CAPE GEOSITES

OORLOGSKLOOF GLACIAL FLOOR

300 million year old glaciation

The grooves on this sandstone surface at Oorlogskloof were created 300 million years ago by ice movement over a veneer of unconsolidated sandy gravel on bedrock of Table Mountain Group sandstone, 7 km south of Nieuwoudtville.

Council for Geoscience

THE CAPE GEOSITES SERIES

Oorlogskloof is just one of the many geologically interesting sites in the Cape. This brochure forms part of an educational series that was compiled by the Geoheritage Subcommittee of the Western Cape Branch of the Geological Society of South Africa and is downloadable free of charge from the Branch website (https://www.gssawc.org.za). Bilingual descriptive plaques were placed at the sites during a programme sponsored by Sanlam in the 1990s.

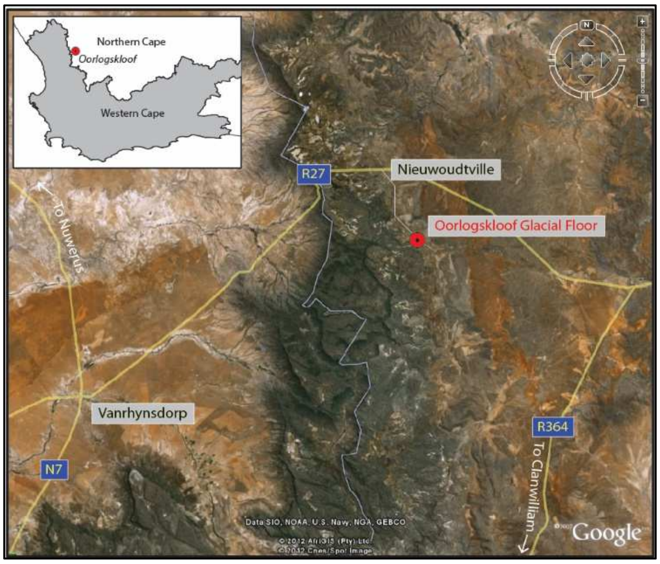

Figure 1: Location map for Oorlogskloof. See geological map below for more detail and GPS co-ordinates.

INTRODUCTION

The glacial floor exposed on the farm Oorlogskloof south of Nieuwoudtville (Von Backström, 1960), has drawn keen interest from geologists (Savage, 1972; Visser, 1981, 1990) because delicate structures are preserved on the pavements. The site, which is about 300 m wide and 140 m long, is protected by a fence erected by the late owner of the farm, Mr J.A. Louw.

GEOLOGY AND GEOLOGICAL HISTORY

About 300 million years ago, glacial conditions prevailed over Southern Africa when it migrated with the rest of the Gondwana supercontinent over the South Pole. The ridges and striations in the sandstone at Oorlogskloof formed as a result of ice movement during this time.

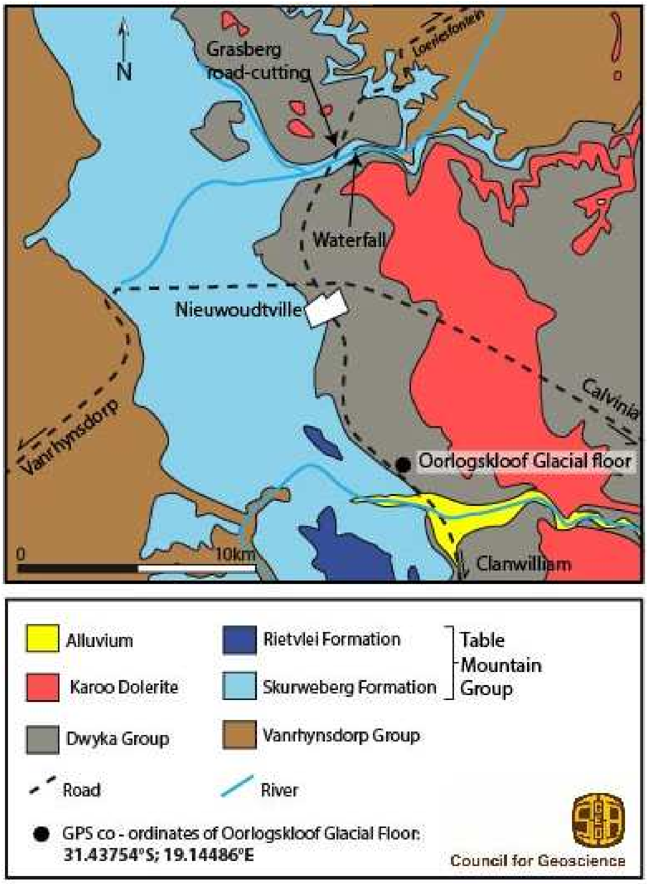

Figure 2: Geological map of Oorlogskloof and surrounding areas.

The grooves were not made on bedrock, but in a thin layer of sandy debris trapped between bedrock and the glacier base. This veneer of glacial detritus, which was eroded from sandstone bedrock and carried along by the ice, is preserved as a pebbly quartzose sandstone. The grooves were made by rock and pebbles held in the ice. The bedrock consists of sandstone of the Skurweberg Formation (upper Table Mountain Group), dating back to about 420 million years (Council for Geoscience, 2001; De Beer et al., 2002), whereas the glaciation occurred some 100 million years later, well after lithification of the bedrock and partial erosion of the rocky surfaces. Glacial erosion was followed by melting of the ice and deposition of its debris load as the diamictite (unsorted glacial debris) blanket of the Dwyka Group moved over the eroded land surface.

Figure 3: The typical Dwyka Group diamictite (at Witbergs River, SE of Laingsburg) is composed of exotic clasts in a dark grey matrix.

The glacial structures at Oorlogskloof include bulbous bedforms, long ridges and small grooves. The bulbous bedforms are large lumps of sandy detritus, 0.8 to 1.5 m high, containing faint internal layering, which sometimes have been folded and sheared. The uneven shapes of these bulbous beds were modified by longitudinal ridges and grooves striking consistently west-northwest. The larger grooves are more than 25 cm wide, about 10 cm deep, and continue for some 50 m, with several smaller striae visible within them. Many are distinctly V-shaped, whereas the ridge crests are either sharp or rounded. Longitudinal ridges sometimes partly curve around bulbous bedforms.

Figure 4: Glacial grooves on pebbly sandstone at Oorlogskloof (looking south-eastwards). Direction of ice movement was towards the observer. Low hills in the back ground contain shale and sandstone sediments of the Dwyka Group overlying the floor.

The ridges and bulbous bedforms were located in cavities at the base of the ice. Some sides of the large grooves show evidence of slumping due to collapse of the unstable ridge sides immediately after the grooves were formed. Elsewhere, soft material from an adjacent groove was pushed in sideways by the twisting movement of a gouging rock fragment. Some fluted surfaces formed by soft sediment flow into leeside openings as a response to the load of the surrounding ice. The bulbous bedforms may have developed through local dissipation of water contained in the sand towards meltwater tunnels under the ice, leaving behind lumps of higher-strength sediment, which formed obstacles to ice flow (Visser, 1990). Continued movement of the glacier streamlined these bedforms. It is clear that many of the delicate structures formed in quiet water, when the ice-front retreated or was lifted clear of the sediments by buoyancy during a rise in sea-level. These beds were eventually covered by fine suspended mud settling on them, leaving sufficient time for compaction to take place before meltwater currents and rain-out debris from the glacier formed a blanket deposit over them.

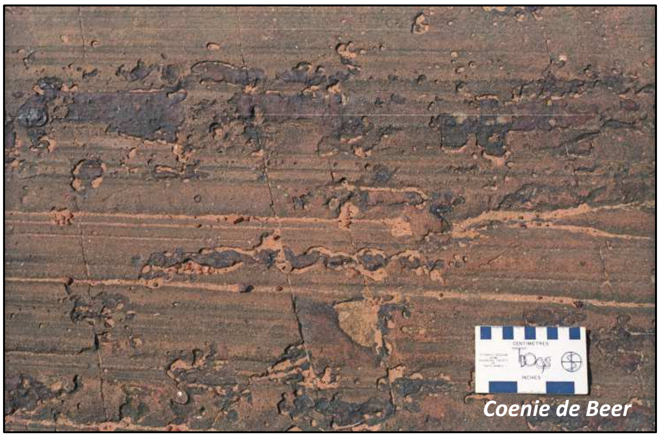

Figure 5: Striations made in the soft sediment by small rock fragments which were embedded in the ice.

Figure 6: Bulbous bedforms which represent lumps of glacial sediment contained in cavities below the ice (looking in the direction of ice movement).

The material covering floors at the base of the Dwyka Group is well exposed in a road-cutting on Grasberg, 6 km north of Nieuwoudtville (Visser, 1990). It has a mixture of sandstone and diamictite with Table Mountain Group sandstone, purple sandstone, banded ironstone, chert and gneiss clasts with carbonaceous claystone beds at the base. This is followed by pebbly sandstone with bulbous bedforms, which is capped by shale and sandy diamictite containing large clasts of diverse rock types, which were probably transported from as far afield as Griqualand West. Six sandy and two shaley beds of this cover material occur in the hills around Grasberg, but only the lower units of these occur east of Oorlogskloof.

Figure 7: Sandstone and diamictite in the road-cut at Grasberg, north of Nieuwoudtville. (co-ordinates 31.31213°S; 19.12174°E).

Variable directions of ice flow are found on the glacial pavements and floors of the area. This may be explained in different ways. It has been postulated that a Namaland ice-sheet flowed southward, an Atlantic ice sheet moved eastward, and a later Transvaal ice sheet flowed westward, obliterating some of the earlier sedimentary structures. An alternative explanation is based on evidence that valley glaciers are directed by the palaeotopography, whereas continental ice-sheets move according to the gravitative push from the most elevated part of the ice surface. At the time of glaciation, a southeast-dipping slope existed over Bushmanland, north of Kliprand, leading to a dissected area with two oblique valley systems between the Kliprand heights and Nieuwoudtville. In the northern parts the ice flowed southwards, whereas south of Loeriesfontein, the flow (from the continental icecap) was largely to the west, with the spreading-centre situated inland towards the northeast. Near the glacial front, the flow directions varied according to the subsurface relief under the ice sheet.

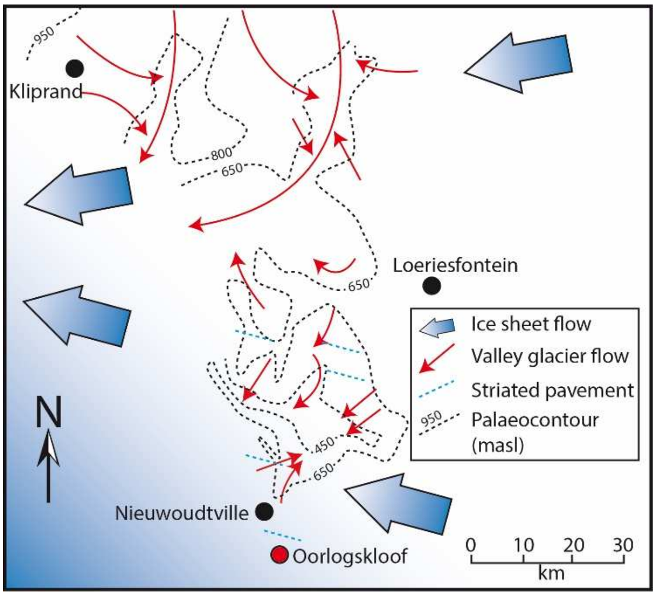

Figure 8: Interpretive palaeo-ice flow map of the Dwyka Group around Loeriesfontein (adapted from Visser, 1981).

The early temperate glaciers in the valleys produced striated surfaces on the bedrock stripped of soil cover. At Oorlogskloof, the ice moved in a west-northwesterly direction. As the climate deteriorated, the entire area became covered by an ice-sheet moving mainly westward, with the ice-front ranging across the tidewater zone into the sea. The unusual bedforms developed at this stage during a series of ice advances and retreats, as controlled by rising and falling sea-level. With the return of a warmer climate, the smoothed Bushmanland plateau probably again caused a southward downslope ice flow direction.

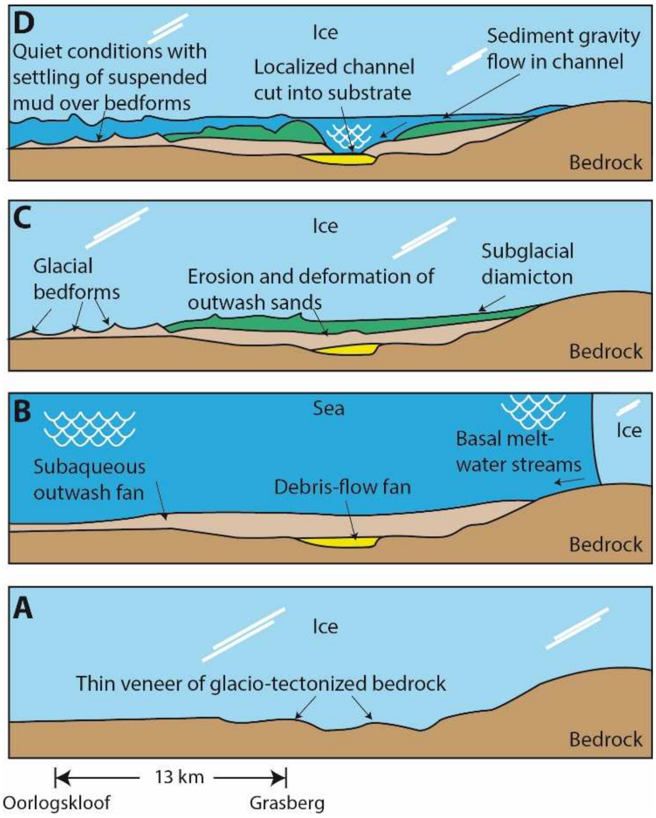

Figure 9: Schematic sections illustrating the sequence of events responsible for the glacial bedforms in the Nieuwoudtville area (from Visser, 1990). Vertical scale exaggerated. (A) Glacial advance over bedrock forming glacially sculpted terrain. (B) Ice retreat and formation of subaqueous proglacial deposits. (C) Ice readvance, overriding of outwash sediments, deposition of reworked outwash sands as subglacial diamicton, and formation of glacial bedforms during partial stagnation of the ice. (D) Cutting of localized subglacial channels and then rapid decoupling of the basal ice from the substrate during a sea-level rise. Deposition of a mud layer from suspension enhanced preservation of the glacial bedforms, whereas sediment gravity-flow sands accumulated in channels.

CONTACT

Western Cape Branch of the Geological Society of SA:
https://www.gssawc.org.za

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http://www.geoscience.org.za

ADDITIONAL READING

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