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An Account of the Geomorphology and Drainage of the Kruger National Park

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An outline is presented of the geomorphic history as well as the present terrain morphology and drainage of the Kruger National Park which forms part of the eastern Transvaal Lowveld. The Lowveld represents the footslope of the Drakensberg, the escarpment of which withdrew parallel from the Indian Ocean in response to the disruption of Gondwanaland. The Lowveld is typically undulating, gently undulating or flat and positive relief is caused mainly by lithological differences. The area is drained from west to east by a vast number of drainage channels, ranging from large rivers to dongas (gullies).

Key words: Geomorphology, Lowveld, geology, Kruger National Park, erosion surface, drainage pattern.

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Introduction

The present southern African landscape is the result of a complex combination of isostatic readjustments (uplifts and deformations) and glacio-eustatic oscillations in the sea-level, followed by planation processes (Du Toit 1954). These processes were initiated with the creation of the African continent in the middle Cretaceous Period when Gondwanaland, the ancient supercontinent, dismantled. The dominant process of planation in Africa is that of backward retreat of scarps formed by the incision of drainage lines and the lateral spread of the newly formed valleys (footslopes) at the expense of former erosion surfaces (King 1978). Since new erosion cycles are initiated at the coastline and along drainage lines whenever differential uplift takes place, the southern African geomorphology is typically multicyclic with relics of older erosion surfaces remaining within younger surfaces (Fig. 1).

In the eastern parts of South Africa several such erosion surfaces exist, notably the 150 million year old Gondwanaland surface which has been preserved on the plateaus of the Drakensberg in Natal and Lesotho; the early-Tertiary (African) erosion surface which forms most of the Highveld; and several phases in the late-Tertiary, including the Transvaal Bushveld, Middleveld and Lowveld. The geomorphology of the Kruger National Park (KNP) is discussed in this paper. To do this, it has, however, been necessary to view the entire region of the Lowveld as an integral geomorphological unit. Consequently areas lying beyond the KNP are also discussed in this paper.

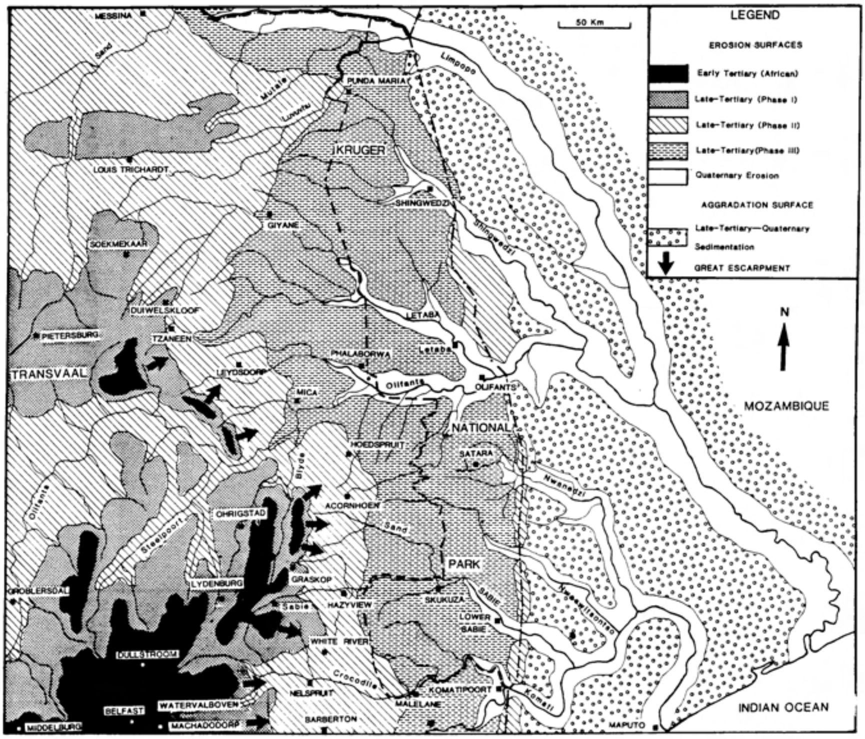

Fig. 1. Erosion surfaces in the Lowveld (after King 1963).

Geomorphic History of the Lowveld

A summary of the major geological and geomorphological events in the Lowveld is shown in Fig. 2. Data presented in Fig. 2, as well as the following account of the geomorphic development of the Lowveld, were summarised from King (1963, 1978) and Van der Eyk, MacVicar & De Villiers (1969):

a) After the disruption of Gondwanaland in late-Jurassic to early Cretaceous times, the newly formed African continent was subjected to denuding forces for more than 80 million years until the mid-Tertiary. During this time it was worn down to a flat, vast plain. Much of the overlying basalts were removed by erosion, exposing the underlying Karoo sediments and other rocks which are found in the present Transvaal Highveld.

b) Continental uplift initiated a new erosion cycle along the east coast in the Miocene. The late-Tertiary erosion is characterised by several phases of uplift and consequent acceleration of rivers and initiation of retreating scarps. The African erosion surface was completely destroyed in the Lowveld – the only relics remaining on the crest of the Drakensberg along the Great Escarpment (Fig. 1). The latter moved from east to west, leaving at its foot the Lowveld and exposing the whole range of the eastward-dipping Karoo sediments and lavas. Since the Indian Ocean lapped the eastern foot of the present day Lebombo Mountains (Du Toit 1954; Truswell 1977) the Great Escarpment must have retreated some 100 km in approximately 20 million years. Meanwhile, the eastward withdrawal of the east coast allowed for the exposure of marine sediments which form most of the Moçambique coastal plain.

c) At this stage the Lowveld had probably been bevelled to a single flat plain. The eastward flowing rivers meandered across it with no apparent influence of the strong north-south lithological control of the Lebombo belt. Subsequent gentle uplifts or eastward monoclinal tilting caused rejuvenation of rivers which enabled them to cut gorges through the resistant north-south trending rhyolites of the present Lebombo Mountains. The tectonic movements must have been very gentle since even small seasonal streams such as the Nwanedzi and Bangu had enough time to cut into the resistant rhyolites. The newly initiated erosion cycle set to work in levelling the landscape and lowering the base levels of rivers. Thus, the area to the west of the rhyolites was again incised, and several of the new drainage lines followed the main trend of the lithology, namely north-south. All sediments ever since stripped from the Lowveld, were transported through the gorges in the Lebombo Mountains. Relics of the former erosion surfaces which were preserved on the crests of the planed Lebombo Mountains and Kwandizwe Peak near Malelane, are the only evidence of a former pre-historic landscape.

d) River valley morphology in the KNP, which occasionally includes terraces, suggests that uplifting of the subregion has not yet subsided, and is of a rhythmic and gentle manner. Terraces along river banks are seldom higher than five metres and are usually similar in appearance. Gullies are occasionally seen creeping up hill slopes, even in areas with low densities of game, indicating that gentle rejuvenation of rivers is still taking place.

Terrain Morphology

The major part of the KNP can be classified as plains. On a regional scale the Lowveld forms the footslope of the Drakensberg escarpment and can be classified as a pediplain with a gentle slope towards the east. On average the Lowveld lies about 300 m above sea-level. The present terrain morphology is to a large extent determined by geological structures and differences in resistance of various rock formations against weathering.

The area underlain by granitoid rocks is characteristically gently to moderately undulating with scattered inselbergs occurring in certain areas, sometimes in clusters. The inselbergs are the result of locally higher resistance against weathering caused by dome-like structures in the granitoid rocks. In the Phalaborwa area syenite plugs have formed prominent inselbergs. Elsewhere, gabbro and dolerite intrusions have formed areas of relief. In the Malelane and Stolsnek areas incised relics of former late-Tertiary erosion surfaces have remained in the form of low mountains (Fig. 1). Along major drainage lines areas of positive relief usually occur as a result of a higher degree of incision and subsequent higher drainage density.

Sandstones and quartzites of the Clarens and Soutpansberg formations have formed rugged areas with low mountains in the Punda Maria – Pafuri area, which present some of the most scenic areas in the Kruger National Park. As the Soutpansberg rocks in the Punda Maria area persistently dip northwards, the southern mountain slopes are generally much steeper and also more precipitous than the northern slopes. Faulting is conspicuous in the mountain range and is represented by features such as high quartzite ridges terminating along a straight line, escarpments continuing along drainage lines and narrow mountain gorges. Valleys and low lying parts are usually occupied by lavas, dolerites and shales, whereas the higher ground is generally underlain by sandstones and quartzites. Low inselbergs and ridges are scattered along the main north-south trending Karoo Sediment belt which forms the divide between the basement rocks and the lavas.

The mafic lavas of the Lebombo belt have been worn down to extremely flat plains, except where they have been more deeply incised along the major rivers or where intrusive rocks of some other kind, such as rhyolite dykes, occur. Directly east of the basalt plains rise the Lebombo Mountains, a north-south trending, narrow, low-lying ridge or series of ridges. In some places it forms a prominent west-facing escarpment of up to 150 m at its contact with the mafic lavas. North of Shingwedzi the range dwindles and from Shingomene to the Luvuvhu River all that remains of what might have been a physiographic continuation of the range is a broad platform that is about 90 m higher than the adjacent plains formed by the mafic lavas. The crest of the Lebombo is usually planed and slopes gently eastwards, suggesting that it is representative of a former late-Tertiary erosion surface which has undergone gentle eastward tilting (King 1963).

In the Pumbe area the planed crest of the Lebombo Mountains is capped by unconsolidated conglomerates and coarse sands which are probably of coastal origin. These sands are continuous in an eastward direction and form most of the vast coastal plains in Moçambique. In the Nwambia area similar conglomerates and sands are separated from the underlying basalts by rocks of the Malvernia Formation. No rhyolites occur in this area. The Nwambia sandveld also forms an extremely flat plain towards the east and is presently being destroyed from the north by tributaries of the Limpopo River through active scarp retreat.

Drainage

The KNP is drained by seven large rivers (*i.e.* Limpopo, Luvuvhu, Shingwedzi, Letaba, Olifants, Sabie and Crocodile) which flow in an eastward direction, and their tributaries. Most of these rivers originate in the Drakensberg along the Great Escarpment (*i.e.* Crocodile, Sabie, Letaba and Luvuvhu). The Olifants River, however, has vigorously incised itself and by active retreat of its headwaters, cut through the Great Escarpment (Fig. 1) and retreated to such an extent that its headwaters today lie in the Highveld near Middelburg. Thus, the great divide between eastward and westward flowing streams was moved to the west of the edge of the Great Escarpment.

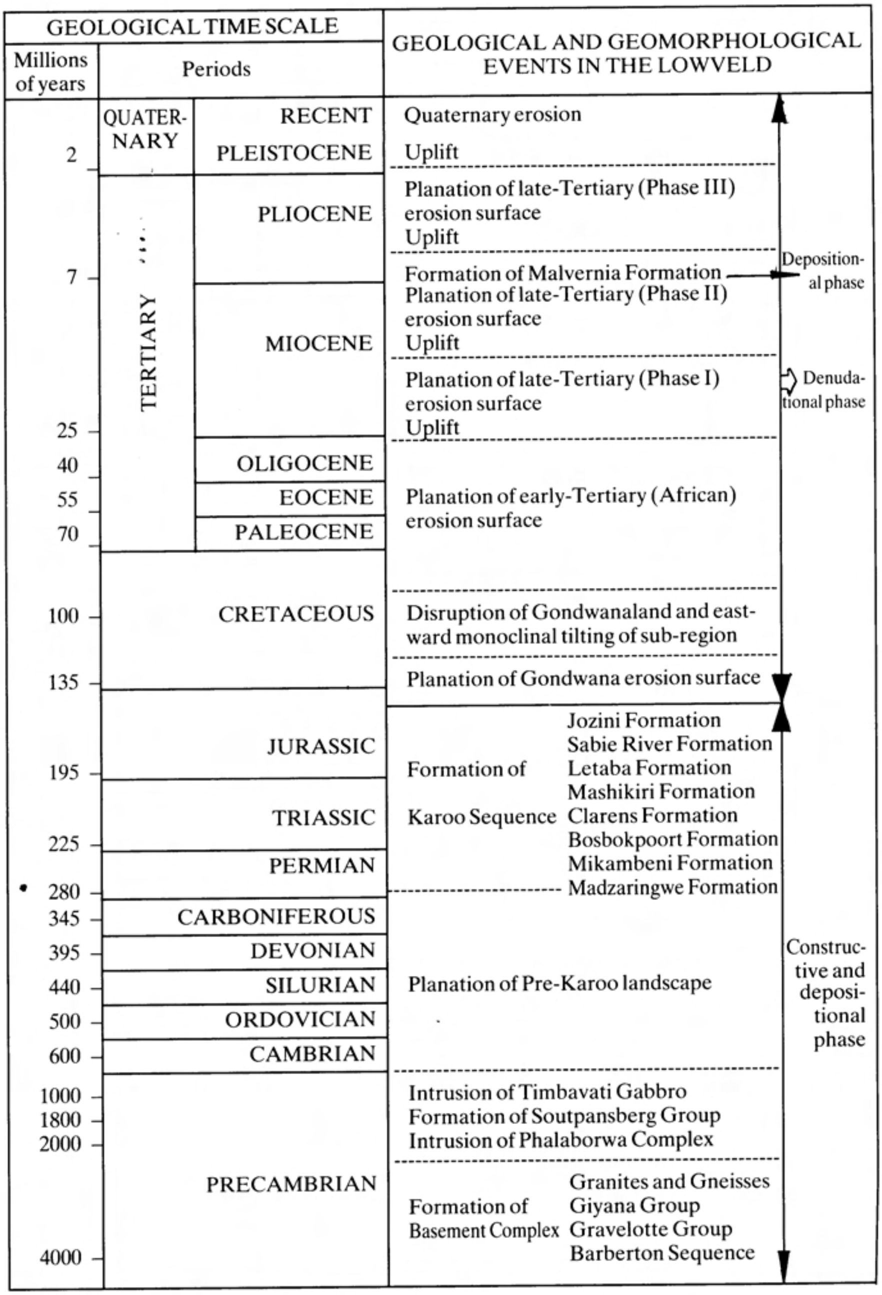

Fig. 2. Schematic representation of geological and geomorphological events in the Lowveld (adapted from Van der Eyk, MacVicar & De Villiers 1969).

A fascinating feature of the drainage is the fact that four large rivers (Shingwedzi, Olifants, Sabie and Crocodile) and two smaller seasonal streams (Nwanedzi and Nwaswitsontso) flow at right angles to the strike of the lithology through impressive gorges in the Lebombo rhyolites. The Shingwedzi gorge is nearly 35 km long. The Nwanedzi and its tributaries (Sweni, Gudzane), which are situated to the west of the Lebombo Mountains, are nothing more than the headwaters of this drainage system, since almost three quarters of the length of the Nwanedzi is to the east of the Lebombo's (Fig. 1).

The Bangu, which is a small tributary of the Olifants River, originates on the basalt plains and flows in a north-easterly direction towards the Olifants. Where it meets the escarpment formed on the western side of the rhyolites, instead of swerving alongside the rhyolites, it plunges into the Lebombo Mountains and follows a deeply incised gorge for some 8 km before it joins the Olifants River gorge. With the Bangu joining the Olifants in a series of waterfalls, the confluence of these two rivers displays a typical example of a discordant junction.

These drainage features clearly belong to a former, different topography which was associated with a former erosion surface. The planed crests of the Lebombo in certain areas (sometimes capped with unconsolidated conglomerates and sands) suggest that a much more extensive erosion surface at this level existed in prehistoric times (Fig. 1), probably in the Pliocene or earlier, which enabled drainage lines to entrench themselves and these drainage patterns were thus superimposed on the present topography (King 1963).

Drainage densities of small consequent drainage lines are typically three to four times higher in the western granitic areas than on the basaltic plains (Fig. 3). In the former area they have fine dendritic patterns, whereas on the basaltic plains they usually display medium to coarse rectangular patterns. The majority of the streams are ephemeral, only carrying water during summer months.

Trellis drainage patterns occur in the Lebombo Mountains and are the result of the tendency of drainage lines to follow parallel dolerite dykes or interbedded mafic lavas which occur in the resistant rhyolites. A deranged pattern of pseudo drainage lines (elongated depressions) of extremely low density is found in the Nwambia sandveld as an occasional linkage between some of the many pans occurring in this region (Fig. 3).

Acknowledgements

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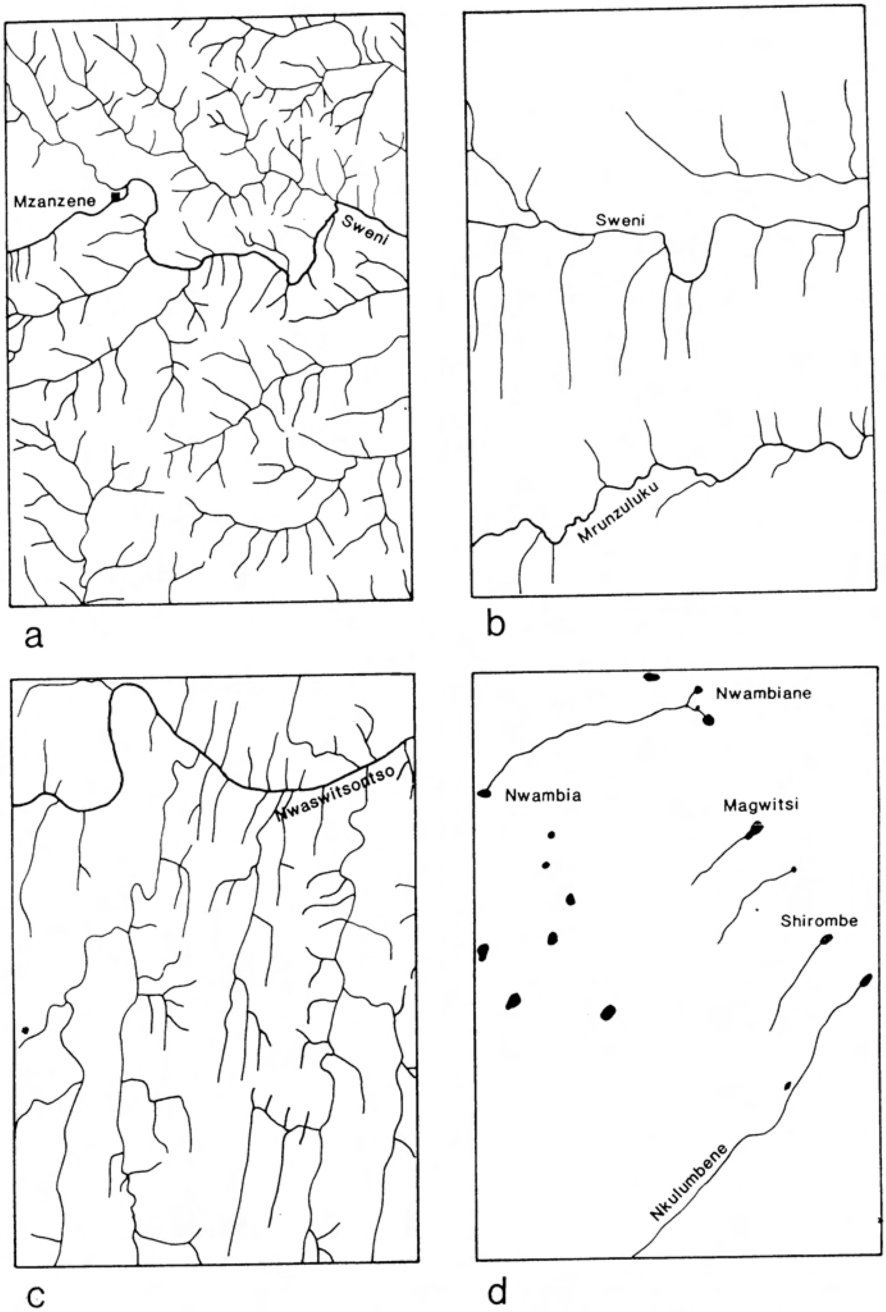

Fig. 3. Drainage patterns in the Kruger National Park. (a) Dendritic pattern on granite/gneiss southwest of Satara. (b) Rectangular pattern on basalt east of Satara. (c) Trellis pattern on rhyolite north of Rietpan. (d) Deranged pattern in the Nwambia sandveld east of Punda Maria.

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