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HIGH INHERITANCE ELONGATE STROMATOLITIC MOUNDS FROM THE TRANSVAAL DOLOMITE

by

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ABSTRACT

Elongate mound-like structures up to 10 metres across and 40 metres in length are described. Characteristic features of the mounds are their high inheritance and considerable relief which, along with the absence of sub-aerial exposure features, the fine-grained nature of the carbonate, and their vertical persistence, are taken to suggest a subtidal origin. Marine currents are considered adequate to account for their elongation.

INTRODUCTION

Study of the environmental significance of stromatolites owes much to the work of Black at Andros Island in the Bahamas. There, in 1933, he recorded contemporary algal mats in the intertidal and supratidal zones, and showed that specific growth forms developed in distinct geographic settings. He went on to draw an analogy between these mats and the stromatolitic structures so prevalent in many Palaeozoic and Precambrian carbonate sequences. Early corroboration of this analogy was provided from the Transvaal Dolomite in the northern Cape by Young (1934). Young also sought to relate stromatolitic and other structures

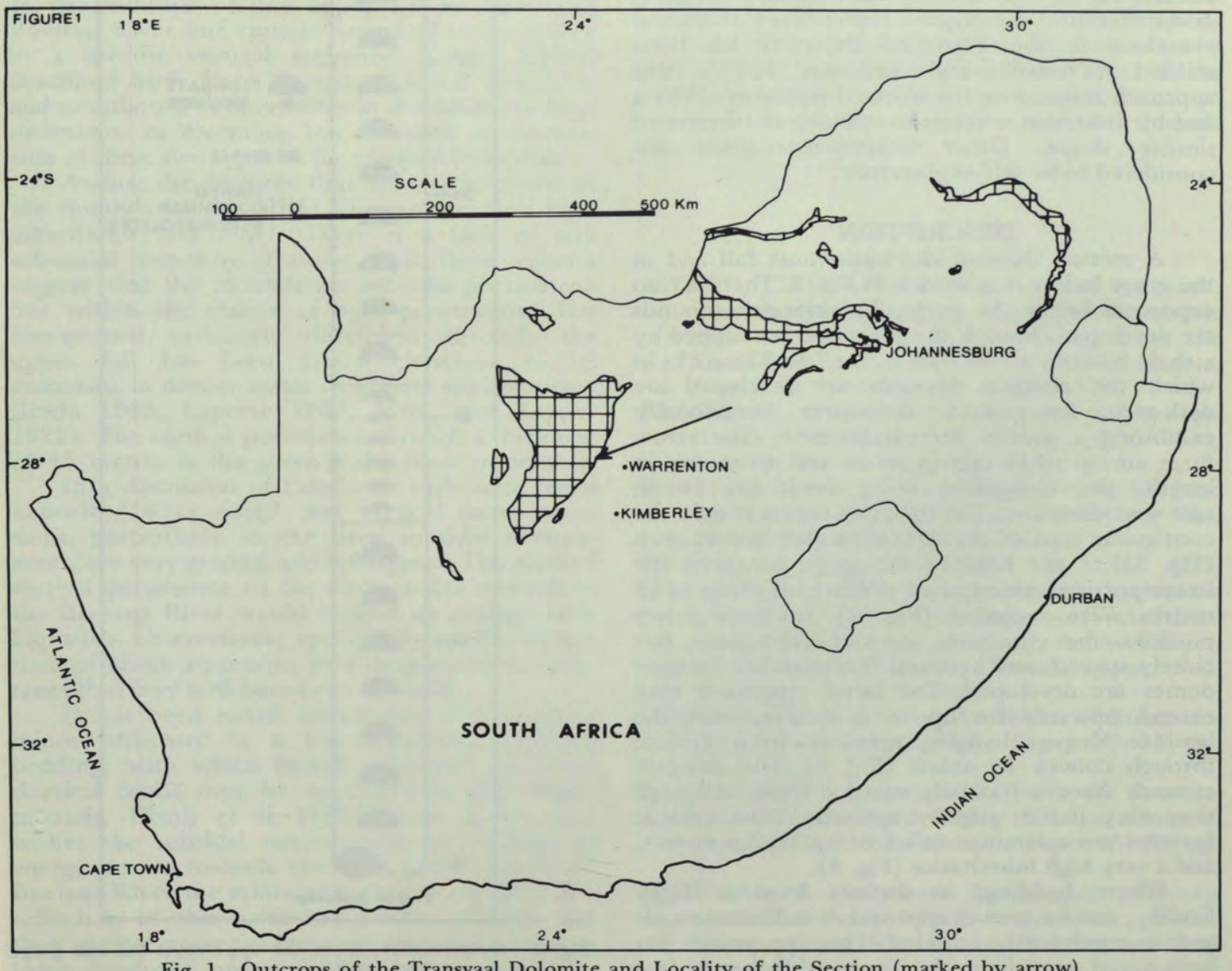

Fig. 1. Outcrops of the Transvaal Dolomite and Locality of the Section (marked by arrow).

to conditions of deposition within a general shallow water environment (Young 1933, 1940). Notwithstanding the significance of the above palaeoenvironmental contributions Young subsequently regarded certain of what are now considered to be types of stromatolite as being of structural origin (Young 1943; see also Young 1928). Structures so considered included many passively branching columnar structures, and also the larger of the domical structures.

Much of Young's work was in a basal portion of the Dolomite in the Hol River, now re-named the Groot Boetsap River, near Boetsap, north-west of Warrenton in the northern Cape (Fig. 1). This classic section 1½ kilometres north of Boetsap has been re-examined recently, and a general account will be published elsewhere. Exposures in it are restricted to the environs of four waterfalls where the river drops off the lower edge of the Kaap plateau into the valley of the Harts River.

In this paper extremely large domical stromatolites, and minor structures developed in them, are described from the uppermost fall and the gorge immediately below. They are described because no obvious analogy can be found for them in the literature. Descriptive terminology as applied elsewhere in the Transvaal Dolomite has been utilised (Truswell and Eriksson 1972); this approach is based on the work of Hoffman (1969 a and b). Inheritance refers to stacking of laminae of similar shape. Other descriptive terms are considered to be self explanatory.

DESCRIPTION

A section through the uppermost fall and in the gorge below it is shown in Fig. 2. There are no exposures below the gorge. The elongate mounds are developed through the gorge and are capped by a shale horizon at the base of the fall. The rocks in which the elongate mounds are developed are dark-grey fine-grained dolomites occasionally exhibiting a patchy recrystallization. The structures are up to 10 metres across and 40 metres in length, the elongation being invariably in an east-west direction. For the most part it is only the contiguous tops of the structures that can be seen (Fig. 3); at the head of the gorge, however, the lower portions are exposed and heights of up to 13 metres were recorded (Fig. 4). In these lower portions the structures are not contiguous but closely spaced, and between them smaller elongate domes are developed. The latter structures may extend upwards for up to 5 metres, with the laminae shape changing upwards from prolate through convex to oblate (Fig. 5). The elongate mounds have a basically convex form, although they may flatten slightly upwards. Most notable features are a laminae relief of up to 2,5 metres, and a very high inheritance (Fig. 4).

Where bedding, as distinct from a flaggy fissility, can be seen it approaches millimetre scale and is consistently crinkled. This appearance has been noted severally in the Transvaal Dolomite (see for example Toens 1966) and by its associations has been considered to be a stromatolitic form (Truswell and Eriksson 1972). At this locality the low amplitude of this feature should be noted (Fig. 6).

In a central portion of the exposure the tops of the elongate mounds have smaller observable

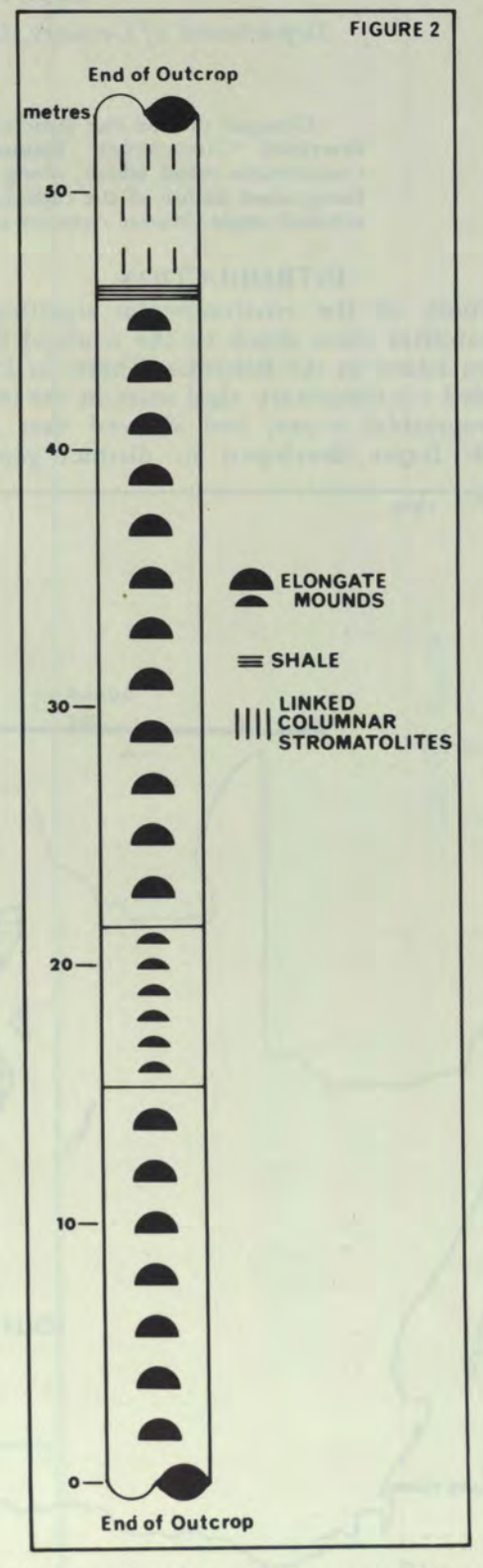

Fig. 2. Stromatolites from the uppermost fall and gorge, Groot Boetsap River.

dimensions. While the dominant minor structure remains the above low-amplitude crinkled bedding, other structures were also recorded. These include a linked columnar form with variable spacing (Fig. 7) and a height of 15–40 cm and diameter of 4–8 cm; and in one horizon an unusual fan-shaped domical structure up to 12 cm high (Young 1940) (Fig. 8).

AN ENVIRONMENTAL INTERPRETATION

A survey of the literature reveals no obvious analogy with the Hol River stromatolitic mounds although a number of structures with a similar external geometry have been reported. Both thrombolites, as discussed by Aitken (1967), and loferites (Fischer, 1964) are characterized by broad contiguous arched bedding structures. However the former has a spongy or clotted internal fabric, while the latter by definition contains small ragged pores filled by clear blocky calcite; and neither of these contain internal lamination. Hoffman (in press) has described large features from the platform edge in the Pethei Group at the Great Slave Lake in Canada. These do have a similar relief to the mounds on the upper fall in the Groot Boetsap River but contain branched stromatolites in a specific vertical sequence. Knight (1968) described both large elongate domical structures and undulatory stromatolites in the Medicine Bow mountains in Wyoming, but recorded no association of these two types in the mapped bioherms.

Among the features that are characteristic of the mounds in the Groot Boetsap are their high inheritance and relief. There is a lack of any sub-aerial exposure features. All these criteria suggest that the mounds are subtidal phenomena but within the realms of light penetration. The fine-grained carbonate developed through the upper fall has been shown elsewhere to be dominant in deeper water carbonate environments (Irwin 1965, Laporte 1967, 1969, and Kepper 1972). The vertical persistence through a thickness of 45 metres in the gorge is also most noticeable.

In a discussion of Palaeozoic carbonate facies Laporte (1971) noted that vertical facies variations, particularly in the deep subtidal environment, are very gradual and infrequent. The marked vertical persistence of the stromatolite mounds in the Boetsap River would suggest an analogy with Laporte's observations; specifically of the formation of these structures in a deep-water environment that may well have been subtidal.

It has been noted earlier that the dominant minor structure is a low amplitude crinkled bedding, with which linked columnar and small domical forms may be associated in the smaller mounds. Heath et al. (1967) have shown that within the subtidal environment an increase in energy occurs towards the land, and in the Groot Boetsap River the minor structure is regarded as a reflection of this, with the smaller mounds and their greater potential variation in minor structure being developed landward of the larger mounds. At Shark Bay Logan (1961) noted that outwards in the intertidal zone flat-bedding gave way successively to dome-like stromatolites, linked columnar forms, and unlinked columnar stromatolites with energy increase towards the surf zone. In the Groot Boetsap section small changes in the minor structures are taken to suggest lesser changes of energy.

A further distinctive, and unusual, feature of the mounds is their consistent east-west elongation, i.e. at right angles to the depositional shoreline (see also Visser and Grobler (in press)). This orientation must be related to persistent, if weak, currents within the subtidal environment. Irwin (1965) considered that in the subtidal parts of an epeiric sea marine currents would constitute the only form of hydraulic energy. Shaw's comment (1964) that such currents were small in size compared with oceanic currents, but if they were steady would have exerted a marked effect, is regarded as being most pertinent in the development of the mounds in the Groot Boetsap River. The stromatolite mounds from the Pethei Group in Canada (Hoffman, in press) have been shown to have formed on a shelf edge, basinwards of which greywackes, marlstones and shales were deposited. To date only cratonic shelf sedimentation in an epeiric sea is indicated as the depositional conditions of the Transvaal Dolomite. There is no evidence of an off-shelf facies, or that the elongate mounds developed on a shelf-edge.

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Fig. 3. Contiguous tops to large elongate mounds, elongated east-west. (Scale : 60 cm in length)

Fig. 4. High inheritance and relief of elongate mounds. (Scale : 60 cm in length)

Fig. 5. Axial zone domical structure. (Scale : 60 cm in length)

Fig. 6. Low amplitude stromatolitic bedding on elongate mounds. (Scale : 15 cm in length)

Fig. 7. Linked columnar minor structure on elongate mounds. (Scale : 15 cm in length)

Fig. 8. Fan-shaped domical structure on elongate mounds. (Scale : 3,5 cm in width)