SEDIMENTARY STRUCTURES IN THE SOUTHERN AND CENTRAL PORTIONS OF THE WATERBERG AREA, NORTHWESTERN TRANSVAAL

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ABSTRACT

Sedimentary structures in the Waterberg System comprise transverse current ripple marks, linguoid ripple marks, cross-bedding, ripple marks on foresets of cross bedding, normal type of convolute structures and so-called convolute lump structures which occur on the upper bedding plane of a convoluted bed.

INTRODUCTION

The southern and central portions of the Waterberg area were mapped in detail by the present author, who proposed a new stratigraphical subdivision for the Waterberg System (d e V r i e s, 1970; see also M e i n s t e r, 1970) (fig. 1).

The purpose of the present paper is to give an account of some types of well known and of less usual sedimentary structures, in part of syndepositional origin and of post-depositional origin and due to the deformation of the unconsolidated sediment (see N a g t e g a a l, 1965).

SEDIMENTARY STRUCTURES

a. Ripple marks

Ripple marks commonly comprise asymmetrical transverse current ripple marks with relatively straight continuous crests. They are abundant in the sandstone of the Swaershoek Stage.

Linguoid or cuspate ripple marks are common in the sandstone of the Upper Langkloof Substage along the western margin of the Waterberge. Of interest is the occurrence of a very small-scale type of linguoid ripples superimposed on large linguoid ripples (fig. 2).

In sandstone of the Vaalwater Stage exposed in the bed of the Sondagsloop, longitudinal ripple-like structures are developed on the foresets of a large-scale, trough-type cross bedding. The ripples are perpendicular to the upper and lower boundary of the foresets and approximately parallel to the maximum dip of the foreset (figs. 3 and 4).

The ripples on the foresets are generally symmetrical with rounded crests and troughs of which the crests are somewhat stronger curved than the troughs. A common type of small-scale ripples has a wavelength of about 35 mm with an amplitude of 3 to 3,5 mm. Ripples of a much larger scale are less common, the wavelength is up to 90 mm with an amplitude of 9,5 mm.

At places small crests are developed between the main crests of the large-scale ripples.

The ripples occur at many succesive foresets (fig. 4).

The ripples may have some relationship with the longitudinal wave ripples occurring on the foresets of megaripples in an estuarine environment (pers. comm. Prof.Dr. J.D. de Jong).

b. Cross Bedding

Cross bedding comprises large-scale, planar-type cross bedding and small-scale and large-scale through-type cross bedding.

The large-scale, planer-type cross bedding occurring in composite beds of several metres in thickness is characteristic for the mature types of sandstones of the Upper Langkloof Substage and the Cleremont Stage (see M e i n s t e r, 1970).

A small- to large-scale, trough-type cross bedding is ubiquitous in the rocks of the Sandriviersberg Stage, i.e. the typical Waterberg Sandstone. The very thick bedded sandstone consists of composite beds of a large number of small cross-bedded units which commonly are up to about 1,5 metre across and 25 cm in thickness. The sandstone is light yellowish and the foresets are rendered conspicuous by laminae of black grains of iron oxide (fig. 5).

Very large-scale, trough-type cross bedding is common in the fine-grained sandstone of the Vaalwater Stage. The beds are composite and consist of cross-bedded units measuring between 25 and 90 cm in thickness, several metres in width and up to 20 metres in length. The units are generally only partially preserved, as during the sedimentation of a subsequent unit the existing unit has been partially eroded. The lower surface of a cross-bedded unit is bowl-shaped and represents an erosion surface.

A well-preserved unit exposed in the bed of the Sondags-

1) Brittenberg 68, Leiderdorp.

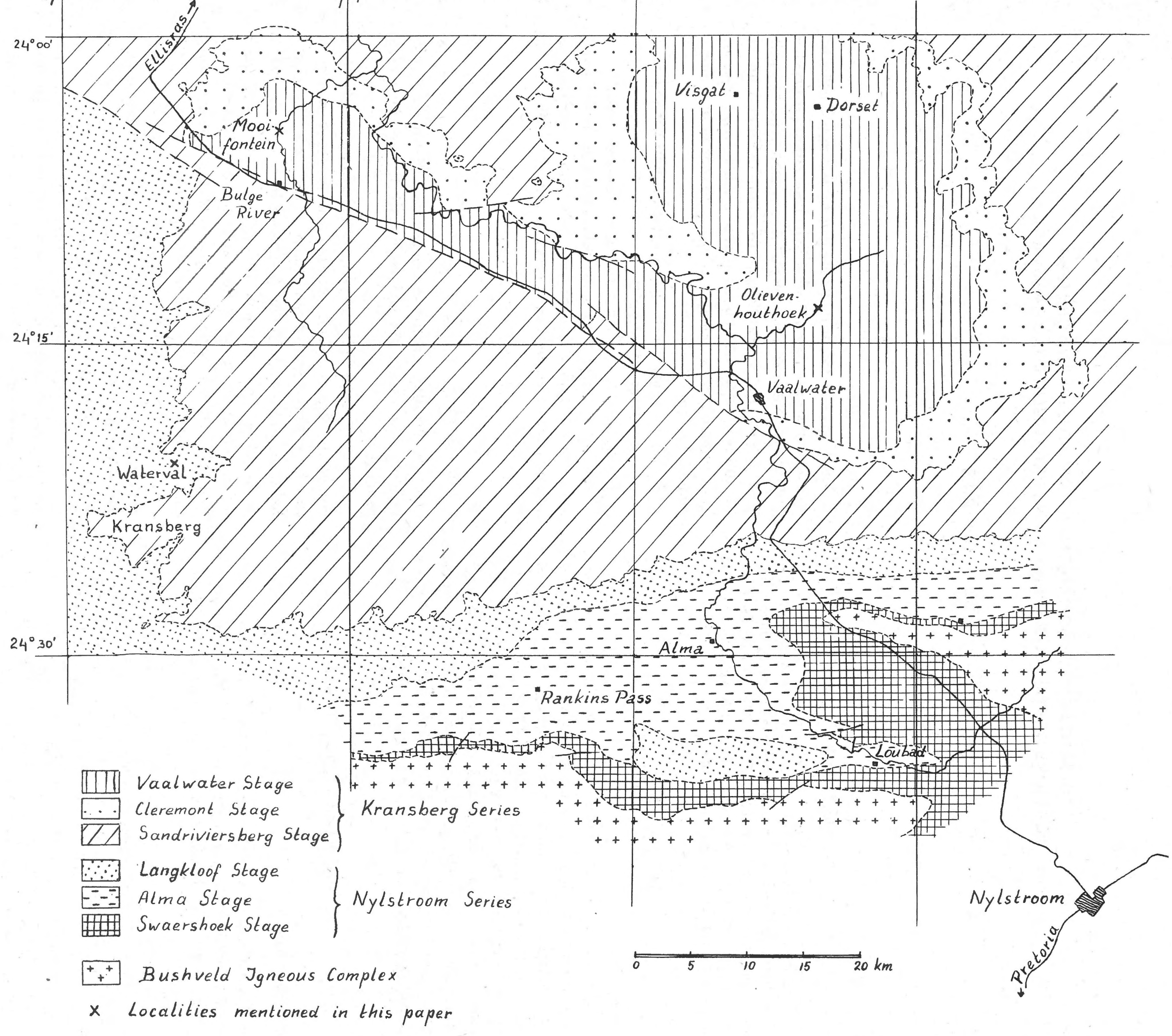

Fig. 1
Geological sketchmap of the southwestern portion of the Waterberg area, Northwestern Transvaal.

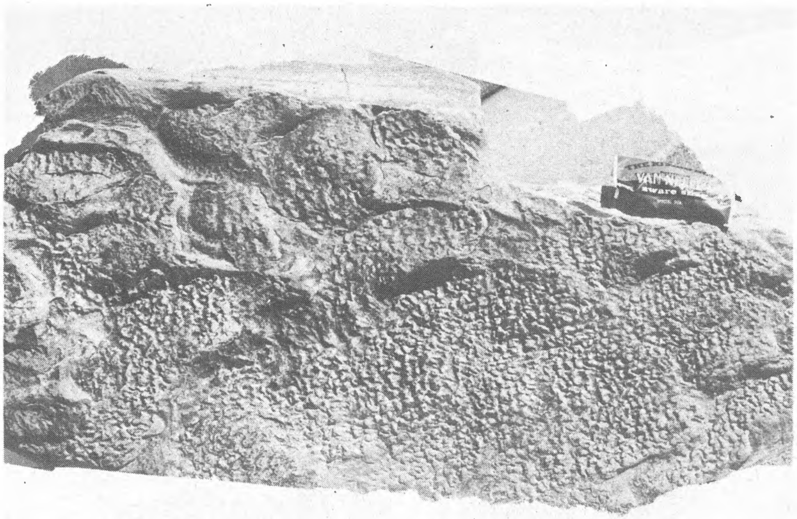

Fig. 2
Small-scale linguoid ripples superimposed on large linguoid ripples. Langkloof Stage. Waterval 267 KO.

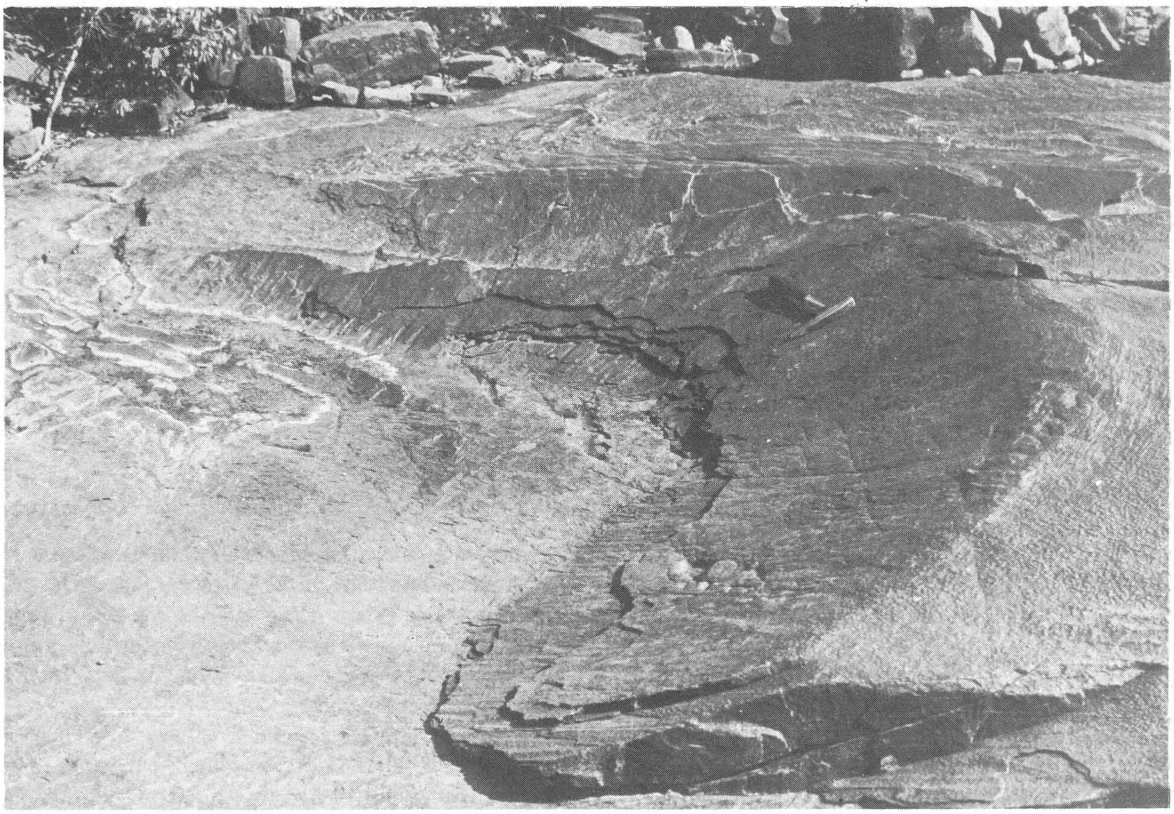

Fig. 3
Longitudinal ripple-like structures on foreset of a large-scale, through type cross bedding. Vaalwater Stage. Bed of the Sondagsloop, Northwest of Vaalwater.

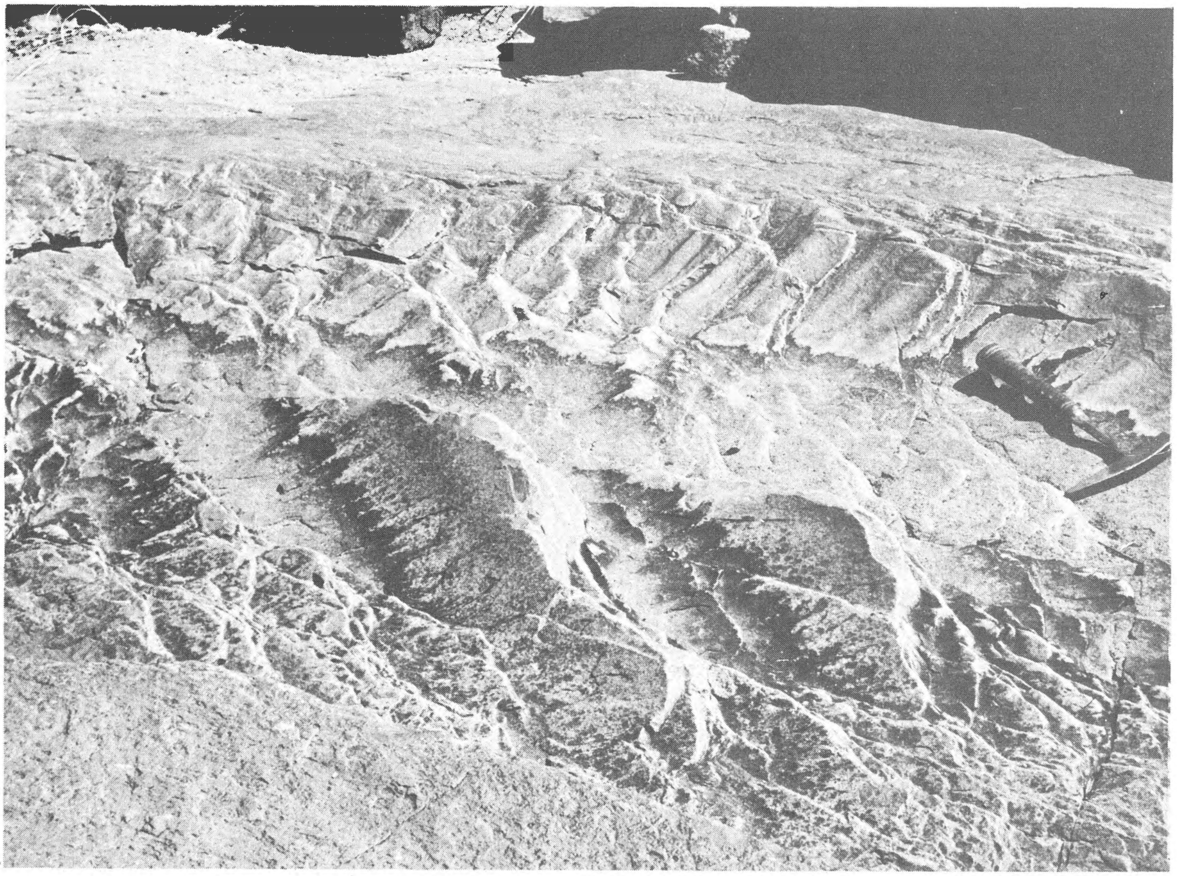

Fig. 4
Ibid. Detail of the ripples.

loop measured 6 metres in width, 11,50 m in length and 40 cm in thickness. The foreset forms an arc of 115°, the maximum dip is 27°, the axis of the trough is N142E, the palaeocurrent direction being from the NE to the SW. Ripple marks, aligned approximately parallel to the maximum dip of the foreset, are present in many cross-bedded units in the bed of the Sondagsloop (figs. 3 and 4).

META- AND POSTDEPOSITIONAL DEFORMATIONAL STRUCTURES

a. Deformed cross bedding

Deformed cross bedding is exposed in fine grained sandstone, for instance in the bed of the Sondagsloop and the Kwa Mokolo (Mogol River), northwest of Vaalwater.

The foresets of the upper portion of the cross-bedded layer are overturned in down-dip direction, with the result that the laminae display a dip of about 15° in upstream direction (fig. 6).

Deformation has evidently taken place in the unconsolidated sediment, before or during deposition of the overlying beds. This type of deformation has been described from many localities over the world (Geikie, 1882; Steward, 1961; Jones 1962; Mountain, 1965; e.a.).

b. Convolute lamination and related deformational structures

Convolute lamination is generally confined to fine-grained sandstone and siltstone of the Vaalwater Stage. The structure can be observed at several localities in the bed of the Mogol River and displays the normal type of convolution in which the thickness of the convoluted bed is being maintained laterally.

Of special interest are the structures, developed on the upper surface of a bed of convoluted, laminated fine-sandy siltstone, particularly well exposed in the bed of the Malmaniesrivier near the homestead of the farm Mooifontein 150 KQ (27°41′20″EL; 24°04′20″ SBr).

The structures are round to oval, dome-shaped protuberances of the upper bedding plane. Two types of structures

Fig. 5
Cross-bedded Waterberg Sandstone. Sandriviersberg Stage. Height of photograph about 1,25 metre.

can be distinguished, which are transitional into each other.

The first type of structure is simple, dome-shaped, round to oval, varying from 20 cm in diameter and 7 cm in height to 40 cm and 10 cm respectively. The laminae dip outwards with a maximum dip of 55 degrees. The crest is smooth; the laminae and the upper bedding plane are gently curved. On the top portion there is no notably distortion of the laminae (figs. 7, 10 and 11).

The second type of the dome-shaped structures displays a depression of the central portion. This depression can be relatively small, the structure is thus reminiscent of a small stratovolcano with a small crater. Other types, however, show a comparatively large depression and are reminiscent of a caldeira. With an overall length of the structure of about 85 to 90 cm, the depression reaches 65 cm (figs. 8 and 9). The lamination of the siltstone closely follows the topographical outline and in particular in the central portion the lamination does not display any disruption as should be expected from a sand volcano (G i l l and K u e n e n, 1958; D z u l y n s k i and W a l t o n, 1965). These structures are closely associated with the normal type of convolution, the convoluted bed has developed protuberances at places, and these can be referred to as *convolute lump structures.*

ORIGIN OF DEFORMATIONAL STRUCTURES

Penecontemporaneous deformational structures which are confined to one bed commonly comprise structures developed either on the lower surface of a particular bed or within the bed.

The first type comprises, inter alia, load casts (K u e n e n, 1953) or load structures (D z u l y n s k i and W a l t o n, 1965), which generally are caused by the vertical sinking of sand in the underlying bed, giving rise to rounded, moulded forms. Structures developed within a bed comprise i.a. the convolute lamination.

Structures on the upper bedding plane are rather uncomm on and comprise sand volcanoes (G i l l and K u e n e n, 1958), spring pits (Q u i r k e, 1930), pit and mound structures (S c h r o c k, 1948) and mud lumps (S h a w, 1913). All these structures, excepting mud lumps, are caused by a mixture of water or gas with sand emanating from inside a bed, giving rise to crater-like or volcano-like structures, in which the original lamination is strongly disturbed. The mud lumps of the Mississippi delta (S h a w, 1913), though developed on a much larger scale than the convolute lumps of Mooifontein, are comparable to the latter regarding the mode of origin. In both cases, liquefaction and lateral movement of the muddy sediment resulted in local bulging up of overlying laminae or layers.

In the case of the mud lumps, a large amount of liquefied mud moves under conditions of plastic flow over a rather large distance, giving protuberances with a height of up to 10 feet and an extension of one acre.

In the Mooifontein case the convolute lumps are caused by temporary liquefaction, due to thixotropic behaviour of the silty sediment (D z u l y n s k i and W a l t o n, 1965; B o s w e l l, 1961). Some of the elevated lumps squeezed away under their own weight, thus causing the collapse of the central protion resulting in the crater- or caldeira-like shape. Because the structures with their extraordinairy steep dips of the lamination are well preserved and have not been eroded or collapsed after or during their formation, the liquefaction of the sediment occurred after burying of the bed by subsequent deposited material and thus the structures can be classified under the subdivision 3.2. of the postdepositional structures in the scheme given by N a g t e g a a l (1965).

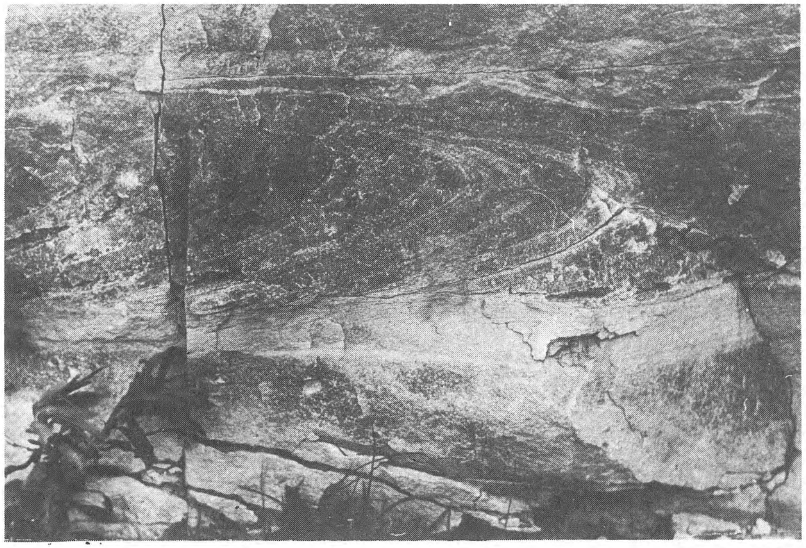

Fig. 6
Deformed cross bedding. Vaalwater Stage. Bed of the Kwa Mokolo, northwest of Vaalwater.

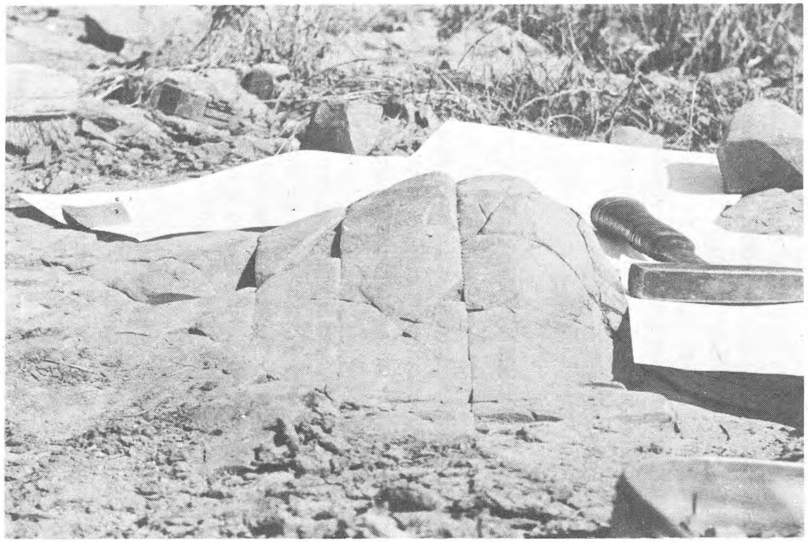

Fig. 7
Dome-shaped convolute lump structure. Vaalwater Stage. Bed of the Malmaniesrivier, Mooifontein 150 KQ.

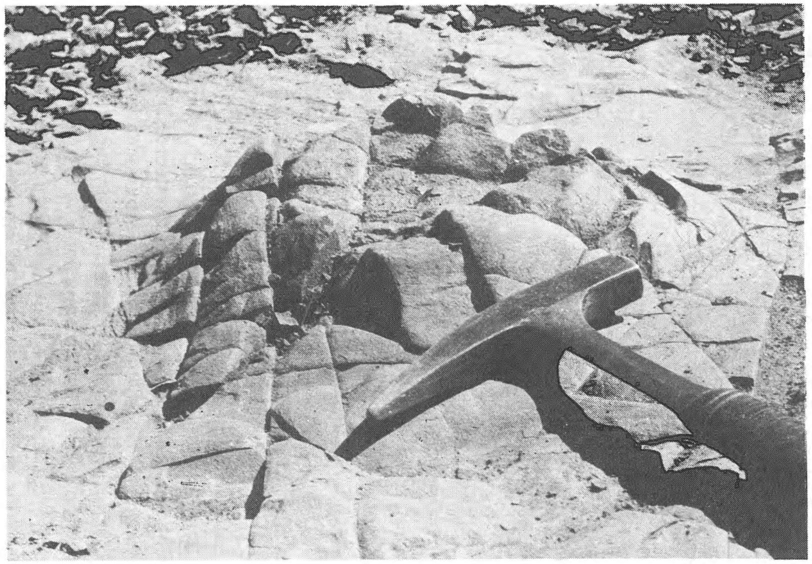

Fig. 8
Volcano-shaped convolute lump structure. Vaalwater Stage. Bed of the Malmaniesrivier, Mooifontein.

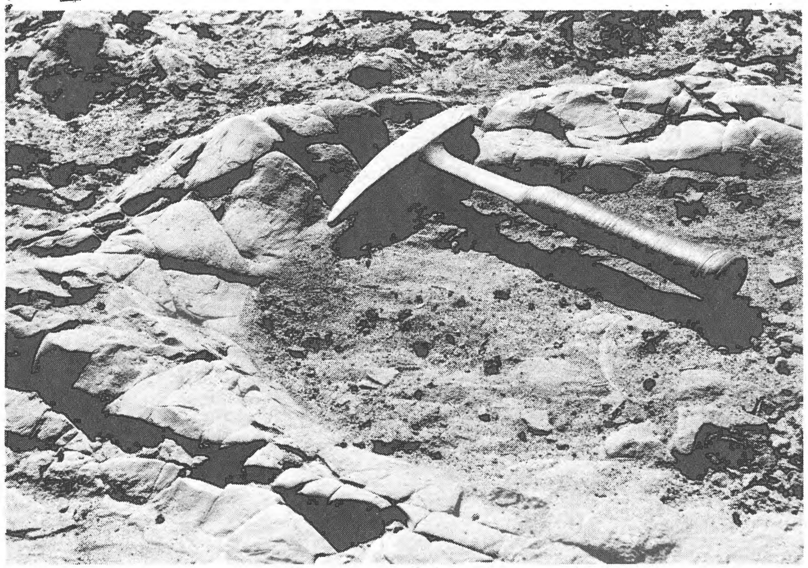

Fig. 9
Caldeira-shaped convolute lump structure. Vaalwater Stage. Bed of the Malmaniesrivier, Mooifontein.

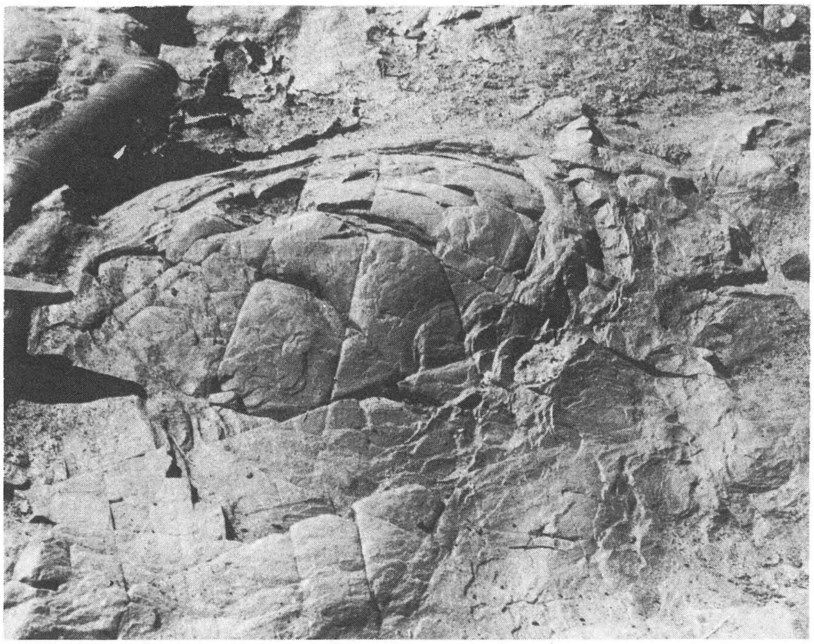

Fig. 10
Lamination of a convolute lump structure. Vaalwater Stage. Bed of the Malmaniesrivier, Mooifontein.

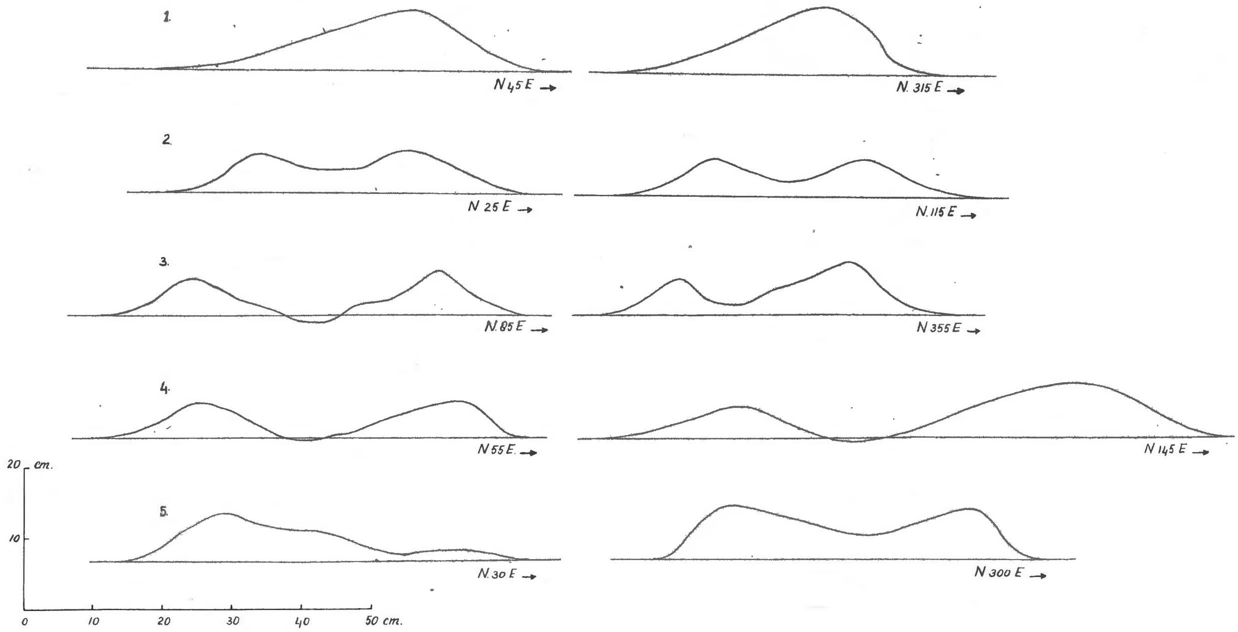

Fig. 11
Cross-Sections of the convolute lump structures.

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