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 PORT ELIZABETH, 3325 CD & 3425 AB UITENHAGE,  
 3325 CB UITENHAGE NOORD AND 3325 DA ADDO

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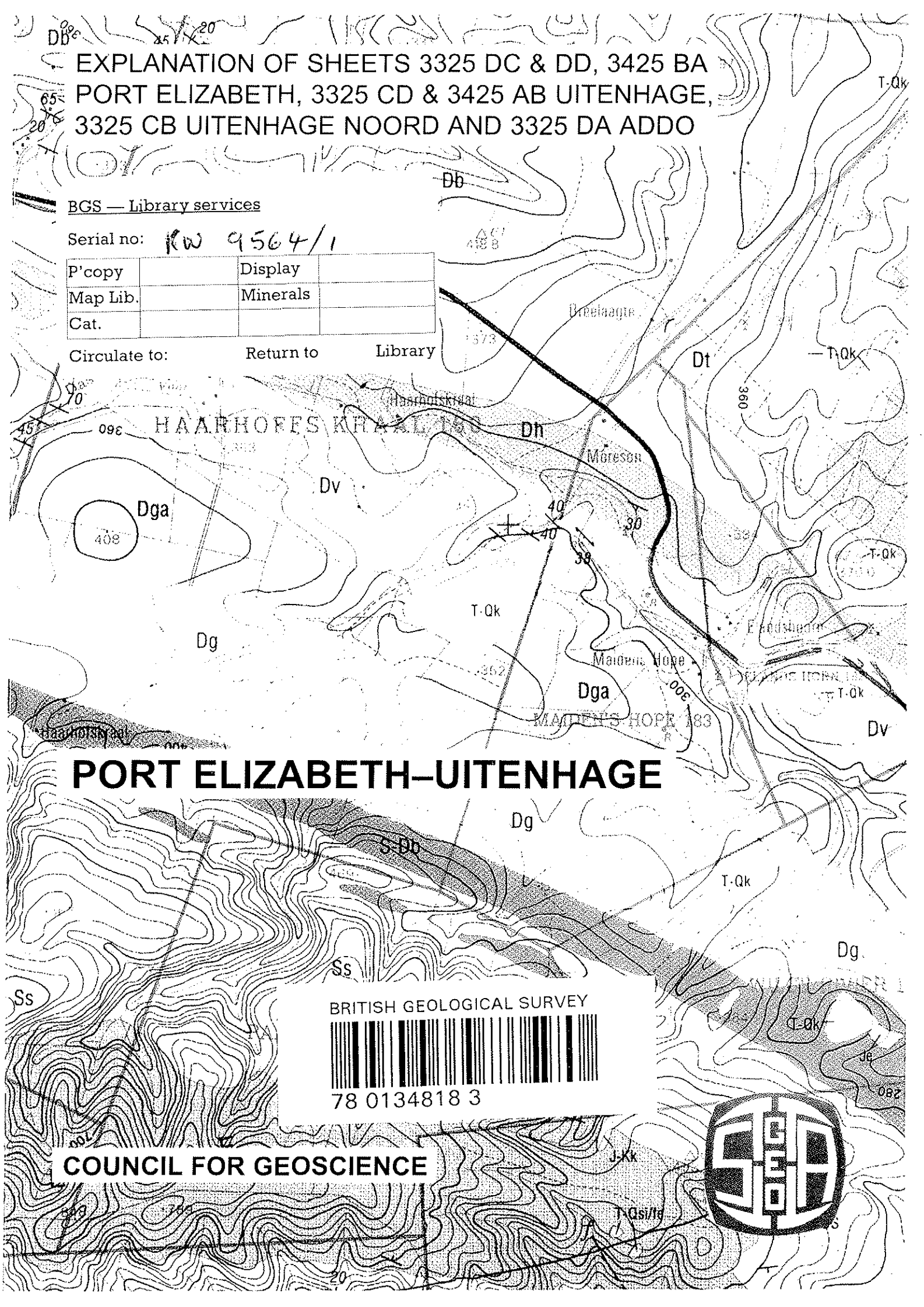
**PORT ELIZABETH-UITENHAGE**

BRITISH GEOLOGICAL SURVEY



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**GEOLOGICAL SURVEY OF SOUTH AFRICA**



**THE GEOLOGY OF THE PORT ELIZABETH-UITENHAGE  
AREA**

*by*

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**Explanation of Sheets  
3325 DC & DD, 3425 BA Port Elizabeth,  
3325 CD & 3425 AB Uitenhage,  
3325 CB Uitenhage Noord  
and 3325 DA Addo.**

**Scale 1:50 000**

2000

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## 1. INTRODUCTION

The area is bounded by longitudes 25°15'E and 25°45'E, and latitude 33°30'S and the coastline. It covers parts of the magisterial districts of Port Elizabeth, Uitenhage and Kirkwood, and includes the 1:50 000 map areas 3325 DC & DD, 3425 BA Port Elizabeth, 3325 CD & 3425 AB Uitenhage, 3325 CB Uitenhage Noord and 3325 DA Addo. Transportation lines include the following: (1) The main railway line from Port Elizabeth via Uitenhage to Klipplaat and the other via Addo to Cookhouse and the north. (2) A narrow gauge line from Port Elizabeth to Humansdorp and Patensie (The famous Apple Express Train) via the steel railway bridge over the 150 m deep gorge of the Van Stadens River just west of the western boundary of the map area. (3) A multitude of roads criss-crossing the area.

The earliest geological observations in the area, those on the Pb-Ag-Zn-Cu occurrence west of Port Elizabeth (later the Maitland Mine) were made by J. Barrow in 1797 followed by H. Lichtenstein in 1803. Arrival of the British Settlers in the 1820s stimulated development of the eastern Cape, and a number of pioneers of South African geology visited the area. Eminent among these were W.G. Atherstone, A.G. Bain and Krauss, who examined (from about 1840) the then unknown stratigraphy and palaeontology of the area, notably the Uitenhage deposits. The colony's first "Geological Surveyor", A. Wyley, investigated and reported on, inter alia, the Maitland Mine during the early 1850s. After the establishment of the Geological Commission of the Cape of Good Hope in 1895, geological mapping was initiated in the eastern Cape. Full-time government geologists, amongst them E.H.L. Schwarz and A.W. Rogers, contributed periodically (1900 and 1916) towards parts of Cape Sheet 9 (published on a scale of 1:238 000). The Cape Geological Commission was incorporated into the newly founded Geological Survey in 1912. S.H. Haughton further contributed (1921-1925) towards the final publication (1928) of Cape Sheet 9. In the course of his investigation of the limestone resources of the Union, the area was also visited by Wybergh (1920).

Thorough investigations of the fossils of the Uitenhage and Algoa sediments by Kitchin (1908), Newton (1913), Spath (1930) and others contributed towards the palaeontological knowledge of the area. In addition, many contributions to the understanding of the geology of the area have been made by teaching staff and students of the local universities and museums, of which only a few have been published.

Preliminary geophysical surveys to investigate the structure of the Uitenhage Artesian Basin have been undertaken by the Geological Survey. This mapping provided a sound foundation for later, more-detailed mapping and interpretation of the geology of the Eastern Cape.

Later geological maps on scales of 1:125 000 (Engelbrecht *et al.* 1962) and 1:250 000 (Toerien and Hill 1991) cover the area. These maps were upgraded for the present 1:50 000-scale maps.

Geological successions in the map area belong to the Gamtoos Group, Cape Supergroup (Table Mountain Group and Bokkeveld Group), Uitenhage Group and Algoa Group. Younger (Cenozoic) sediments include river terrace gravels, spring deposits (Amanzi Formation), lacustrine deposits, calcrete, silcrete/ferricrete, scree, pedogenic soil profiles, alluvium and modern land-fill material. (See Legend on maps).

## **2. PHYSIOGRAPHY**

### **2.1. RELIEF**

The gently seaward-sloping (inclination  $< 2$  degrees), stepped, Neogene coastal plain covers more than half the map area. Various drainage systems have carved relatively wide and deep valleys on the more easily erodible bedrock of the Uitenhage Group in the Algoa Basin (Fig. 2.1).



**Fig. 2.1 – Neogene coastal plain exposed along the horizon near Amsterdamhoek. The Swartkops River, responsible for the broad valley in the foreground, flows seaward at the base of the distant cliffs.**

The highest point of this coastal plain is situated above 330 m a.m.s.l. The plain slopes to the southeast and almost reaches sea level in the vicinity of the Swartkops River Mouth. In a few places, e.g. Coega Kop 316, older rocks protrude through the Tertiary sediments that cover the plain. This almost

featureless landform contrasts sharply with the high, rugged, mountainous terrain in the northwestern part of the map area, produced by intensely folded and erosion resistant bedrock of the Cape Supergroup. West of Port Elizabeth, the ancient dunes of the Nanaga Formation form an undulating topography which breaks the monotony of the Miocene marine platform on which it is developed.

## 2.2 DRAINAGE

From west to east, the Maitlands, Baakens, Papkuils, Swartkops, Coega and Sundays Rivers are the most important drainage systems. Of these, the Maitlands and Coega Rivers are choked by wave-built sand bars, resulting in blind river mouths which are breached only after heavy rains in the catchment areas.

### 2.2.1 Maitlands River

The Maitlands River originates on the coastal plain southeast of the Lady's Slipper and flows in a deep, steep-sided valley towards the sea.

### 2.2.2 Baakens River

The valley of the Baakens River is also engorged and has a steep gradient in the upper reaches. The river flows in a general eastward direction from its origin towards the mouth.

### 2.2.3 Papkuils River

The valley of the Papkuils River is fairly deep and steep with a high gradient where it cuts into the Table Mountain Group quartzites. It opens up and loses gradient on the sediments of the Uitenhage Group. A characteristic feature of this part of the area is the escarpment of Table Mountain quartzite striking in a general east-west direction. The escarpment reaches a height of about 100 m above the floor of the Swartkops River Valley, and is probably related to that river system. The Papkuils River and its tributaries have carved deep valleys in the quartzite, exiting along this escarpment.

A possible case of stream capturing occurs in the vicinity of Herenvale. A tributary of the Papkuils River that flows in a northeasterly direction through the Grootkloof, abruptly changes its course towards the southeast as it reaches the Uitenhage Group sediments. Between the sharp curve of this stream and the southeastern point of Bethelsdorp Salt Pan, a shallow depression occurs, suggesting that the stream had previously flowed into the pan. A palaeotributary of the Papkuils River has apparently cut back eastward along the foot of the escarpment of Table Mountain quartzites and captured the stream flowing into the pan, diverting it seaward.

#### 2.2.4 Swartkops River

The two main streams of the Swartkops River System, the Swartkops and Chatty Rivers, are both permanent and join together near Redhouse (sheets 3325 DC & DD, 3425 BA Port Elizabeth). No important tributaries join this system. The valley slope on the northern side of the Chatty River is steep and sharp and reaches a height of about 55 m above river level at Redhouse. It is composed of Uitenhage Group rocks and is covered by a thin layer of Cenozoic deposits. On the southern side, the valley slopes are gentle. The two streams of the system flow through a wide flood plain whereon numerous salt marshes and pans occur. The Swartkops River is tidal for a distance of about 12 km from the mouth.

#### 2.2.5 Coega River

The Coega River rises from outside the map area, is ephemeral and flows in a wide valley through the area. The valley is inordinately large compared to the size of the present river, suggesting a former period during which the river had a much larger flow than at present. The sides of the lower valley, composed of Uitenhage Group rocks, are relatively steep, but the valley floor in this region is flat and supports a flood plain through which the river meanders. No important tributaries join this river, although a number of small streams join the river from the high-lying area in the vicinity of Welbedachtsfontein 300, Grassridge 223 and Brak River SW 224 north of the Coega Valley (3325 DA Addo). A number of gravel terraces are present along the valley flanks.

#### 2.2.6 Sundays River

The main stream of this system flows through the northeastern corner of the map area (3325 DA Addo) in a wide alluvial valley. The low-gradient, meandering course and wide, alluvium-covered plain, are typical features of a mature river.

In the map area a few smaller streams join the main stream, the most important of which are those draining Kudus Kloof 117, Wolverton 130 and Coega Kammas Kloof 191. These streams and their tributaries have carved deep valleys into the coastal plain, the best examples of which can be seen at Zoetgeneugd 192 and Ebb and Vloed 230. These valleys are incised into rocks of the Uitenhage Group which, despite its highly erodible nature, forms irregular terrain as can be seen on the western bank of the Sundays River.

### 2.3 PANS

A number of pans are present in the area. The Swartkops Salt Works on the farm Saltpan 434 (3325 DC & DD, 3425 BA Port Elizabeth) forms a prominent hollow in the coastal plain. The terrain on the western side of the pan is

slightly higher than at the eastern side and a number of distinct drainage courses entering the pan from the north and northwest can be recognised. A possible explanation for the development of the pan is as follows: During the Neogene at least three distinct marine terraces were carved at different elevations in the land surface. Following marine planation of the oldest (highest) terrace, a small drainage system, discharging into the sea, developed on the terrain now occupied by the Swartkop Salt Works. The stream mouth was probably an estuary, blocked by a sand bar. Since the streams periodically entering the sea through the estuary were likely small and weak, the mouth survived after the sea regressed completely. The estuary was never eroded by downcutting to the new base level because the streams feeding the estuary were captured by larger downcutting antecedent drainage systems such as that of the nearby Coega River. The estuary thus survived as a pan in a localised drainage system.

A number of smaller pans are present on the coastal plain nearby, especially on the farms Coega 313 and Coegas Kop 316. These pans are probably related to palaeodrainage systems which, in turn, are related to those of the Swartkop Salt Pan. Most of these pans are interconnected via shallow depressions. Similarly, immediately south of the Markman Industrial area, some pans, underlain by impermeable Sundays River Formation, are forming where solution and pedogenesis of the calcareous Alexandria Formation has reached an advanced state due to capture of drainage between linear palaeobeach berms.

Further south, in the vicinity of Bethelsdorp and Cradock Place, a number of large pans occur. The largest of these is known as the Bethelsdorp Salt Pan. On its southern side it is bordered by fairly steep slopes whereas the northern side is less steep. On this side a slight depression connects this pan with the valley of the Chatty River. The pan may therefore represent the position of a number of meander loops of a previous tributary of the Chatty River that were cut off when river capture by the Papkuils River occurred in the vicinity of Herenvale (mentioned earlier). All the pans along the side of the Swartkops Valley were probably originally related to the Swartkops River system.

## **2.4 CLIMATE AND VEGETATION**

The climate of the area is mild, with hot summers and cool winters. Light frost may occur. Precipitation varies from 300 to 450 mm per year in the area north of Port Elizabeth and averages 560 mm in Port Elizabeth. It is well distributed throughout the year, and falls in the form of light showers. The maximum rainfall occurs during spring and early summer.

Various vegetation regions, largely controlled by geological features, are recognised in the area (Low and Rebelo 1996):

- (a) Vegetation of the map area underlain by the Uitenhage and Bokkeveld Groups, consist largely of Mesic Succulent Thicket, e.g. the xerophitic

*Cotyledon* (plakkies), *Aloe*, *Euphorbia* (melkbos), *Pentzia* (Karoo bush), *Acacia* (thorn trees), *Euclea* (ghwarrie) etc. In certain areas the indigenous vegetation is displaced by *Cactus* (prickly pear) resulting in outcrop accessibility being extremely limited.

- (b) Soil, developed on the calcareous rocks of the Algoa Group, is normally shallow, sandy red-brown loam. It supports some xerophytes e.g. *Pentzia* and hard grass types.
- (c) On the plateau west of Port Elizabeth, the thin soils developed on bedrock of the Table Mountain Group are acidic and sandy, and supports Renosterveld grasses and mountain fynbos.
- (d) Dune Thicket, with grassy Fynbos, occurs on the coastal dunes. Exotic Rooikrans (*Acacia cyclops*) and Port Jackson (*Acacia cyanophylla*), originally introduced to stabilise the dune fields, have invaded extensive areas.

### 3. GAMTOOS GROUP

Inliers of metasediments of the late Proterozoic Gamtoos Group are exposed along the lower reaches of the Maitland River Valley and along the coast (Fig. 3.1) between Maitland River Mouth and Laurie's Bay (3325 CD & 3425 AB Uitenhage). This group represents the oldest known rocks in the southeastern Cape Province and is presumably Namibian in age (SACS 1980). The strata of the whole group are apparently overturned. Both the lower boundary of the group, and the upper contact with the overlying Sardinia Bay Formation of the Table Mountain Group are faulted, or unconformable. The structural complexity of the area, and poor exposures, cause uncertainty regarding thickness estimations of the lower three (of four) constituent formations present in the area. The stratigraphy, originally established by Amm (1935) and later reinterpreted by Frankel (1937) and Haughton *et al.* (1937), was recently further described by Bell (1980), Hill and Nolte (1989), and Booth and Shone (1992a). Whereas the group is characterised by calcareous and feldspathic units, phyllite is the rock type common to all the individual formations.

Rocks of the Gamtoos Group underlie a hilly terrain and upon weathering yield a typically red soil that supports dense bush. This contrasts with the sparse fynbos-type vegetation supported by the acid soil derived from sandstones of the Table Mountain Group. Strata in the Gamtoos Group display tight recumbent folds, large-scale thrusts, plastic deformation, shearing and post-orogenic faulting. The group has undergone low-grade metamorphism. Nolte (1990) recognised four phases of deformation in the Gamtoos Group.

Tankard *et al.* (1982) envisaged depositional environments ranging from an upward-shoaling marine shelf to a fluvial fan delta in a tectonically active setting. According to Nolte (1990) the carbonates probably formed in a shallow-marine environment over which alluvial fans and turbidites were deposited as basin margin uplift was accelerated. The arkosic rocks are tentatively attributed to a shallow-marine environment.

Clayey peat also occurs in the upper reaches of the Baakens River Valley in Sherwood.

## **19.9 PETROLEUM**

Oil prospecting in the Mesozoic rocks of the Algoa Basin dates back to 1908 when a 1 106-m-deep borehole was drilled at Swartkops. More recent prospecting operations, including extensive geophysical work, led to the drilling of 21 deep boreholes during the late 1960s and early 1970s, both in and outside the mapped area. Oil shows were encountered in two of these, both in and not far above the Colchester Member of the Kirkwood Formation. Production tests were negative (Winter 1973).

## **19.10 LEAD, SILVER, ZINC and COPPER**

Galena and associated silver, zinc and copper minerals occur in limestone of the Kaan Formation (Gamtoos Group) adjacent to the Maitland River on the farm Maitland Mines 478 west of Port Elizabeth. It is probably the first occurrence of lead prospected in the country and records exist of an analysis dating back to 1792 (Amm 1935 and Willemse *et al.* 1944). Sporadic prospecting through the years ceased in 1931 although renewed interest has recently again been shown.

The mineralisation occurs as irregular veins and nodules of argentiferous galena, chalcopyrite, pyrite, chalcocite (or tetrahedrite), sphalerite, malachite and azurite in dolomitic limestone, which is associated with secondary calcite in fault breccia (Gray 1976).

## **19.11 UNDERGROUND WATER**

### **19.11.1 Artesian boreholes**

Artesian water was originally found in two areas of the Uitenhage Subterranean Ground Water Control Area (USGWCA). Both are bounded by the Coega fault, a known groundwater conduit. South of the fault, a well-known mineralised source of temperate (52°C) artesian water was present in the Kirkwood Formation south of Swartkops. In the Bethelsdorp vicinity, artesian water was apparently found near the contact between Bokkeveld shales and Table Mountain quartzites. Most of the artesian boreholes are present north of the Coega Fault. The one at Motherwell (Coegas Kop 316) yielded 1 820 000 litres per day when it was drilled in 1950, but has since dropped back to 96 000 litres per day. Artesian water was also encountered in three holes north of Markman Industrial area. These holes were, however, sealed since they had a negative influence on the flow of other artesian holes as far away as Amanzi Estates. On Pollockshaws (Coegas Kop 316) an artesian hole yielding almost 1 000 000 litres per day keeps a dam at the site at a constant level.

A few boreholes on Welbedachts Fontein 300, of which some are artesian and other subartesian, are recharged by water from the contact of the Uitenhage Group with quartzites of the Table Mountain Group. The well-known artesian boreholes on Amanzi Estates yield 4,5 million litres per day from Table Mountain quartzites. Artesian conditions at that locality are the result of impervious Uitenhage Group sediments covering water-bearing fractured Table Mountain quartzite (See Chapter 15).

The syncline formed by Sundays River Formation layers (especially the interlayered sandstone lenses) between the Coega and Sundays Rivers result in favourable conditions for artesian water. The water from the Sundays River Formation is, however, very salty, and may be connate.

#### 19.11.2 Other boreholes

Boreholes, abstracting water from sandy horizons in the Uitenhage Group have fair to large yields, but the water is normally brack and generally cannot be used for domestic or irrigation purposes (Meyer 1998). Boreholes in the Quaternary sediments are usually successful if the contact with the Alexandria or other older formations are encountered. Where present, the basal conglomerate of the Alexandria Formation yields low to fair quantities of water. On the high plateau, where catchment areas are small and drainage is developed to the sides, few successful boreholes have been sunk. In the Cenozoic deposits of the map area, it is recommended to locate boreholes in the valleys to minimise drilling costs and maximise catchment area.

#### 19.11.3 Springs

Permanent springs are scarce and are commonly related to joints in Table Mountain quartzites (Meyer 1998). A few weak springs, yielding salt water, are present in the Uitenhage Group, e.g. on Kentvale (Coega Kammas Kloof 191) and Eb and Vloed 230 (sheet 3325 DA Addo). A number of perennial fresh-water springs, situated on the contact between Quaternary deposits (Salnova and/or Nahoon Formations) and the Table Mountain quartzites, are present on the coast west of Skoenmakerskop. On the beach at Hougham Park (Coegas River Mouth 303), fresh water issues from the contact between the Salnova Formation and impermeable mudstones of the Sundays River Formation. Perennial freshwater fountains are also present in semi- or unconsolidated aeolian deposits (Nanaga and/or Schelm Hoek Formations), e.g. at Lovemore Park to the west of Port Elizabeth.