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GEOLOGIESE OPNAME

I THE GEOLOGY ALONG THE ORANGE RIVER VALLEY BETWEEN ONSEEPKANS AND THE RICHTERSVELD

EXPLANATION OF SHEETS 2817D (VIOOLSDRIF) 2818C AND D (GOODHOUSE) AND 1819C (ONSEEPKANS)

BY

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DIE GEBIED LANGS DIE ORANJERIVIERVALLEI GELEË TUSSEN ONSEEPKANS EN DIE RICHTERSVELD

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Geological map in colour on a scale of 1:125 000 obtainable separately 60c Overseas 75c

Geologiese kaart in kleur op 'n skaal van 1:125 000 apart verkrygbaar teen 60c Oorsee 75c

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I. INTRODUCTION

A. LOCATION AND EXTENT OF THE AREA

The area under consideration is situated along the northern border of the Divisions of Namaqualand and Bushmanland in the north-western part of the Cape Province. It is bounded in the north by the Orange River, in the east and west by longitudes 19°30' and 17°30', respectively, and in the south by the 29th parallel: in all it embraces approximately 3350 km^2 comprising Geological Sheets 2817D, 2818C and D and 2819C.

Government-sponsored irrigation schemes are in operation at Vioolsdrif and Onseepkans. At the former a weir was built across the Orange River at Namma Keinam (Thamma Keinanni), from where a canal extends down the river past Vioolsdrif, Rooiwal and Kotzeshoop to Modderdrif. Some 630 people live on the 300 smallholdings under this scheme. Under a similar scheme at Onseepkans 300 people occupy 58 developed smallholdings. The rest of the area is sparsely inhabited and not more than a dozen families occupy the few farms throughout the year. Some inhabitants make a meagre living by keeping small herds of goats close to or along the Orange River where water is available.

The desert country west of Goodhouse is practically uninhabited except for the occasional fortune-seekers who attempt to make a living by prospecting for minerals such as beryl, spodumene, columbite-tantalite, mica and feldspar in the pegmatites. The only steady producer of pegmatite minerals since the early 1950's has been the Noumas mine. Since 1963 a determined attempt has been made to exploit the Norrabees pegmatites but to date (1967) this has not met with any great measure of success.

B. MEANS OF COMMUNICATION

The western portion of the area is well served by the tarred main road from Cape Town which crosses the Orange River at Vioolsdrif, and by a good dirt road to Goodhouse. A further main road connects Pofadder to Onseepkans in the north and another traverses the entire length of the area from Pofadder via Pella to Goodhouse in the west.

Throughout the rest of the area roads are generally in poor condition and many are mere tracks more suited to animal-drawn than to motorised vehicles. It should be noted that, while all the roads indicated on the maps were travelled at one time or another by the authors, they may have deteriorated since, and care must be exercised not to be caught in treacherously loose sand.

Parts of the area are quite inaccessible to wheeled vehicles and can be reached on foot only.

For the western part of the area the nearest town is Warmbad situated 64 km north of Goodhouse in South West Africa, but much valuable time may be lost in crossing the river by ferry. Springbok, situated roughly 640

km from Cape Town and 102 km south of Goodhouse, is therefore more convenient to use as postal and provision centre. Bitterfontein, the present terminus of the railway from Cape Town, is 180 km from Springbok and connected to the latter by Road Motor Service. This road is in the course of being tarred (1968).

Pofadder, the nearest village for the eastern portion of the area, lies 58 km south of Onseepkans and is situated about halfway between Kakamas, the nearest railhead, 153 km to the east, and Springbok, 177 km to the west.

C. PREVIOUS WORK

Geological investigation of the area dates back to 1913 when A.W. Rogers (1915) made a reconnaissance of the general geology of Namaqualand and covered the ground west of Vioolsdrif. He described the rocks of the Neint Nababeep Plateau and correlated them with the Nieuwerust and "Malmesbury" beds of the Vanrhynsdorp area. The outliers of Dwyka tillite at Vioolsdrif were also mentioned.

A large part of the western area, between Ramansdrif and Vioolsdrif was surveyed by T.W. Gevers in 1934 at the time of the beryl boom. The results of this investigation of the economic possibilities of the pegmatites was reported on by T.W. Gevers and G.K. Joubert, with a chapter on the mineralogy by F.C. Partridge (1937). The schistose mafic lavas between Vioolsdrif and Henkries were tentatively correlated with the Wilgenhoutdrif Series as they apparently lay stratigraphically above meta-sediments of the Kaiing Series. Both these Series form part of the Kheis System. Ancient post-Kheis intrusives were divided into an older group comprising ultramafic to dioritic bodies intruded by widespread biotite-hornblende granite, and a younger group including the "Younger Namaqualand granite-gneiss", with accompanying more siliceous granitic intrusives. The profusion of pegmatites was ascribed to this younger group. Various kinds of mafic to syenitic dykes of pre-Nama age were recognised and briefly described.

The area between Goodhouse and Pella was surveyed and reported on by C.B. Coetzee (1941). He established a relationship, based on chemical analyses, between the Archaean granites of Port Shepstone, Camperdown in Natal and Hlatikulu in Swaziland with the younger Namaqualand granite and between the older Namaqualand granite and the Archaean granites of the Transvaal. He accounts for this by postulating two periods of granite intrusion, one in the Transvaal and the other in Namaqualand-Natal-Swaziland.

The results obtained from a quantitative microscopic investigation of a number of samples of granite collected along the road from Garies to Vioolsdrif were given by M. Mathias (1940). The Namaqualand granite-gneiss was correlated with the younger Cape granite. Doubt was cast on this correlation by Gevers (1940) who pointed out that whilst the younger Cape granite is intrusive into the Malmesbury Series, the Namaqualand granite-gneiss is not intrusive into the Nama beds of the Steinkopf and Neint Nababeep plateau which are correlated with the Malmesbury beds. He mentioned, however, that there is still some doubt as to certain beds

described as Nama.

A. Poldervaart and J.W. von Backström (1949) published a monographic study of the geology and petrology of the Kakamas area, which lies about 128 km east of Onseepkans. Some of the rock types are identical to those of the area under description since the Kakamas area is also composed of regionally metamorphosed Precambrian sedimentary rocks of the Kheis System. They are intruded by gabbro, granodiorite, charnockitic adamellite and pegmatite, and comprises a series of pitching synclines and anticlines.

Both the present authors published detailed monographic studies of large areas situated within the Orange River valley in which many of the rock types, now under discussion, are described. In his memoir on the Keimoes area, which lies about 160 km east of Onseepkans, Von Backström (1964) describes Kaiing sediments of the Kheis System which have undergone large-scale metamorphism, in many places yielding a wide variety of schist, granulite and gneiss, indistinguishable from the Namaqualand rocks. Likewise De Villiers and Söhnge (1959) in their memoir on the Richtersveld which adjoins the present area in the west, have given descriptions of most of the rock-types which occur within the confines of the territory here described.

D. PRESENT INVESTIGATION

1. Distribution of Work

The mapping was undertaken by Drs. J. de Villiers, J.W. von Backström and D.J.L. Visser and by Mr. P.G. du Plessis. The portion of the map for which each contributor is responsible is shown on figure 1.

This Explanation was compiled by Von Backström on the basis of his own work and reports written by De Villiers, but no distinction is drawn in the text between individual contributions, for which both authors take joint responsibility.

2. Base Maps

Mapping on a scale of 1:50 000 was first started in 1941, employing plane-table methods. When aerial photographs on a scale of 1:25 000 became available early the following year, the entire area was remapped on the new scale and the task completed.

The following methods were employed to transfer the data from the loose photographs to a 1:50 000 trigonometrical plot.

1. The geology was transferred pantographically to a block plot, constructed with the help of slotted templates. The plot showed the principal and pass points of all photographs. This method, used for the area west of Vioolsdrif to counter the large elevation differences of the Neint Nababeep plateau, gave the most accurate results, but is very tedious.

A_____J. de Villiers
B_____D.J.L.Visser
C_____J.W.von Backström
D_____P.G.du Plessis

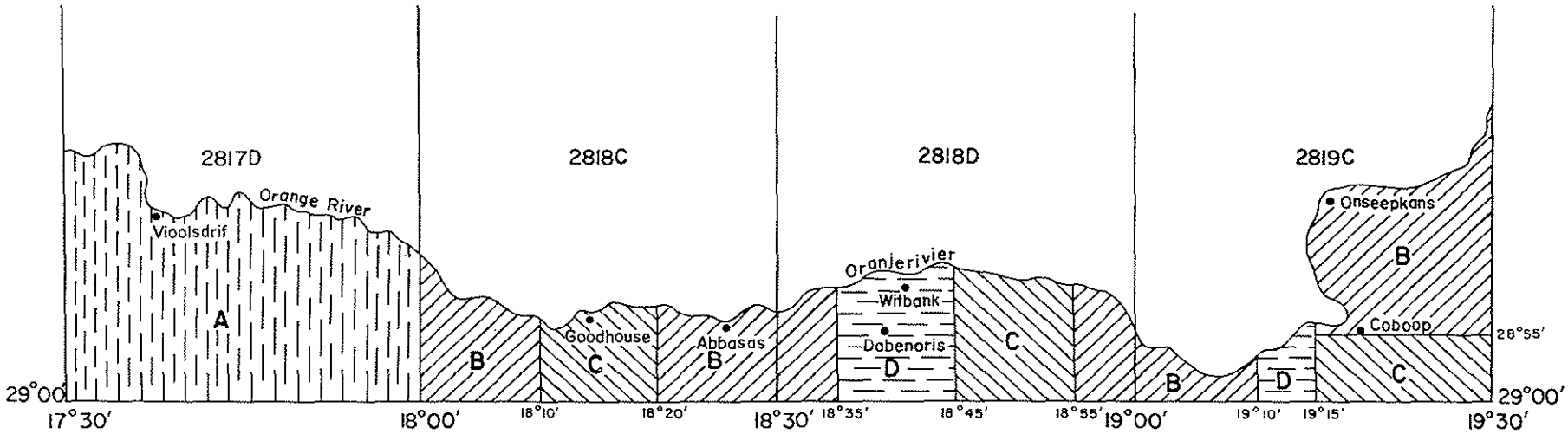

Fig.I. Sketch-map of areas mapped by individual geologists

Sketskaart van gebiede deur indiwiduele geoloë gekarteer

2. Uncontrolled aerial photograph mosaics were made and the geology marked in, before being transferred by pantograph to the trigonometrical plot. In areas of low relief this method worked well, but in rugged terrain the uncontrolled mosaic was often inaccurate.

3. The geology was transferred pantographically to the trigonometrical plot, on which fixed points previously marked on the loose photographs and surveyed, had been plotted. This method gave very satisfactory results.

Place names on the geological sheets were obtained from existing topographical maps and from the local inhabitants.

II. PHYSIOGRAPHY

A. SURFACE RELIEF

The area is one of marked but very variable surface relief. The most striking single feature is the deeply incised gorge of the Orange River, which forms the northern boundary.

In the area east of the Neint Nababeep plateau true mountain ranges, in the accepted sense of the word, are not encountered. The mountainland consists of a gigantic jumble of bare peaks and boulder piles, without either system or arrangement. Those formed of the grey gneissic granite give the impression of being piles of loose boulders, while those carved out of the sheared lavas are sharp and jagged, with knife-edge ridges joining individual peaks. Conspicuous among these peaks are those composed of the old mafic rocks such as the mountains bearing the Viools River and the Vuurdood trigonometrical beacons and the group of peaks between them. These often weather into nearly perfect conical masses, with black crowns and streams of black talus down the steep lower slopes, looking for all the world as if tar had been poured on the peak and had then formed runnels down the mountain sides before congealing (plate 1).

West of Vioolsdrif this mountainland flattens out appreciably and is abruptly succeeded by the Neint Nababeep plateau, formed by nearly horizontal strata of the Nama System. Bounded everywhere by a steep escarpment, this plateau is gently synclinal in general structure with the axis of the syncline pitching northwards at a low angle. It is a bare, inhospitable tract of country with the flat surface either rock-strewn or, where underlain by limestone, carved into miniature karst by wind and rain. The drainage channels on the level portions of the plateau are shallow depressions; they plunge over the precipices of the encircling escarpment in high waterfalls, which have frequently migrated upstream, leaving deep precipitous gorges incised into the plateau.

Between the steep-sided mountains dry stream-beds meander, the larger of which are sand-filled and often have their sources in wide sandy plains. The most prominent of these are the Kouband River (plate 2), the Henkries River valley, also known as the Koa Valley, and Noncaip-se-Leegte. At least a dozen or more similar smaller sand-filled valleys

occur throughout the area and reach the Orange River at irregular intervals. The Henkries valley is comparatively straight, open and broad and affords a very fine example of a fairly deep valley more or less completely drowned in debris. Isolated inselbergs, representing the summits of irregularities on the drowned floor, project through the sand. For the last 6 km the rapidly descending floor of the valley contains a number of distinct limestone terraces. All these valleys, drowned in rock débris and sand, have a distinct slope from the more elevated tract to the south, the great peneplain of Bushmanland, down to the Orange River. In the south-eastern portion of Sheet 2819C this slope is more or less completely sand-covered, being the western extension of the great tracts of Bushmanland. Noncaip-se-Leegte, already mentioned, occupies the greater portion of this region. It is drained by the dry Coboop River, south of which a veritable forest of kokerbome (Aloe dichotoma) is found growing on the sandy plain. A large number of residuals project as "inselberge" through the cover of sand along these drowned valleys.

North-east of Pella Mission, the Pellaberg builds a very prominent range which at Pella II trigonometrical beacon (1208 m) stands approximately 900 m above the Orange River, situated 8 km to the north.

B. CLIMATE AND DRAINAGE

The climate of the area is healthy and may be described as arid or of semi-desert type. Close to the river in areas enclosed by precipitous mountains it becomes excessively hot during the summer months, the heat being oppressive from November to March. In the summer there is a marked difference between day and night temperatures, the nights being mostly cool due to cool winds blowing along the river canyon during late afternoon after the oppressive heat of the day. During winter the climate is mild and due partly to the low humidity of the atmosphere the evenings get decidedly cold.

The only meteorological stations covering the area are situated at Goodhouse and at Pofadder, which lies outside the Orange River Valley and some 13 km south of the 29th parallel which forms the southern border of the area.

The following table* gives some of the temperature normals:

Name of Station	Mean maximum temperature	Mean minimum temperature	Highest mean temperature	Lowest mean temperature	Absolute maximum temperature	Absolute minimum temperature
Goodhouse	31,7°C	14,9°C	39,6°C	9,3°C	47,8°C	-1,1°C
Pofadder	25,9°C	10,9°C	32,2°C	4,0°C	40,8°C	-3,3°C

*Data supplied by Weather Bureau, Department of Transport.

The rainfall along the entire section of the Orange River covered by the two present sheets is very low, as can be seen from the following table:-

Name of Station	Number of years of observation	Average number of days of rain	Max. annual rainfall mm	Min. annual rainfall mm	Average annaul rainfall mm
*Goodhouse	21	26	136,4	15,4	54,6
Schuitklip	7	12	224,4	3,8	95,5
Pella	66	13	242,5	9,4	77,5
Pofadder	13	15	222,7	25,4	98,8

There is a slight increase in the rainfall as one proceeds eastward along the river canyon from Goodhouse past Pella to Schuitklip just off the eastern border of the map, and also as one leaves the highly dissected area along the river. For the area as a whole, however, the annual precipitation is well below 100 mm.

In summer, thunder conditions may arise in the interior, and then restricted areas may receive more rain in an hour than they usually receive in a year or more.

In spite of the low rainfall, the drainage pattern of the area is remarkably well established and integrated, and obviously owes its inception and development to much wetter conditions. The Orange River is the master stream. The 152,5-m contour crosses the river just upstream of Modderdrif and the 30,5-m one just downstream of the in-fall of the Coboop River. The distance is 200 km, which gives the river an average fall of 0,61 m per km. The drop between the Coboop River in-fall and Styrkraal on the Orange River at the eastern edge of the map, is probably greater, as the Ritchie Falls is developed just below Onseepkans. Rapids are of fairly frequent occurrence but islands are rare. The largest are Martin and Krapohl islands opposite Witbank and a series of small islands above Onseepkans.

All drainages are tributary to the Orange River. The largest of these are, from west to east: the Dabbeam Aoub with its tributaries the Saap Xuaap and Tc Cowiep; the Viools River with its tributaries the Kowiep, Kosies and Koubank Rivers; the Nous River; the Uranoop River; the Henkries River with its tributaries the Koa and Brak Rivers; the Goodhouse, Ramansdrift, Hom, Abbasis and Kabis Rivers which are all autochthonous; the Hartebeest River; the Pella River and the Coboop River. None of these contain permanent running water. Between Styrkraal and Vioolsdrif, where the northern bank flattens out, the Orange River flows in a deep canyon with very precipitous walls which have been highly dissected by deep tributary canyons to form innumerable marginal ravines down which the above-mentioned rivers and their tributaries flow.

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*Data supplied by Weather Bureau, Department of Transport.

Subsequent to their formation a large number of these tributary valleys have been drowned in their own débris and windblown sand.

C. VEGETATION

The country is practically devoid of vegetation except for widely scattered low bushes and certain xerophitic plants which manage to survive in the hot, arid climate. The great variety of succulents has for many years attracted the attention of botanists who have described many new species from this area.

It is not proposed to list here the numerous types of succulents of which the Mesembrianthemum, Stapelia, Gasteria, Haworthia, Anacampseros and Crassula are the most common.

The banks of the Orange River are marked by a border of green trees which contrasts sharply with the bare sandy flats and dry rocky mountains so characteristic of the area in general. The indigenous bush includes both evergreen and deciduous types of which the most important are: Kameeldoring (Acacia giraffae), soetdoring (Acacia karroo), karee (Rhus lancea), ebbehout (Euclea pseudebenus), wildevy (Ficus cordata), wag-'n-bietjie (Ziziphus mucronata), langdoring (Acacia robusta), witdoring (Acacia litakunensis), noorsdoring (Euphorbia pulvinata), ghwarrie (Euclea undulata) and swarthaak (Acacia detinens).

Various of the above types are found along stretches of the dry river courses. Isolated trees on the sandy plains occur but rarely.

Voëlent (Lorathus oleaefolius) is very common on many of the larger trees and various climbers such as mossietou (Helichysum argyrosphaerum) and boontjierank (Pergularia gariepensis) are found along the river.

Various shrubs and wild tobacco grow wherever the sandy river courses contain a little moisture. The most important shrubs are: driedoring (Rhigozum trichotonum), asbas (Psilocoiton absimile), brosdoring (Lycium salinicalum) and gannabos (Salsola tuberculata).

Various types of melkbos were encountered, such as Euphorbia glaucella, Euphorbia mauritanica and the tall Euphorbia candelabra.

The tree aloe or kokerboom (Aloe dichotoma) is abundant throughout the area and especially, as mentioned previously, along Noncaip-se-Leegte where there is a veritable forest of them. Smaller types of aloe are found more rarely, the most common being Aloe broomii and Aloe hereroensis var Orpeni. The so-called "halfmens" (Pachypodum) is very rare except on the high quartzite ridges around Pella.

Although the veld is usually sparsely covered with grass, it will spring up on the sandy valley flats after a rare, good shower of rain and the following varieties are common: boesmangras (Aristida uniplumis), gemsbokgras (Aristida obtusa), steekgras (Aristida engleri), steekkweek (Aristida namaguensis), suurgras (Schmidtia kalikariensis) and klipgras (Enneapogon scaber).

In common with much of Namaqualand some of the sand-filled valleys become covered with flowers in the spring after good rains. The best known are various types of calendula such as Arctotis sp. and Gorteria corymbosa, and aandblommetjie (Lapeyrocia galadioides), but there are so many varieties that it is impossible to list them all.

D. GEOMORPHOLOGY

Comparison of erosion surfaces is rendered difficult by the presence of the ancient, re-exposed Orange River valley which, probably since the Triassic period, if not earlier, appears to have exercised a strong, modifying influence on the shaping of the major surfaces in South Africa that extend across its drainage basin.

Remnants of fossil topography of various ages are wide-spread. The oldest adjoin the Nama beds of the Neint Nababeep plateau and represent a now very much distorted surface that may be termed the sub-Nama surface. East of this plateau the basal Kuibis beds lie on a comparatively even plain that is being destroyed almost as rapidly as the Nama cover is eroded away. West of the plateau, the Kuibis quartzite, tilted steeply to the east, is severely dissected and near Modderdrif rapid destruction of the sub-Nama surface has likewise occurred. Farther south, away from the Orange River, occasional peaks and domes of the basement formations project upwards into the Kuibis. It is concluded that the pre-Nama topography consisted of a peneplain with occasional monadnocks and low ridges indicating maturity in the cycle of probably fluviatile erosion. The few exhumed remnants of this surface hug the plateau tracts of the Nama beds and indications of an ancient, pre-Nama Orange River valley are completely absent.

Next in order of age is the sub-Karoo surface (Carboniferous) which was carved by glaciers and rivers and covered most of Africa south of the equator. In the north-western Cape and southern South-West Africa, however, certain peculiar features arise. According to Du Toit (1954), two directions of glacier movement meet in this vicinity, a view which is substantiated by the work of Haughton and Frommurze (1936), and Gevers (1937). In the Vioolsdrif area they recognised the presence of the so-called "red" Dwyka with a source different from that of the normal blue Dwyka.

The sub-Karoo surface on which the Dwyka Series was deposited was undoubtedly uneven in places. At present it rises gradually and evenly towards the east-northeast from Vioolsdrif (plate 3) until it attains and passes the general peak altitude of the Orange River mountain land. At Vioolsdrif itself, however, this sub-Karoo surface lies 335 to 427 m below the top of the Neint Nababeep plateau, the transition from the one to the other being a steep escarpment, while no fault could be found separating these two surfaces. It is therefore obvious that this portion of the escarpment of the Neint Nababeep plateau must be a pre-Dwyka feature, a view that has already been expressed by Haughton and Frommurze (1936). They have also found evidence suggesting that the present gorge of the Orange River through the Neint Nababeep plateau existed in pre-Dwyka times (p. 33-34).

To the north and north-west of Vioolsdrif the pre-Dwyka cliffs and

steep slopes must have extended past the western border of the area as far as the Nabas basin in the Richtersveld. It is concluded, therefore, that an ancient river valley existed in this area when the Dwyka tillite was deposited.

At Vioolsdrif the above-mentioned very marked topographical features must have prevented the free flow of the glaciers and rivers. The original surface probably sloped gently upwards away from the base of a high cliff towards the east-northeast, much as it does at present, to join the main surface that extended northwards from Bushmanland through Kenhardt and Upington to southern South West Africa.

Modification of the early Bushmanland plateau since the beginning of the Cretaceous period has been slight in Bushmanland proper, but severe along the Orange River. Following relatively slight uplift, the Orange River and its tributaries incised their courses and then later, by lateral corrosion, widened their channels and formed a coalescent surface with a downstream gradient and an inward slope on either side of the main river channel. In this manner the Orange River mountain land surface was formed, gently ascending from the river until it melts into the Bushmanland peneplain. This younger surface, which rises from 610 m near Vioolsdrif to 882 m at the Abiam trigonometrical station, incorporated at least the northern part of the Neint Nababeep plateau, but some isolated eminences survived the attack by the rivers. The incision of the rivers must have been completed by the very late Cretaceous, which date is provided by the dinosaur remains obtained from gravels in the bed of the Henkries River under the cover of later sand, as mentioned by Du Toit (1954).

After the late Cretaceous, the climate evidently became progressively more arid and the tributaries of the Orange River, if they had ever flowed continuously, now dried up completely. Lateral corrosion, therefore, was never active in these rivers, while very little incision took place later; what little was accomplished, took place as a result of periodic torrential rains and was only sufficient to keep the mouths of the tributaries free from talus and to allow their entry into the Orange River at grade, for hanging valleys are absent.

During this arid period, the deeply incised valleys became choked with rock-waste and sand, which was partly windborne. The major portion of the material was largely brought in by surface water, and deposited as fans and cones of talus and finer material at the foot of hills, from where it was further distributed and worked over. Physical weathering of the rocks probably played a major role. At present, in the upper Koubank valley, the surface is composed of coarse granite grit with remarkably little fine material. One is forced to the opinion that much of the finer material that must have been present at one time was removed by wind action and deposited elsewhere. It is probable that much of the sand now collected in dunes in the Henkries valley and Noncaip-se-Leegte originally came from such areas, leaving the coarser material behind as deflation residua.

The drowning of the old topography in coarse sand and grit explains the peculiarly sudden transition from the flat, sandy plains to the inselberge. The older hills, which were steep but had a general sigmoid profile, were buried to various depths in the sand, so that the portions projecting exhibit a convex profile. Any fans formed at the base of

GEOLOGICAL FORMATIONS

FORMATIONS			REMARKS
Alluvium, silt Wind-blown red and white sand Older sand, deflation residua, talus Surface limestone, calcrete River-terrace gravel	Early Tertiary to Recent deposits		May cover large areas but never attain a great thickness
Dolerite dykes	Post-Karoo		Age uncertain
Tillite, siltstone	Dwyka Series	Karoo System	Underlies a small area
Green shale, thin limestone, quartzite	Schwarzrand Series	Nama System	Slightly disturbed sedimentary rocks
Limestone, shale, quartzite, arkose, chert	Schwarzkalk Series		
Arkose, quartzite, shale, conglomerate	Kuibis Series		
Mafic dykes, gabbro, amphibolite, perknite			Precambrian
Granite and quartz porphyry	Richtersveld Igneous Complex		
Pegmatite			
Aplite			

Red granite grading into Pink Gneiss Namaqualand granite-gneiss Grey gneissic granite, biotite granite, granodiorite	Granites and associated gneisses		
Gabbro, diorite, peridotite, amphibolite	Mafic and ultramafic intrusives		
Metamorphosed rocks containing garnet, cordierite, sillimanite or andalusite in places	Metamorphosed rocks of uncertain origin and age	Namaqualand granite-gneiss massif	Agent of metamorphism is the grey gneissic granite
Schist, hybrid rocks, migmatite, leptite ultrametamorphosed lava, granitisation products	Metamorphosed rocks of the Wilgenhoutdrif Series		
Schist, phyllite, paragneiss, "muscovitised granite" ultrametamorphosed sedimentary rocks, granitisation products	Metamorphosed rocks of the Kaiing Series		
Basic lava, agglomerate	Wilgenhoutdrif Series	Kheis System	Relatively little altered rocks
Quartzite, metaquartzite, quartz-sericite schist, lime-silicate rocks	Kaiing Series		

these hills were soon distributed over the plain by wind and water.

III. GENERAL GEOLOGY

With the exception of small patches of Karoo strata and Recent Deposits, all the rocks are of Archaean, Proterozoic and possibly, Cambrian age. There is a great variety of lithological types. Some grade into one another and it was found impossible at times to show individual types separately and genetically related rocks were grouped together on the geological map.

In describing the geology of an area such as this, in which the geological history is long and complex and in which practically every known geological process has played its part, it was found best to adopt a stratigraphical classification based on general field relationship, community of character and mineral composition. Thus the description of the more typical rocks of the Kheis System is followed by a description of their metamorphic products. The intrusives held to be responsible for the granitisation processes are dealt with later, even though they may be considered to be at least partly contemporaneous.

In the geological table the rocks are arranged stratigraphically and are given as far as possible in their order of relative age.

IV. THE ARCHAEAN COMPLEX

A. THE KHEIS SYSTEM

1. Introduction

The oldest rocks in Namaqualand belong to the Kheis System and thus form part of the Basement Complex. Original sedimentary and volcanic features of the majority of the rocks, now overwhelmingly represented by granulite, gneiss and schist, have been more or less completely lost through regional and contact metamorphism.

For the still recognisable rocks, the threefold classification of the Kheis System, as introduced by Rogers (1910, p. 93-104), has been adopted.

His Marydale "Beds" include both sedimentary and volcanic rocks, the latter comprising both acid and basic varieties.

The Kaiing "Beds" consist of sedimentary rocks only, mainly quartzite and quartz-sericite schist interbedded with thin argillaceous or calcareous bands. Pelitic intercalations are biotite or chlorite-schist, with or without magnetite. Calcareous bands are represented by para-amphibolite, quartz-epidote schist, and various lime-silicate rocks. These Kaiing rocks appear to follow conformably on the Marydale "Beds" with which they have been intimately folded.

The Wilgenhoutdrif "Beds" consist of volcanic and sedimentary rocks,

variable amounts of silver, but none has so far yielded values high enough to be regarded as a silver ore. Recent analyses of galena specimens from several localities between the Neint Nababeep plateau and Goodhouse have given a silver content ranging from 22 to 93 g Ag per ton.

N. UNDERGROUND WATER

Away from the Orange River, which is the only perennial stream, water is scarce throughout the region. The only natural supplies are those to be found in the various ephemeral water-holes, usually depressions and hollows in the solid rock in which rain water collects and occasionally lasts for some time. The more important of these water-holes are shown on the map.

Wells and shallow pits have been sunk at many points away from the river, usually in the beds of valleys drowned by sand and rock debris. Most homesteads marked on the map have a well which invariably yields small supplies of brackish water which are barely sufficient for domestic use and some small stock.

West of the Uranoop River wells have been sunk at several points, usually in the basement rock. It is of interest that wells sunk in sheared dyke (gabbroic) material frequently yield water, as do those dug in sheared xenoliths in the grey gneissic granite.

The highly dissected mountainous tract all along the Orange River is practically devoid of springs, apart from a few weak ones in the Nama strata of the Neint Nababeep plateau.

DIE GEBIED LANGS DIE ORANJERIVIERVALLEI GELEË TUSSEN ONSEEPKANS EN DIE RICHTERSVELD

O P S O M M I N G I N A F R I K A A N S

deur

J.W. von Backström

INLEIDING

'n Gebied van 3400 km^2, wat oor 'n afstand van 240 km langs die suidelike oewer van die Oranjerivier strek en ingesluit word deur oosterlengtes 17°30 en 19°30 en suiderbreedte 29°, is gekarteer en beskrywe.

Die Sisteem Kheis is vir die eerste keer deur Rogers (1910), in die tipegebied tussen Upington en Prieska volledig ontrafel en beskryf. Sy drieledige indeling in die Serieë Marydale, Kaiing en Wilgenhoutdrif word hierin nagevolg.

Hierdie drie serieë rus in bogenoemde volgorde konkordant opmekaar en is aldrie ingedring deur die grys-granietgneis.

Beskrywing van die geologie van die Oranjeriviergebied in Namakwaland is gegee deur Gevers, Partridge en Joubert (1937) en Coetzee (1942).