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THE GEOLOGY OF THE COUNTRY AROUND PORT ALFRED, CAPE PROVINCE

AN EXPLANATION OF SHEETS 3326D (PORT ALFRED) AND 3327C

by

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Met 'n opsomming in Afrikaans onder die opskrif:
DIE GEOLOGIE VAN DIE GEBIED RONDON PORT ALFRED,
KAAPPROVINSIE

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I. INTRODUCTION

Sheets 3326D (Port Alfred) and 3327C lie south of the parallel $33^{\circ} 30'$ and east of the meridian $26^{\circ} 30'$, forming a triangular area bounded by the sea. Together they are about 338 square miles in extent.

The village of Bathurst is situated at the middle of the northern boundary while Port Alfred, at the mouth of the Kowie River, lies near the midpoint of the coast-line. Most of the area falls within the Bathurst Division but a small portion in the northwest is in Albany and that part lying west of the Bushmans River lies in the Alexandria Division.

A strip about ten miles wide running from north to south along the western margin of the area was mapped by Haughton (1928) as part of Cape Sheet No. 9 on the scale of 1,600 Cape rods to the inch, but this work has been revised. Apart from a traverse of the coastal rocks between Kowie River mouth and Salt Vlei and also to the Kleinmond River by G. F. Gilfillan (1870 and 1871) in connection with a search for coal, no other mapping appears to have been done. A few references to geological features in the area have, however, been made by other writers as well and will be mentioned in the appropriate places.

The present survey was carried out intermittently between 1935 and 1957.

II. PHYSIOGRAPHY

A. TOPOGRAPHY

The coast-line is fairly straight and runs in a direction 25° south of west from the mouth of the Great Fish River almost to Cape Padrone. While there are no very well defined bays the coast-line is broken up by a series of small capes the most distinct of which, from east to west, are Great Fish Point, the Three Sisters, Riet Point, Kowie Point, Kenton Rocks and Kwaaioek where the Diaz Cross replica stands. The rivers have no wide estuaries and have little effect on the coast-line, and the rocky points which tend to diversify the coast-line are not prominent. The coast is backed throughout by bare sand dunes which reach a maximum width of somewhat less than a mile and a maximum height of about 200 feet.

The topography offers no simple pattern and the only general feature is the existence of what has been termed the coastal plain or coastal peneplain, which is an extraordinarily plane surface sloping at a small angle towards the sea. It is partially buried by hills of superficial material and is also dissected to a fair extent by a number of important river-valleys.

The hills are irregular in shape with a tendency towards elongation parallel to the coast-line and rise in a somewhat fortuitous manner to various heights above the coastal plain. The highest point with an altitude of 1,117 feet, is at the Belton trigonometrical beacon near the northwestern portion of the area on a short ridge running east—west; but this is only about 250 feet above the peneplain or general level of the country thereabouts. About 8 miles to the east on what might be regarded as originally a continuation of the above-mentioned hills is the beacon Lombards Post at 1,007 feet and here again there is a relatively short ridge. The hills on Lombards Post (A. 1) are separated from those on Belton (A. 1) by the valley of the Kariega River and are cut off in the east by the Kowie River. They may well be considered to continue again in the hills north of Bathurst which, however, lie mostly just outside the area.

Although not quite so high, the beacon on Nanqua's Kop near the southwest corner of the map is more conspicuous at 980 feet above sea-level because it rises about 800 feet above the peneplain. This prominence forms portion of the coastal hills which also rise to 636 feet at the Glendower nautical beacon 5 miles west of Port Alfred, and to 500 feet at the Groenfontein beacon about 6 miles east of Port Alfred. These hills are not uniformly high but nevertheless form a fairly continuous range up to a mile or two inland behind the present-day sandhills.

B. DRAINAGE

A number of rivers enter the sea along the coast-line of this area. From east to west they are the East Kleinmond or Wellington, the West Kleinmond or Lynedoch, Riet or George, Rufans, Kowie, the Salt Vlei, Kasuka (Kasouga), Kariega, Bushmans and Richmond (Boknes or Brak) Rivers. As will be observed from the map both the Kleinmonds, the Kowie, the Kariega, the Bushmans and the Richmond River rise outside the area, the others all within the area. Only the larger rivers keep their mouths open continuously and are tidal for some distance, viz. the Kowie for 12, the Kariega for 11, and the Bushmans for 19 river miles, whereas the smaller rivers possess a lagoon which is generally cut off from the sea except after heavy rains, when it becomes open to the sea. The larger rivers, too, have meandering courses, except for the last 3 or 4 miles of the Bushmans River which is almost straight. These meanders are generally incised into the coastal peneplain and give rise to places of attractive scenery. The most striking meanders occur at the Kariega River and are known as the Serpentine (plate I), but they are cut only in an alluvial deposit and not in the coastal plain. They are situated 5 river miles up the Kariega River where a mere 20 yards separates two portions of the course, but unfortunately no complete view of this winding course is possible except from the air. Other beautiful views are provided at the Horseshoe Bend on the Kowie River about 3 miles southwest of Bathurst village and at the Lookout on the Kariega River about a mile above the Serpentine.

Striking also is the view from the Lookout to the north where the Kariega River is seen to emerge from a gorge cut into the quartzite below the coastal plain (plate II). Here the plain carries virtually no sediments and consequently offers a remarkably even skyline. The plain is about 400 feet above sea-level and the floor of the valley is scarcely above sea-level and a very little distance from the tidal limit. In general the width of the meanders is proportional to the length of the river so that the widest meanders are to be found on the Bushmans River, but on that portion of the Bushmans River falling within the area the width of the meanders is rarely as much as a mile, a figure not much in excess of that for the Kowie and Kariega Rivers.

The depth of incision also depends upon the size of the river. Upwards from a river-mouth the level of the coastal plain rises more rapidly than the river-bed until in the middle course maximum difference of height is attained and beyond this the two levels begin again to approach one another. Within the area of the map the greatest incision can be observed near where the Bushmans River enters the area. Here the general country-level is at about 950 feet and the river-bed about 150 feet above sea-level giving a drop of 800 feet with quite precipitous valley-sides. Incision by the Kowie and Kariega Rivers scarcely exceeds 500 feet.

C. VEGETATION

The coastal bush generally gives way inland fairly suddenly to grassveld, especially on the coastal plain, whereas the somewhat lower-lying areas are covered with scattered bush or scrub. The coastal hills are also generally grass covered but often have a patch of bush on the seaward side. The river-valleys are mostly densely wooded or even forested but very restricted in width. In the extreme southwest corner, a relatively large patch of forest surrounds the Nanquaskop beacon and represents an outlying patch of the Olifantshoek Government Forest Reserve.

III. GEOLOGICAL FORMATIONS

The geological formations encountered in the area are:—

Late-Tertiary to Recent	{	Wind-blown sand, soil and weathering residues, alluvium and river-gravel, unconsolidated beach-deposits
		Semi-consolidated sand, calcareous tufa, calcareous sandstone
Tertiary System.....	Alexandria Formation	{ Massive, crystalline limestone, sandy limestone and minor pebble-beds
Karoo System.....	Dwyka Series.....	Tillite
Cape System.....	{	Witteberg Series..... { Sandy, micaceous shale with thin quartzite bands
		Quartzitic sandstone with thin bands of shale
	Bokkeveld Series.....	{ Sandy, micaceous and carbonaceous shale with a few sandstone bands

IV. CAPE SYSTEM

A. BOKKEVELD SERIES

As will be seen from the map, the Bokkeveld Series forms three broad strips separated by strips of Witteberg Series and the largest of these is at the southwest corner of the area. Apart from local pitching there is a distinctly uniform regional strike at about E.20°S. The rivers are not particularly well adapted to structure so that these three areas only roughly correspond to the drainage-basins of the Bushmans, Kowie and Kleinmond Rivers. Nevertheless the shale has a strong tendency to occupy slightly lower ground than the more resistant quartzite.

Since there is no evidence of Table Mountain Series in the area, the base of the Bokkeveld Series is nowhere exposed and, owing to the absence of any recognisable markers within the sequence and to the high degree of folding over most of the area, it is impossible to ascertain what amount of the series is actually represented. There is no difficulty in drawing a fairly sharp margin between Bokkeveld and Witteberg if the base of the Witteberg is taken as the first occurrence of massive quartzitic sandstone upwards in the succession. There are some quartzitic sandstone zones in the Bokkeveld but they are of no great thickness and their association with great thicknesses of shale distinguishes them from the Witteberg quartzite which does not appear to include shale zones more than about 20 feet in thickness. However, it is possible that the upper part of the Bokkeveld Series as mapped in this area may in reality belong to the Witteberg Series as known in areas farther to the west.

XII. WATER SUPPLIES

The area is fairly well endowed with surface supplies of water. The average rainfall for the region is 675 mm. (27 inches) per annum but the water carried by the larger rivers is derived from outside the area. The only part of the area where the rainfall drops below 625 mm. is in the Bushmans River valley in the northwest corner of the area and this is due to the increased distance from the sea without any concomitant rise in height. On the other hand the 750 mm. isohyet lies outside the area in the direction of East London. This rainfall is spread fairly uniformly throughout the year with a slight excess in the summer months, but approach to the coast almost eliminates this excess, so that the rainfall of Port Alfred is almost equal for summer and winter. There is, however, throughout the area a strong tendency towards maxima in or about October and March, a feature which the author has called the Grahamstown type of seasonal rainfall distribution.

Small farm dams are built on numerous small watercourses but the tidal nature of the larger rivers within a great part of the area precludes the use of river-water for most purposes. Indeed this has been a serious problem for Port Alfred and for the smaller settlements at Boesmansriviermond and Kenton. Until 1942 Port Alfred was entirely dependent on rain-water tanks but then a dam was constructed on the Mansfield River, a left-bank tributary of the Kowie River some four miles above Port Alfred. Although the capacity is 46 million gallons, the run-off is normally inadequate to fill it and the water in the dam becomes brack. Boesmansriviermond and Kenton have to rely on rain-water or private bore-holes.

Springs occur at the base of the Alexandria Formation along the southern margin of the occurrences around Bathurst, Lombards Post and Belton (A. 1). This includes the town spring and two others at Bathurst and a well-defined spring on Belton in the kloof between the Wilmot and Belton trigonometrical beacons. The three springs at Bathurst together probably yield about a thousand gallons an hour but this is greatly reduced in periods of drought. Small springs also occur around the margins of the fixed dunes and in many places fairly fresh potable water can be obtained at a depth of 2 or 3 feet behind the bare dunes immediately facing the sea corresponding to a level only a few feet above high-tide. Thus Axelson (1938) records the occurrence of sweet water one or two feet below the surface of the sand at the site of the Diaz Cross, and perforated drums have been sunk in the sand for campers at Kenton and Kariega River mouth. Fresh water can also be obtained at Clayton's Rocks, east of Kleinmond.

A fairly large number of bore-holes have been sunk for water. The total number drilled by Government machines is 134 and in addition a few holes have been put down privately. Only the former are tabulated owing to incomplete data concerning the private bore-holes.

No bore-holes have obtained water in the Alexandria Formation but quite a large number of the holes tabulated below have penetrated a cover of Alexandria Formation before reaching the formation listed.

	Bokkeveld	Witte- berg Quartzite	Witte- berg Shale
Number of holes (total).....	88	36	8
Average total depth in feet.....	267	239	249
Average depth at which water is struck.....	132	138	150
Average depth to which water rises.....	85	82	78
Average <i>hourly</i> yield in gallons.....	519	425	390
Per cent. of failures.....	50	14	37
Per cent. of holes deeper than 300 feet.....	43	28	25
Per cent. of deep holes striking water above 300 feet	17	19	12
Per cent. of deep holes striking water below 300 feet	3	6	—
Per cent. of deep holes blank.....	23	3	13
Per cent. of holes brack.	29	3	0
Per cent. of holes brackish.....	40	16	0

The deepest bore-hole sunk in the area is 509 feet deep on the farm Crown Nook (A. 1) some 5 miles up the Bushmans River on its left bank. After 150 feet of sand and sandstone, the remainder of the hole passed through black shale and only 60 gallons of water per hour described as of fair quality was obtained at 303 feet.

The greatest yield obtained in the area came from The Ghio (A. 1) just above Crown Nook where 2,050 gallons was tested per hour but it was described as salt. In addition, eight other bore-holes yielded 1,000 gallons or just over, per hour in both Bokkeveld and Witteberg quartzite.

Where sandstone and shale alternate, a number of cases showed water struck on entering sandstone as though under subartesian conditions. Although water is generally struck in the sandstone or quartzite, several bore-holes record water struck in shale.