

NOTES ON THE DWYKA SUCCESSION AND ON SOME PRE-DWYKA VALLEYS IN SOUTH WEST AFRICA

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[PLATE V]

ABSTRACT

Between Mariental and Keetmanshoop the Dwyka succession contains at least two zones of marine sediments that have yielded fossils. These sediments are interspersed between beds of glacial origin, having been deposited by ice that came from the west and northwest.

Pre-Dwyka valleys containing remnants of glacial deposits have been observed in several parts of the country. These suggest that many of the present-day valley systems already existed in pre-Dwyka times.

Two pre-Dwyka peneplains have been recognised, one into which the valleys are cut, and one on to which they emerge. The lower peneplain is surmounted by monadnocks. The Joubert mountains in the Kaokoveld seem to represent a pre-Dwyka watershed from which the Dwyka glaciers moved eastwards and westwards.

1. THE DWYKA SUCCESSION

(a) The Mariental-Keetmanshoop Area

In this area the succession begins with a hard, calcareous tillite of ground-moraine type. South of Tses this basal tillite is seldom more than 20-30 feet thick, but from there northwards it increases in thickness and, in doing so, splits into three to four ground-morainic sheets separated by boulder-shale (Plate V). West of Asab the total thickness of this basal group is approximately 300 feet.

Between Tses and Mariental the ground-moraine is overlain by soft, dark-gray or black, bituminous shale. This contains in its lower portion the fish fauna of Ganikobes. South of Tses this zone peters out, having probably been eroded by the agency which deposited the succeeding boulder-shale.

The basal portion of the boulder-shale has yielded the Eurydesma fauna of Hardap (and probably of Range's collection from east of Mariental). The fossils are enclosed in a calcareous sandstone that contains abundant pebbles of granite and Nama quartzite and rests directly on the shale (No. 2 in Fig. 1).

Between Tses and Asab this second glacial zone is succeeded by gray shale with slabs and lenses of gray limestone (zone 4 in section A-B, Fig. 1). This limestone has yielded gastropods and crinoids.

Following on this second zone of marine beds is a third glacial zone (No. 6, Fig. 1) which is again composed of boulder-shale. Along a definite horizon between Brukkaros Siding and Tses this zone contains giant blocks of granite. Some of these erratics measure up to 100 feet across.

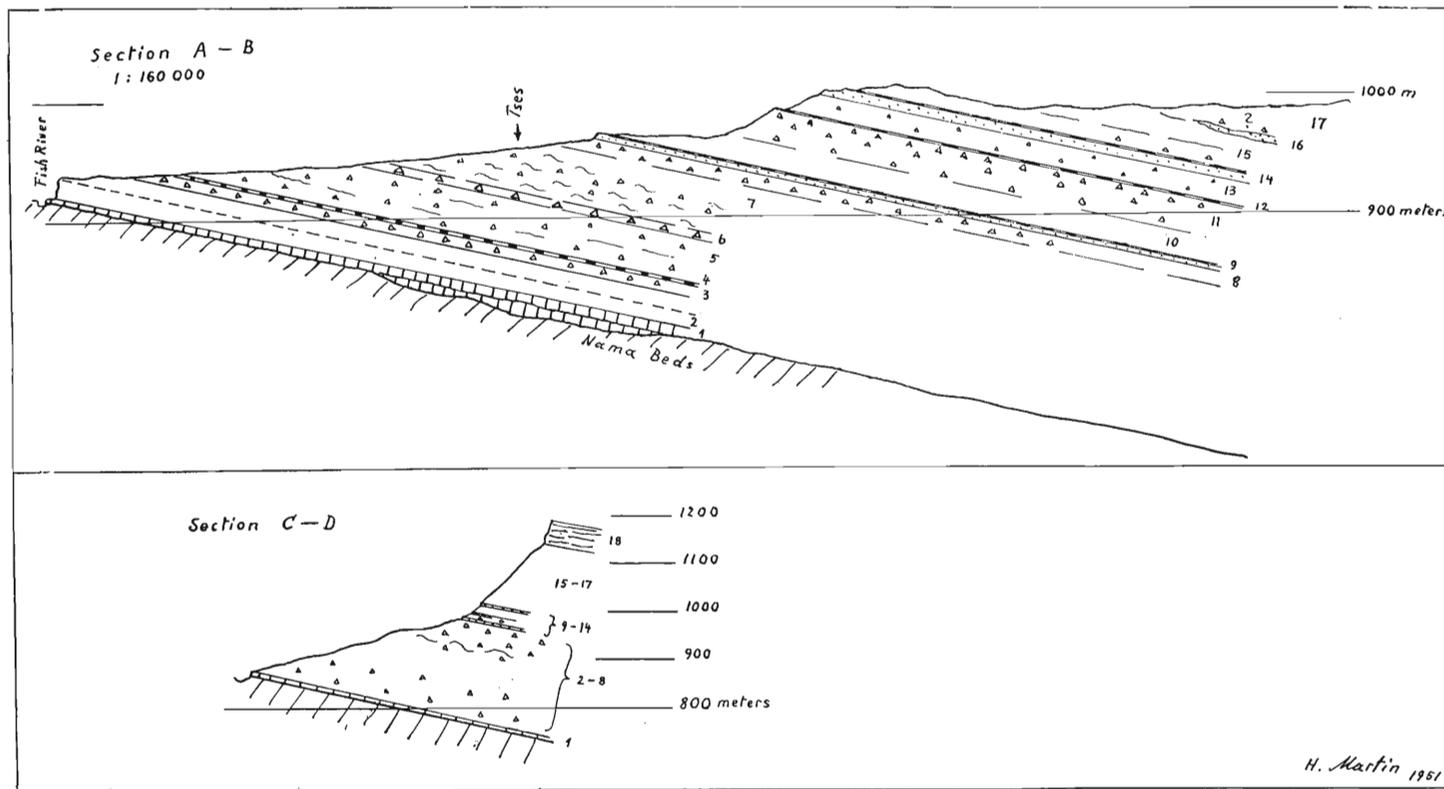


FIG. 1

- (1) Hard, basal, calcareous tillite (ground-moraine). (2) Black, bituminous shale with zone of cone-in-cone marl. Near the base occur the fossil fishes of Ganikobes. (3) Boulder-shale. (4) Zone of gray, calcareous lenses in gray shale. In this zone the gastropods and crinoids occur. (5) Gray shale with occasional boulders. (6) Boulder-shale with giant granite boulders (up to 100 feet). (7) Boulder-mudstone with big, yellow concretions of marl and beds which are folded and contorted by ice-rucking. (8) Boulder-shale. (9) Yellow sandstone with dark, calcareous layer on top. (10) Gray shale. (11) Boulder-shale, more boulders towards the top. (12) Dark, calcareous sandstone. (13) Boulder-shale. (14) Yellow sandstone with dark, calcareous layer on top. (15) Gray shale, locally with a few boulders. (16) Sandstone lenses. (17) Dark, blue-black shale. (18) Siltstone containing Mesosaurus on top of Gellap plateau.

H. Martin 1951

The next zone (No. 7, Fig. 1) is of boulder-mudstone and is characterised by big, yellow concretions of marl and by the fact that the beds are frequently contorted and folded. One gains the impression that this latter phenomenon must have been caused by floating ice which occasionally rubbed against the bottom of the basin. This zone seems to extend continuously from north of Asab to Gellap.

The zone of folded strata is followed by more boulder-shale interspersed with two to three very persistent bands of sandstone (Nos. 8 to 15, Fig. 1). These sandstone bands are in most places topped by thin, dark, calcareous layers and east of Tses impressions of ice-crystals were observed in one of them. In the same locality isolated boulders occur above the highest band of sandstone, whereas on Gellap Ost and east of Mariental no boulders seem to occur above the second sandstone, which, incidentally, is the aquifer of the artesian water in the Nossob valley.

The sandstones can conveniently be regarded as marking the closing-phase^s of the glaciation. The total thickness of the glacial succession is approximately 800–1,000 feet (250–300 meters) and above this follow monotonous, mostly dark shales, 600 to 700 feet thick. Between Mukorob and Mariental this zone contains a sandstone which locally attains a thickness of 100 feet and constitutes the aquifer of artesian water in the Auob valley. At Goamus and Mukorob this sandstone contains numerous stems of *Dadoxylon rangei* (drift-wood). At Norronaub a coaly lens in it has yielded *Glossopteris*. The lens or seam of coal encountered at a depth of 1,000 feet in the bore-hole sunk in the Kalahari on the farm Silurian (lat. 24° 33', long. 19° 38') is probably from the same horizon.

On the Gellap mountain the shales mentioned in the last paragraph are overlain by fine, hard siltstone which has yielded *Mesosaurus* remains (No. 18, section C-D, Fig. 1). The White Band, which can still be recognised in the Warmbad district, is not developed here.

From the direction of overfolding in the contorted beds it is possible to deduce that the ice came from the west and northwest (Fig. 2). In support of this deduction is the fact that at Gibeon the basal tillite contains boulders of folded Nama of the characteristic facies of the Naukluft mountains and that boulders of amygdaloidal lava of the Sinclair series which outcrops predominantly west of the Great Escarpment, are encountered everywhere in the tillite south of Mariental.

(b) The Gobabis District

With the exception of a small remnant of tillite preserved in the Nossob valley immediately south of Gobabis, the Dwyka succession in this vicinity contains no glacial beds and is represented only by the higher, non-glacial zones which overlap on the older systems.

II. PRE-DWYKA VALLEYS

The tillite to which reference has been made in the last paragraph, occurs about three quarters of a mile south of Gobabis and west of the location. It comprises numerous granite boulders, up to 2 yards in diameter and foreign to

the gravels of the Nossob valley. Several of the constituent pebbles are striated and faceted. A few hundred yards farther south, on the west bank of the Nossob valley, the tillite seems to be overlain by light-purple, unfolded, and unmetamorphosed shale with thin, red sandstone intercalations. No faults are in evidence.

In the western part of the Rehoboth district, in the headwaters of one of the tributaries of the Fish river, a remnant of tillite occurs to the west of Garis, approximately at latitude $23^{\circ} 55'$ and longitude $16^{\circ} 28'$. The tillite covers the floor of the broad, flat-bottomed valley over 2 or 3 square miles and contains abundant boulders of granite up to 3 meters in diameter, although no granite outcrops anywhere in this valley system at the present time. Striated and faceted pebbles are frequent constituents. The occurrence is not bounded by faults. The valley is here 660 feet (200 meters) lower than the adjacent dolomite plateaux crowned by an old peneplain at an altitude of 1,800 meters. Towards the east the valley debouches on to a lower peneplain which slopes towards the southeast and in that direction disappears beneath the Karroo rocks of the

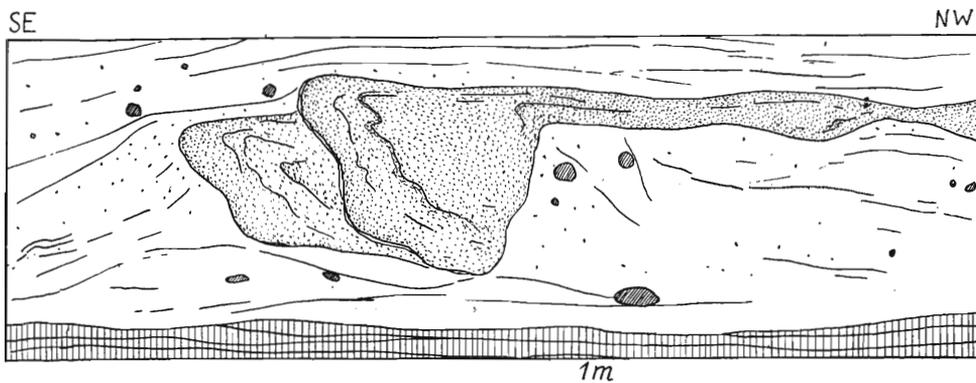


FIG. 2—Overfolding due to ice movement.

Mariental area. Above this lower peneplain rise numerous monadnocks which are relics of the denuded, higher peneplain. There can therefore be little doubt that these monadnocks are of pre-Dwyka age.

An undoubted pre-Dwyka gorge is preserved in the Tsondab valley on the farms Blässkranz and Büllsport, 20 miles southwest of Garis. Here tillite occurring on a terrace 1,300 feet (400 meters) below the high plateau, marks the site of a pre-Dwyka valley that drained towards the east. The enclosed granite boulders could only have come from the Nauchas highland in the north, which to-day is separated from the Tsondab valley by high plateaux and deep gorges. The subsequent reversal of drainage of the Tsondab valley which is now to the west, was effected by headward erosion through the Great Escarpment. In a previous paper (Korn and Martin) this reversal was erroneously considered to have taken place during the Pleistocene. A Cretaceous age would seem to be more likely.

In the Kaokoveld most of the big valleys draining westwards to the Atlantic ocean contain remnants of Karroo rocks. Thus, tillite has been observed in the Kunene valley below the Ruacana falls, at Otjingerese, five miles east of

Ohopoho, in the neighbourhood of Kaoko Otavi, and in the Anabib valley southwest of Franzfontein.

In the Kunene valley the hard, basal tillite is overlain by boulder-shale that contains yellow concretions of marl similar to those occurring in Zone 7 near Tses. In the same way as at the latter locality, the Dwyka beds in the Kunene valley have furthermore been locally folded and contorted by the glaciers. The big Ruacana falls owe their existence to the erosion of the soft boulder-shale, and in those parts of it where it has just been stripped of Dwyka beds the Kunene valley is seen to be perfectly U-shaped.

The tillite-bearing valleys between Ohopoho and Kaoko Otavi have their origin in the Joubert mountains which, with an altitude of 1,800 meters, form the highest elevation between the Ugab river and the Kunene river. Valleys similar to those containing the tillite remnants, drain from the Joubert mountains eastward into the Ovamboland basin. No tillite has been found in them, but they are topographically so similar to the western valleys that there can be little doubt that they are of the same age and origin. Indeed, it would seem that already in pre-Dwyka times, the Joubert mountains had been a major watershed.

The Anabib valley, with remnants of tillite in its easternmost part, is cut into the main Namib peneplain which slopes westwards towards the coast. At Doros, however, the Mesosaurus beds (Reuning, 1925) lie high above this peneplain, whereas north of the Brandberg and the Goboboseb mountains the Karroo succession, according to J. F. B. Jeppe, begins with thin fluvioglacial beds resting on the main Namib peneplain.

Collectively the features enumerated in the preceding paragraphs indicate beyond any doubt that in the Kaokoveld the Great Escarpment dates back to pre-Dwyka times. This explains why it is not nearly so well defined there as between the Swakop and Orange rivers where it was modified by post-Karroo faults.

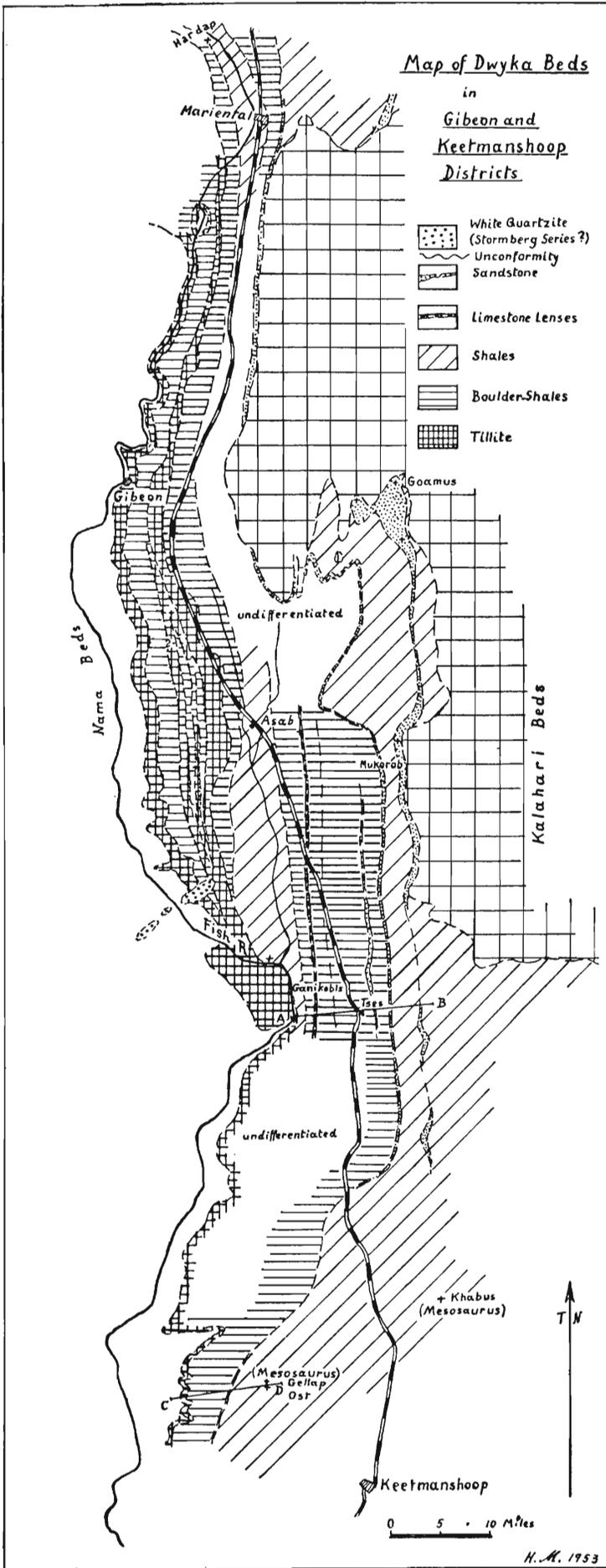
From the above it is also evident that no single peneplain can be regarded as "the pre-Karroo peneplain" and used as a geomorphological datum-plane. Instead, the pre-Karroo topography consists of a great number of geomorphological elements and it seems that over wide areas the present-day topography diverges only slightly from that of the old pre-Karroo landscape.

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