandy, as along the Transvaal border in the Markani, Donkerpoort and Dry Harts Valleys, camel-thorn is fairly abundant and attains great sizes.

Along the escarpment of the Ghaap Plateau, grass and bush mingle, the latter being vaalbos, swarthaak and minor quantities of camel-thorn, bloubos (*Royena pallens*) and broom-bush (*Rhus dregeana*). The Ghaap Plateau itself is a flat, sparsely vegetated area, the bare, extensive flats being covered only with grass and patches of swarthaak and vaalbos. Westward bushes become still more scarce, except on the long, narrow, straight ridges of limestone, the so-called " aars ", which support a prolific growth of trees and bushes which make them conspicuous for miles. Lemoendoring (*Parkinsonia africana*) comes into prominence here.

III. GEOLOGICAL FORMATIONS

The following geological formations are represented in the area:—

Tertiary to Recent		Sand and surface-drift Alluvium River-terrace gravel Surface-limestone and calcrete
	Unconformity	
Karroo System	Dwyka Series	Tillite and shale
	Unconformity	
Transvaal System	Dolomite Series (Campbell Rand Series)	Dolomitic limestone and chert with intercalated quartzite, shale and flagstone
	Black Reef Series	Flagstone or sandstone, the former with dolomite in places Andesitic lava with flow-breccia Quartzite with flagstone and locally dolomite above and below Andesitic lava Quartzite, grit and conglomerate overlain by flagstone
	Unconformity	
Ventersdorp System		Andesitic lava, scoriaceous in places and with flow-breccia at top Volcanic breccia and agglomerate Quartzite, grit, conglomerate and boulder-conglomerate; tuff and tuffaceous sediments, cherty or calcareous in places
	Unconformity	
Zoetlief Formation (Dominion Reef System?)		Various types of bedded tuff Quartz porphyry
	Unconformity	
Kraaipan Formation (Swaziland System)	Abelskop Beds	Greywacke, grit, shale, quartzite; banded ironstone; various kinds of schist; andesitic and rhyolitic lava, tuff and cherty rocks and volcanic breccia; amphibolite

INTRUSIVE ROCKS

Post-Karroo	Dolerite
Post-Ventersdorp but Pre-Karroo	Diabase
Archaean	Veins and irregular bodies of quartz Granite and gneiss

The area is characterised by five large unconformities, one period of granite intrusion, four major periods of volcanicity and two periods of basic intrusion. All these facts are indicative of an unstable crust even though there are no signs of any major orogenesis, except that the Kraaipan Formation has been intensively folded.

IV. THE SWAZILAND SYSTEM

A. The Abelskop Beds

Rocks correlated with the Swaziland System and known locally as the Abelskop Beds form a long narrow outcrop, which strikes approximately north–south from Bothmansrust 76 HO (A–B. 3) and Abelskop 75 HO, near Amalia, past Goudplaats 96 HO, Ongerust 103 HO, Twyfel 121 HO, Jerusalem 133 HO, Vryheid 134 HO and Nooitgedacht 259 HO (all B. 3) and as far as the southern limit of the area. Owing to the superficial cover of soil and sand, contacts could only be determined approximately. Usually the cherty banded ironstone forms outcrops but the softer rocks are only seen very occasionally as is well illustrated on the map of the outcrops shown in folder 1. In the southern portion outcrops are even scarcer.

Rafts of the Swaziland System occur in the Archaean granite on Modimo, Fouries Graf 23 HN, Braklaagte 24 HN, Joubertsrust 18 HN and Pollington 13 HN (all B. 2). Although they have a haphazard distribution, they all fall within a second narrow zone which also strikes roughly north–south from Pollington 13 HN to Modimo.

Another fairly large outcrop which belongs to the first-mentioned zone occurs on Avondster 120 HO (B. 3).

Of the sedimentary phase of the Swaziland System the banded chert is the most conspicuous. It consists of thin alternative bands of white jaspery chert and black magnetite-bearing siliceous material. The thickness of individual bands vary appreciably, but is on an average between 3 and 8 mm. These cherty rocks are not replacement deposits but have been precipitated from solution and consolidated in situ in the manner described by Moore and Maynard (1929).

Easily recognisable shale is associated with the banded chert as well as quartz-chlorite-carbon schist, undoubtedly derived from the shale.

The majority of the remainder of the sedimentary rocks of this system has a greenish colour with no distinct macroscopic sedimentary structures and appears to be diabasic in composition. At the old Goudplaats goldmine (B. 3) they were termed "epidiorites". Examination of thin sections of these rocks showed that they contained appreciable amounts of quartz and that they corresponded closely in composition with the greywacke of the Fig-tree Series of Barberton described by Van Eeden (Visser, comp., 1956).

XIII. UNDERGROUND WATER

Surface-water is scarce throughout the area and farmers are therefore largely dependent on underground water obtained from bore-holes, wells and springs. Even a large town like Vryburg, just to the north of the area, obtains all its water from underground sources.

Although conditions over the area as a whole are not very favourable for the replenishment of underground water, drilling for water has met with considerable success.

Unfavourable conditions for replenishment are:—

(1) Lack of relief over a large percentage of the area with the result that rain-water is not concentrated on comparatively small areas to give a high infiltration.

(2) Thick cover of sand over certain areas, and dense vegetation.

(3) High rate of evaporation and transpiration coupled with the fact that between 80 and 85 per cent of the rain falls during the very warm summer months. Gross annual evaporation is between 75 inches (1905 mm) and 85 inches (2059 mm).

(4) Comparatively low average rainfall of 17·5 inches (446 mm).

Factors which are favourable for replenishment over either certain portions of the area, or the whole area, are:—

(1) Surface-limestone, dolomite, and other rocks with a thin cover of soil.

(2) Absence of trees with deep penetrating roots.

(3) Years with abnormally high rainfall—25 inches (635 mm) and higher.

(4) Heavy showers.

A complete assessment of the various factors governing infiltration has not been made, but one interesting conclusion has already been referred to in chapter II C, namely that the underlying formations have a negligible influence on the vegetation where the depth of soil exceeds 4 feet, except perhaps, in the case of a soft, easily weatherable rock in a moist climate. The fact that such a comparatively thin cover of soil has this effect, may mean that water seldom infiltrates beyond this depth under existing conditions.

In the Transvaal portion of the area the Geological Survey has done very little work in connection with underground water, and has selected only a few bore-hole sites. The account for underground water is based nearly entirely on a study of the records of bore-holes drilled by the Department of Water Affairs and on experience gained in neighbouring areas.

In the Cape portion Mr. B. D. Maree, formerly of the Geoglogical Survey, carried out investigations during 1938 to determine the applicability of the electrical resistivity and magnetometric methods in locating underground water. A few sites for bore-holes were selected by the Geological Survey.

A. Water in the Archaean Rocks

1. In the Granite

Many bore-holes have been drilled in the granite and the rocks of the Swaziland System intruded by it. The following are averages obtained from 151 of the holes drilled in the granite up to 1949 and from 33 holes drilled subsequently.

Period	Depth of bore-hole (ft.)	Water struck at (ft.)	Rest-level (ft.)	Yield (g.p.h.)	Percentage yielding more than 100 g.p.h.
Up to 1949..............	124	102	66	630	57
After 1949...............	167	94	58	221	36

The depths of the holes for the first period vary from 45 to 302 ft. and only 4 per cent are deeper than 200 ft. In 7 per cent no water was struck.

From the frequency curves shown in figure 5 can be deduced the percentage of bore-holes giving more than a certain yield within the limits given.

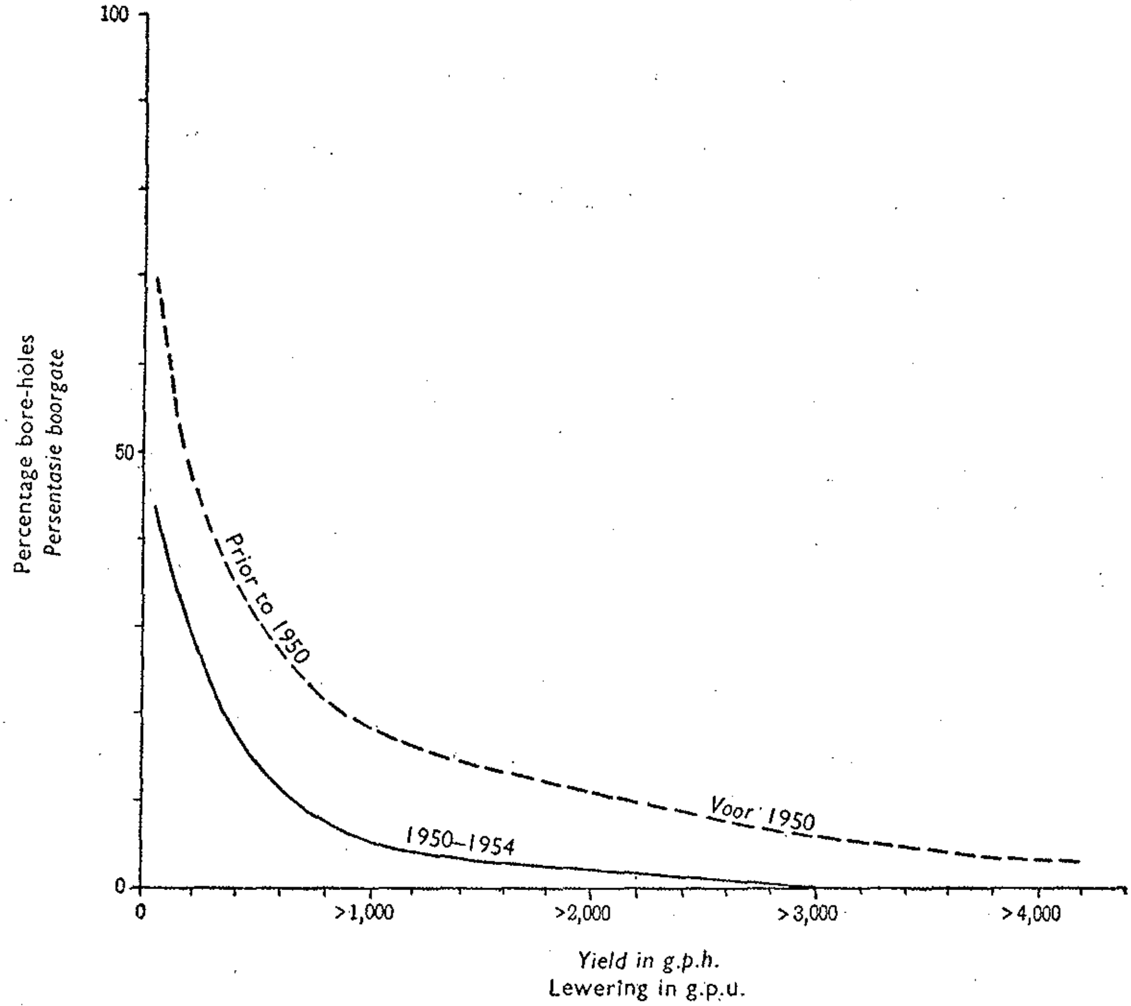

Fig. 5.—Yield-frequency curves of bore-holes in the granite.
Frekwensiekrommes van lewering van boorgate in die graniet.

A comparison of the results for the two periods shows that the average depth of the holes increased, while the average depth at which water was struck, rest-level, yield and percentage of successes decreased. The decrease in the last-mentioned four averages could possibly be explained by the need for drilling on high ground and the increase in depth of the holes by the fact that it was more difficult to obtain water and deeper drilling was attempted.

The water-yielding properties of granite are determined largely by the depth and degree of weathering and to a lesser extent by fracturing. Weathering is easily determined by means of the electrical resistivity method and the use of this method in the area should increase the percentage of successes quite appreciably.

No analyses of the water are available, but it is of good quality.

2. IN THE SWAZILAND SYSTEM

These rocks are not such good aquifers as the granite and the percentage of successes is lower, namely about 50 per cent.

In most of the bore-holes water was struck at a depth of less than 100 ft. and drilling beyond this depth was seldom successful.

The rest-level was on the average 67 ft. and the yields in most cases either less than 500 g.p.h. or greater than 1500 and 3000 g.p.h.

The percentage of successes could no doubt be increased considerably by selecting sites geologically and by means of the electrical resistivity method.

The water is of good quality.

B. WATER IN THE VENTERSDORP SYSTEM

1. IN THE SEDIMENTS AND PYROCLASTICS

The records are very unreliable and in many instances quartzite was logged as granite. It would, however, appear that the sediments are fairly good aquifers, about 70 per cent successes having been obtained.

In most of the bore-holes water was struck between 100 and 150 ft. with a rest-level between 60 and 100 ft. The deepest bore-holes are between 100 and 160 ft.

The sediments are predominantly arenaceous and contain bands of tuff and lava. It is not known which are the best aquifers, but it would appear that they are the softer bands.

The electrical resistivity method should be of assistance in locating softer, or weathered, bands.

No analyses are available but the water is of good quality.

2. IN THE LAVAS

The water-bearing properties of these rocks have been fully described in Bulletin 34 (Boorplekaanwysing vir water in Suidwes-Transvaal) of the Geological Survey and the reader is referred to this publication (De Villiers, 1961).

C. Water in the Transvaal System

1. IN THE BLACK REEF SERIES

The Black Reef Series has a limited development in the Cape section of the area. Few bore-holes have been sunk in it and little is known about its water-bearing properties. Most of the rocks of this series are compact and more or less impervious and in spite of being composed of two lava flows and several shaly and quartzitic layers, providing a series of contacts, results are generally poor.

Two contact-springs in the Black Reef Series on Takwanen and Waterloo each yield approximately 1500 g.p.h. On Uitenhage an artesian bore-hole situated next to a dyke near to the confluence of the Dry Harts River and its tributary from the east, yields 200 g.p.h. at a depth of 97 ft. (29·6 m).

2. IN THE DOLOMITE SERIES

The Dolomite is only water-bearing by virtue of the presence of solution conduits which can as a rule not be located. Drilling results are, therefore, very erratic.

In the Dolomite the water-table is generally horizontal, or very near to horizontal, and the depth is determined by the height of impervious barriers such as dykes and shale bands. Springs occur where the depth to the water-table and a barrier is the same.

A number of limestone "aars", described in a previous chapter, occurs in the Dolomite, especially on the southwestern portion of the Ghaap Plateau. Although some of these "aars" probably mark the positions of faults and fractures, most of them represent dykes which are weathered to variable depths. These dykes are responsible for different water compartments in the Dolomite.

It is not yet known whether the chances of encountering fissures in the Dolomite are better close to dykes than away from them. The weathered portions of dykes yield fair quantities of water.

It is not known to what extent the flagstone bands in the Dolomite determine water-tables. These bands, and especially the thick main one, however, are fairly good aquifers on the Ghaap Plateau.

A number of contact-springs occurs at the contact of the Dolomite Series and the underlying lava of the Black Reef Series on the farms Rudmansfield (portion of Nazareth) (A. 1), Driepoort (A. 1) and Brussels (A. 1).

Water from the Dolomite is usually very rich in calcium and magnesium carbonates, as the following analysis of a sample from the spring at Luselong shows:—

	Mgm/litre	N/1000
$Na^{\cdot}$	—	—
$*K^{\cdot}$	0·97	0·02
$*Mg^{\cdot\cdot}$	39·46	3·25
$*Ca^{\cdot\cdot}$	45·20	2·26
$Mn^{\cdot\cdot}$	nil	—
Sum of cations	85·63	5·53
Cl'	28·4	0·83
F'	0·60	0·03
$*SO_4''$	14·78	0·31
$*HCO_3'$	474·20	3·89
Sum of anions	517·98	5·06
Sum of ions	603·61	
SiO_2	5·00	
Sum-total	608·61	

Total solids (95° C)	454 mgm/litre
Total solids (180° C)	397 mgm/litre
Specific resistance (60° F)	1512·5
pH	7·4

* These values were calculated from an analysis which was given on a percentage basis.

3. APPLICATION OF GEOPHYSICAL METHODS

Mr. B. D. Maree made a number of magnetometric traverses across "aars" and although most of these linear structures gave pronounced positive anomalies, the magnetometer is not of much use in locating them because they are as a rule shown by the deposits of surface-limestone and denser vegetation. Even where they give no anomalies, they are still plainly visible.

The anomalies may, however, give an indication of the depth of weathering of the dykes. The magnetometer could also be used for tracing the dykes where they are covered by superficial material like alluvium.

The flagstone bands in the Dolomite cannot be located, or traced, magnetometrically. Iron-bearing chert bands in the Dolomite are highly magnetic and can be traced with the magnetometer, but such bands are of no, or little, importance as far as underground water is concerned.

The electrical resistivity method proved to be of little value, but it could be of value if used with discretion.

D. WATER IN THE KARROO SYSTEM

1. IN THE TRANSVAAL

The rocks seldom outcrop but from information of bore-hole records they consist of soft shale and tillite of the Dwyka Series. Sandstone is nearly absent.

It should be pointed out that it is difficult to distinguish between tillite and Ventersdorp lava from the borings and where the records show lava, the rocks may in part be tillite.

A considerable number of bore-holes has been drilled in the area overlain by the Karroo rocks, but only 23 drilled before 1949 were used in obtaining the following averages:—

Depth of bore-hole	Thickness of Karroo penetrated	Water struck at	Rest-level	Yield	Percentage yielding more than 100 g.p.h.
148 ft.	84 ft.	105 ft.	54 ft.	660 g.p.h.	78

In eight of the successful holes water was struck in the underlying Ventersdorp lava, in six on the lava and in four in the sediments. In one of the failures, on the farm Geluk 56 HO (A. 4), 267 ft. of shale and 33 ft. of lava were penetrated. S. B. de Villiers of the Geological Survey has analysed the results of a number of bore-holes drilled by the Department of Water Affairs in the Karroo areas between Schweizer-Reneke and Wolmaransstad, and south of Makwassi, for the period March, 1948 to July, 1952 with the following results:—

	South of Makwassi		Between Wolmaransstad and Schweizer-Reneke	
Number of bore-holes........	93		133	
	Selected by the Geological Survey	Selected by others	Selected by the Geological Survey	Selected by others
Percentage holes selected......	56	44	23	77
Percentage successes..........	34	9	42	42
Number of feet drilled per successful hole................	310	1232	503	350

As regards the second area, De Villiers has come to the following conclusions:—

In the area between Wolmaransstad and Schweizer-Reneke water is often struck in the Dwyka tillite and Ventersdorp lava. Out of a total of 83 bore-holes which were on the average drilled 100 ft. into the tillite and lava and in which the water was struck in either of these two rocks, 35 per cent was successful. The average depth at which water was struck in these holes, is 150 ft.

When water is struck in the tillite, it is usually just above the lav where the borings are coarse. When the lava below the Karroo yields water it does so by means of joints and fissures because the rock is unweathered. The solid nature is clearly shown by electrical coring—there is a sharp increase from a few thousand ohm cm to more than 100,000 ohm cm from Karroo to lava.

In the area south of Makwassi it would appear that the chances of finding water in the tillite and the underlying solid lava are much less than in the previous area, because the tillite here is not as thick.

In the whole area of Karroo rocks in the Western Transvaal, dolerite intrusions in the form of dykes, sheets and irregular bodies, are scarce. They have been made use of by geologists of the Geological Survey in site selection with variable success. In the area of the present sheet no, or few, sites have been selected relative to dolerite but it is doubtful whether they would influence the drilling results as a whole.

From the work done by De Villiers and others, it would seem that the applicability of geophysical methods in site selection on the Karroo formation in the area of the present sheet is as follows:—

With the magnetometer dolerite dykes can be located and their contacts determined.

With the electrical resistivity method weathering in dolerite sheets (2500–5000 ohm cm) can be determined and in certain cases the thickness. It is also possible to locate the zones of indurated shale, which are good aquifers, adjoining dolerite sheets. The resistivities of such sediments are between 3000 to 6000 ohm cm compared with 1000–2000 ohm cm of the unaltered shale and 10,000 to 30,000 ohm cm of the unweathered dolerite.

Where the sandstone outcrops at the surface, its thickness can in certain cases be determined by electrical depth-probes. The sandstone in the Ecca Series between Wolmaransstad and Schweizer-Reneke is a fairly good aquifer. According to the work of De Villiers, there would appear to be a relationship between the thickness of the Karroo rocks and the percentage successes obtained—the greater the thickness the higher percentage successes that can be expected. The resistivity method can be used to determine the thickness of the sediments.

Generally the quality of the water is good.

2. IN THE CAPE PROVINCE

In the Cape portion of the area Karroo rocks, consisting of shale and tillite of the Dwyka Series, are confined to the glaciated valleys. The records of 25 holes were analysed with the following average results:—

Depth of bore-hole	Thickness of Karroo penetrated	Water struck at	Rest-level	Yield	Percentage yielding more than 100 g.p.h.
158 ft.	123 ft.	83 ft.	44 ft.	419 g.p.h.	71

In most of the bore-holes the water was struck in the sediments, but in some at the base of the sediments and in others in the underlying rocks.

The quality of the water is good.

In the Cape and Transvaal the results are very much the same and as the rocks are very similar, the application of geophysical methods should yield similar results.

After this report was written, S. B. de Villiers (1961) published the results of his work on the selection of bore-hole sites for underground water in Southwestern Transvaal. The reader is referred to this publication (Bulletin 34 of the Geological Survey).

DIE GEOLOGIE VAN DIE GEBIED RONDOM SCHWEIZER-RENEKE

OPSOMMING IN AFRIKAANS

Deur O. R. van EEDEN, D.Sc.

INLEIDING

Die gebied wat begrens word deur oosterlengtelyne 24° 30′ en 25° 30′ en suiderbreedtelyne 27° 00′ en 27° 30′, het 'n oppervlakte van 2118·41 vierkante myl en val in die Distrikte Schweizer-Reneke, Bloemhof en Christiana van Transvaal, en Vryburg en Taung van die Kaapprovinsie. Dit is hoofsaaklik 'n landbougebied wat hom hoofsaaklik op beesboerdery en saaiery toelê. Daar is twee dorpe, nl. Schweizer-Reneke met 'n Blanke bevolking van 1658 (1960) en Amalia met 183.

Die gebied is goed met paaie bedien en die hoofspoorlyn vanaf Kaapstad na Rhodesië, asook 'n lyn vanaf Johannesburg na Pudimoe, gaan daar deur.

Dié gedeelte van die gebied in die Kaapprovinsie is gedurende die jare 1905 en 1907 deur A. L. du Toit en A. W. Rogers gekarteer. R. B. Young het sekere verskynsels in die Dolomiet beskryf en A. O. D. Mogg het op die verhouding tussen die verskillende geologiese formasies en die plantegroei gewys. E. Jorissen en G. G. Holmes weer het die geologie van die Transvaal-gedeelte beskryf.

Die opname waarvan die resultate in hierdie verslag verstrek word, is met tussenposes vanaf 1934 tot 1946 gemaak.

FISIOGRAFIE EN KLIMAAT

Fisiografies is daar 'n groot verskil tussen die gedeeltes wat in die twee provinsies lê wat tot 'n groot mate 'n gevolg van die verskil in geologiese formasies is. In die westelike gedeelte van die gebied is daar die Ghaapplato wat sowat 4000 voet bo seespieël lê en deur die Serie Dolomiet gebou word. Tussen die plato en die grens tussen die twee provinsies is 'n ou gletservallei met die Droë Hartsrivier wat suidwaarts vloei. 'n Kenmerkende verskynsel op die dolomiet is die sogenaamde „ are " wat op gange van diabaas en doleriet gevind word. Die are wat 'n bietjie hoër as die omliggende landskap is, word gekenmerk deur kalk en 'n digte stand van bome. Sommige is vir myle byna pylreguit.