SOME MAIN CONCLUSIONS DRAWN FROM A BASINAL ANALYSIS OF THE DWYKA SERIES IN THE KARROO BASIN

By T. Stratten

I. Introduction

The investigation of the Dwyka glaciation and its relationship to the pre-Karroo surface was undertaken as a research project at the University of the Witwatersrand under the sponsorship of Union Corporation, Limited. A thesis on this study has been submitted for the degree of Doctor of Philosophy under the supervision of Professor T. W. Gevers.

The research fell mainly into two separate but related fields of study.

The first field was to investigate the pre-Karroo surface with special reference to the geology beneath the Karroo System.

The second field was to investigate the paleo-ice flow directions of the Dwyka Tillite and relate this to the position and lithology of the source areas.

II. Sub-Karroo Geology

The Sub-Karroo geology illustrates the geology as it would appear at present if the rocks of the Karroo System were removed. Only a very brief summary of the main results will be given here.

The sub-Karroo geology of the central part of the Karroo Basin consists of granite, while in the more northern parts, rocks of the Swaziland System become widespread. Towards the periphery of the Karroo Basin rocks more recent than the Swaziland System and Basement Granite make their appearance.

III. Paleo-ice flow Analysis and Conditions of Deposition

The more important measurements used in this study were till fabric and glacial striae. This research has disclosed two new source areas giving rise to ice sheets which were previously unknown. These are:

1. The newly discovered granitic source area off the present Western Cape coast produced an ice sheet for which the name *Atlantic Ice Sheet* has been proposed (Stratten, 1967). This ice sheet flowed towards the east and deposited material in the western and southern parts of the Karroo Basin (Plate **1**).

2. The newly discovered granitic source area off the present southern Cape coast produced an ice sheet for which the name *Southern Cape Ice Sheet* has been proposed (Stratten, 1967). This ice sheet flowed towards the north and deposited a little material in the southern Cape (Plate **1**).

Du Toit (1921, p. 193) named the four previously known ice sheets. The present work has confirmed their source areas and enlarged the known extent of their ice radiation. These are:

1. The Windhoek Highlands in South West Africa produced the *Namaland Ice Sheet* which flowed towards the south. It deposited some material in the western part of the Karroo Basin but its main depositional area was in South West Africa outside the Karroo Basin (Plate **1**).
2. The Kaap Plateau produced the *Griqualand Ice Sheet* which radiated a short distance towards the south-east, south and south-west and deposited a little material in the vicinity of the Kaap Plateau (Plate **1**).
3. The central and eastern Transvaal source area produced the *Transvaal Ice Sheet* which radiated towards the south-east, south, south-west and west to deposit material throughout the Karroo Basin but mainly in its eastern and northern parts (Plate **1**).
4. The granitic source area off the present Natal coast produced the *Natal Ice Sheet* which flowed towards the west and south-west and deposited material on the eastern side of the Karroo Basin (Plate **1**).

The periods of maximum ice production from the source areas moved from west to east across the country.

The Dwyka Tillite reaches a thickness of almost 3,000 feet in the southern Cape. For such a vast thickness to be deposited, it seems probable that there were a number of advances and retreats of the ice. These are indicated by intercalated sandstones and varve shales, striations on the tillite and boulders of the older Dwyka Tillite held as clasts in younger Dwyka Tillite.

There was an opening to the Karroo Basin towards the north-west between Loeriesfontein and Lüderitz, in the general region of the Orange River mouth. This was the main opening to the sea during the deposition of the Upper Dwyka Shales. There was probably a second opening to the basin in the vicinity of East London. That this area provided an opening for a marine incursion is indicated by the presence of *Eurydesma*, *Conularia*, *Peruvispira* and echinoids in the Upper Dwyka sediments (Martin, 1961, p. 32). The main area covered by this sea during the Dwyka Period is shown by the occurrence of Upper Dwyka Shales, which are present in the southern and western parts of the Karroo Basin. The Upper Dwyka Shales occur south-west of a line drawn very approximately from Vryburg through Kimberley and central Lesotho to Port St Johns, and reach their greatest thickness of over 900 feet north-west of Beaufort West.

The Upper Dwyka Shales were deposited in a nearly isolated sea in which the muds are rich in organic matter. The deeper water is toxic, through the presence of hydrogen sulphide, to scavengers and stagnation prevents oxidation.

IV. Implications Relative to Continental Drift

The present research is in some ways complementary and in other ways contradictory to recent suggestions regarding the Theory of Continental Drift. A possible reconstruction of Gondwanaland during the Dwyka Period is appended (Plate II). The main difference between this reconstruction and that more normally presented for Gondwanaland is that South America is placed a little farther away from South Africa to accommodate the source area off the present western Cape coast between the two continents; and that Antarctica is placed a little farther south relative to South Africa in which position the high land area of Queen Maud Land would be very suitably situated as the source area off the present Natal coast.

V. References

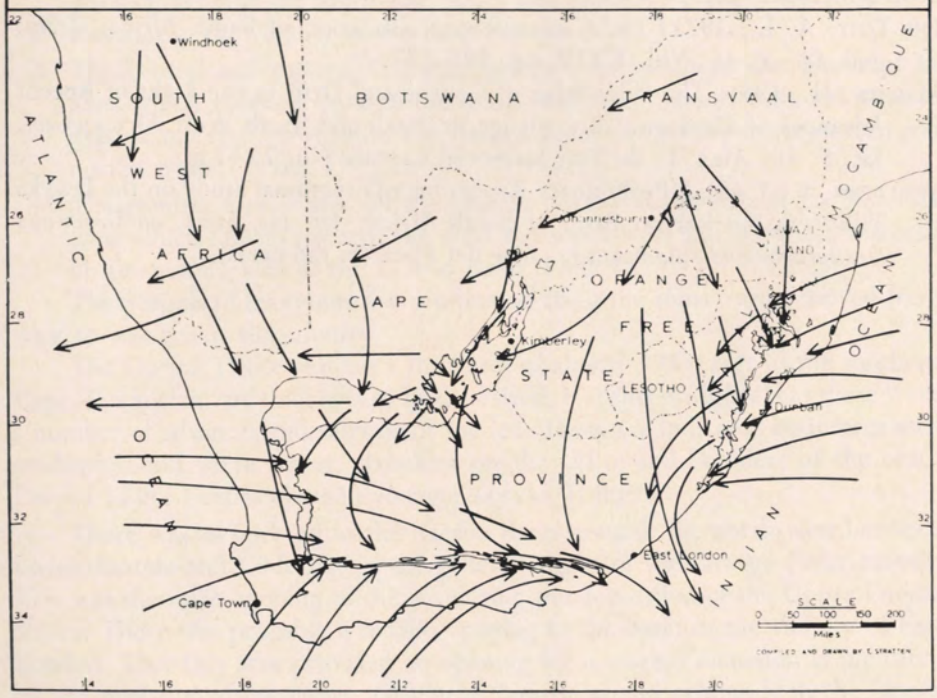
Du Toit, A. L., 1921. The Carboniferous Glaciation of South Africa. *Trans. geol. Soc. S. Afr.* Vol. **XXIV**, pp. 188–227.

Martin, H., 1961. The Hypothesis of Continental Drift in the Light of Recent Advances of Geological Knowledge in Brazil and South West Africa: *Geol. Soc. S. Afr.* Alex. L. du Toit Memorial Lecture No. **7**, 47 p.

Stratten, T., 1967. A Preliminary Report on a Directional Study on the Dwyka Tillites in the Karroo Basin of South Africa: *1st. Int. Symp. on Gondwana Stratigraphy and Palaeontology*, Mar del Plata (in the press).

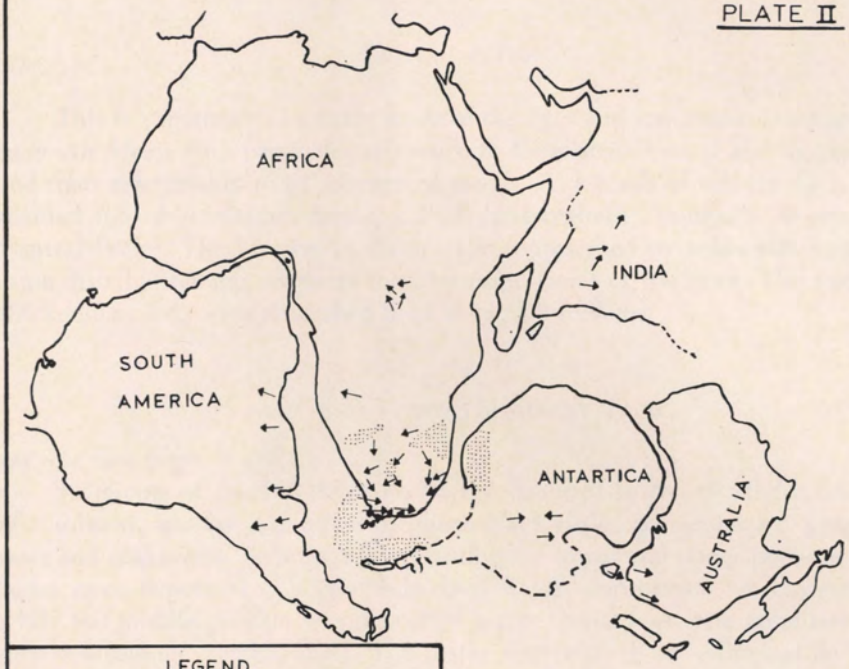
PLATE I

SPECULATIVE PALEO-ICE FLOW MAP



REASSEMBLY OF GONDWANALAND DURING THE DWYKA PERIOD

PLATE II



LEGEND

DIRECTION OF ICE FLOW DURING THE DWYKA PERIOD

APPROXIMATE POSITION OF HIGHLANDS PRODUCING THE DWYKA ICE SHEETS IN SOUTH AFRICA

MODIFIED AFTER DU TOIT, 1937

DRAWN BY T. STRATTEN