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REVISED STRATIGRAPHY OF THE BEAUFORT GROUP IN THE SOUTHERN KAROO BASIN

by

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ABSTRACT

The Beaufort Group in the southern Karoo Basin between Graaff-Reinet and Sutherland has been divided into three formations based primarily on the changing ratio of sandstone to mudstone. The former Abrahamskraal Formation is elevated to subgroup status and divided into two new formations, the Lootskloof Formation and the Verlatenkloof Formation, whilst the Teekloof Formation is retained but more precisely defined. The Verlatenkloof Formation includes two members, the Jakhals Valley Member and the Paalhuis Member. The Teekloof Formation includes the Oukloof Member in addition to the previously defined and described Oudeberg Sandstone Member. Stratotypes are erected for the new formations and members in accordance with the recommendations of the South African Committee for Stratigraphy.

Subdivision of the formations and their relationship to the established biostratigraphy and facies patterns provides a means of fixing and correlating the most important uranium mineralised units in the succession with greater accuracy. These comprise the Paalhuis Member, the Oukloof Member and the Jakhals Valley Member, although the most important mineralised unit is the Paalhuis Member which contains up to 90 per cent of all known uranium occurrences in the Beaufort West area.

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INTRODUCTION

The main Karoo Basin in South Africa (fig. 1) contains one of the most extensive and well exposed sequences of Gondwana rocks in the southern hemisphere. The middle part of the succession, or Beaufort Group, which is the most extensively exposed stratigraphic unit in the Basin, contains a rich reptilian fauna that allows for a fairly refined scheme of biostratigraphic zonation (Keyser and Smith 1979). In comparison, little is known about the lithostratigraphy of the group; a situation occasioned to some extent by the vast and apparently monotonous succession of sandstones and mudstones lacking any well-defined lithostratigraphic markers. This problem is compounded by the lenticularity of most sandstones and the extensive dolerite intrusions which make correlation difficult. At the same time attempts to match straight lithologies rather than general lithological sequences have to contend with diachronism.

Uranium mineralisation occurs in the Beaufort Group in the southern Karoo Basin, usually as widely dispersed local concentrations within lenticular sandstones (Turner 1978, 1979). Because of this mode of occurrence and lack of adequate stratigraphic guides, the relationship between different mineralised horizons is uncertain (Turner 1981). A more detailed stratigraphic subdivision and correlation is therefore essential in order to try and overcome these problems. The main purpose of this paper is to attempt to establish a more detailed formal lithostratigraphic subdivision and correlation of the Beaufort Group in the southern Karoo Basin between Graaff-Reinet and Sutherland (fig. 1) based on the regional lithostratigraphic relationships outlined by Keyser and Smith (1979) and Turner (1979). All new formations and members are described in accordance with the requirements of the South African Stratigraphic Code (1971) and the International Subcommission on Stratigraphic Classification (1970).

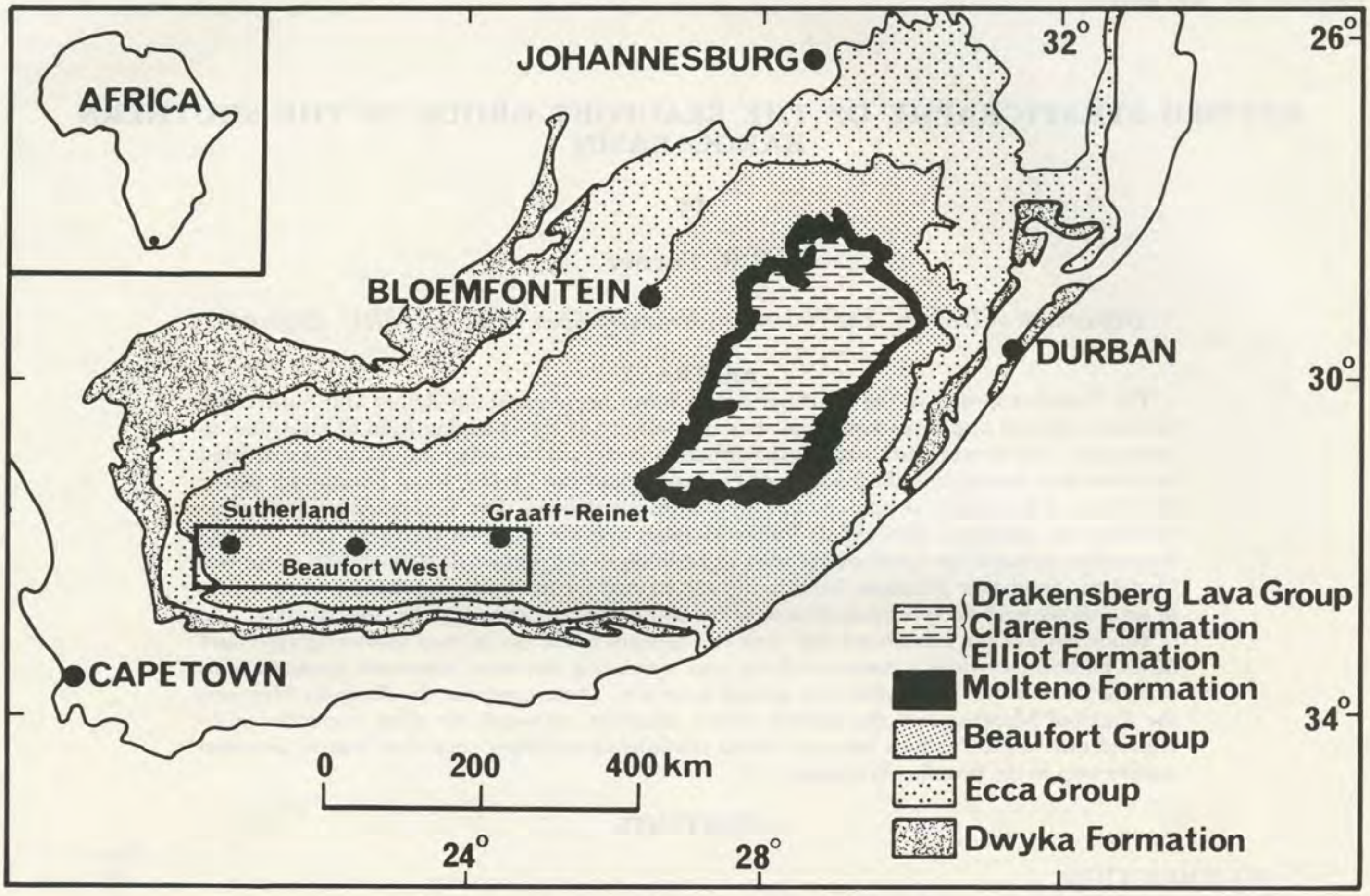

Figure 1. Karoo Basin and location of study area.

STRATIGRAPHY

General

Beaufort Group sediments were deposited in an intracratonic basin receiving detritus from a source area located to the south and west (Ryan 1967, Martini 1974, Turner 1975). Sedimentation was initiated by source area uplift (especially in the south), possibly due to collision between two lithospheric plates reproducing a cordilleran type orogenic event as predicted by modern plate tectonic theory (Dewey and Bird 1970). The sediments consist mainly of mudstones, siltstones and sandstones, and along the southern margin of the basin they have been caught up in the Cape Orogeny and extensively folded. Northwards the folding decreases in intensity and dies out completely on approaching the northern boundary of the study area (fig. 1) where the sediments are flat-lying.

The Beaufort Group lies conformably on the Ecca Group, the contact between them records a gradual change from a deltaic depositional system to a fluvial depositional system in response to source area uplift and the northward progradation of Beaufort sediments, accompanied by a gradual shallowing and shrinkage of the Ecca Basin in the same general direction. Thus argillaceous sediments assigned to the Ecca Group in the northern part of the basin may be the time equivalent of the Beaufort Group in the south (Turner 1978) and the boundary on a basinwide scale must be diachronous. The Ecca–Beaufort boundary is generally defined and mapped on the basis of the first occurrence of red and purple mudstones characteristic of the Beaufort Group. Unfortunately this definition cannot be applied in many areas because of the sporadic distribution of red and purple mudstones in the lower part of the Beaufort succession, as pointed out by Ryan (1967). A more reliable and accurate indication of the boundary is the presence of thick, laterally persistent sandstones of delta front origin that Johnson (1976) included in his Waterford Formation at the top of the Ecca Group. These sandstones can be distinguished from those in the Beaufort on the basis of their internal structure (presence of deformation structures and lack of cross-bedding), coarsening-upwards as opposed to fining-upwards grain-size trends, and the interbedded shales, which are generally darker, more carbonaceous and better laminated than the argillaceous rocks in the Beaufort.

A lithostratigraphic subdivision of the Beaufort Group in part of the eastern Cape Province was proposed by Johnson (1976). Although this scheme, with minor modifications, was accepted by the Karoo Working Group of the South African Committee for Stratigraphy, it is uncertain as to how it relates to areas farther west. This arises largely from facies changes and the fact that the scheme depends mainly on the presence or absence of red mudstones which are only sporadically

TABLE 1
Beaufort Group stratigraphy and facies associations in the southern Karoo Basin between Sutherland and Graaff-Reinet

Sequence*	Group	Subgroup	Formation West	Formation East	Member West	Member East	Biozones† West Keyser and Smith (1979)	Biozones† East Kitching (1977)	Facies Associations	Correlations with Eastern Cape‡
			Teekloof		Steenkampsberg§		*Dicynodon lacerticeps-Whaitsia*	*Daptocephalus*	Flood basin	Balfour Formation
					Oukloof		*Aulacephalodon-Cistecephalus*	*Cistecephalus*		
					Hoedemaker§	Oudeberg Sandstone	*Tropidostoma-Endothiodon*			
Karoo	Beaufort	Abrahamskraal			Paalhuis		*Pristerognathus Diictodon*			
			Verlatenkloof		Jakhals Valley		Dinocephalian	*Tapinocephalus*	High Sinuosity Channel	Middleton Formation
			Lootskloof						Low Sinuosity Channel	Koonap Formation

* Terminology according to recommendations of Karoo Working Group, South African Committee for Stratigraphy.
† The biozones in the west are assemblage zones whereas those in the east are essentially range zones.
‡ Terminology according to Johnson (1976).
§ Informal terminology according to Stear (1980).

present in the succession farther west. Thus, as a means of defining stratigraphic boundaries on both a local and regional scale, colour change is of little value, especially in the lower part of the succession where rapid changes in colour are particularly common. For this reason Keyser and Smith (1979) divided the Beaufort Group in this part of the Karoo Basin into two formations, the Abrahamskraal Formation and the Teekloof Formation. The Abrahamskraal Formation is distinguished from the overlying Teekloof Formation mainly in the presence of chert bands, the more numerous sandstones and the paucity of red mustone. Unfortunately, a twofold division recognises only broad lithostratigraphic trends and is inadequate in many areas where the Beaufort succession may comprise up to three lithostratigraphic divisions of formational status, which can be further divided, in some cases, into members based essentially on the changing ratio of sandstone to mudstone.

In view of this it is proposed that the Abrahamskraal Formation should be divided into two units of formational status, and the term Abrahamskraal elevated to subgroup status within the Beaufort Group, in accordance with the recommendations of the International Subcommission on Stratigraphic Classification (1970). The Teekloof Formation retains its name and status (table 1).

Stratigraphic studies reveal that all the formations within the Beaufort Group are of regional extent. However, the degree of exposure is poor in the Camdeboo Flats west of Pearston with the result that the formations in this area are of a composite nature based on borehole data and measured sections. Since both the Lootskloof and Verlatenkloof formations have been affected by the Cape Folding in this area, the relationship between stratigraphy and structure was determined prior to section measurement in order to try, as far as possible, to eliminate repetition of beds and anomalous thickness values. The location of stratotypes and reference sections is shown in Figure 2 and the generalised lithostratigraphic relations in Figure 3.

Lootskloof Formation

The formation is well exposed along Lootskloof River south of Pearston (fig. 2) where up to 400 m of continuous section is exposed in the northern limb of a large syncline. The formation attains a maximum thickness of about 490 m, but in the west in Verlatenkloof Pass, it thins to less than 100 m (fig. 5). To the east it grades laterally into the Koonap and possibly the lower part of the Middleton Formation (table 1). It is underlain by arenaceous deposits of the Waterford Formation at the top of the Ecca Group, and overlain by sediments of the Verlatenkloof Formation (fig. 3). The lower boundary is transitional and diachronous, being based primarily on differences in character of the sandstones and associated argillaceous strata. The upper boundary, which is not markedly diachronous, is transitional and arbitrarily defined on the changing ratio of sandstone to mudstone (mudstone increases at the expense of sandstone)

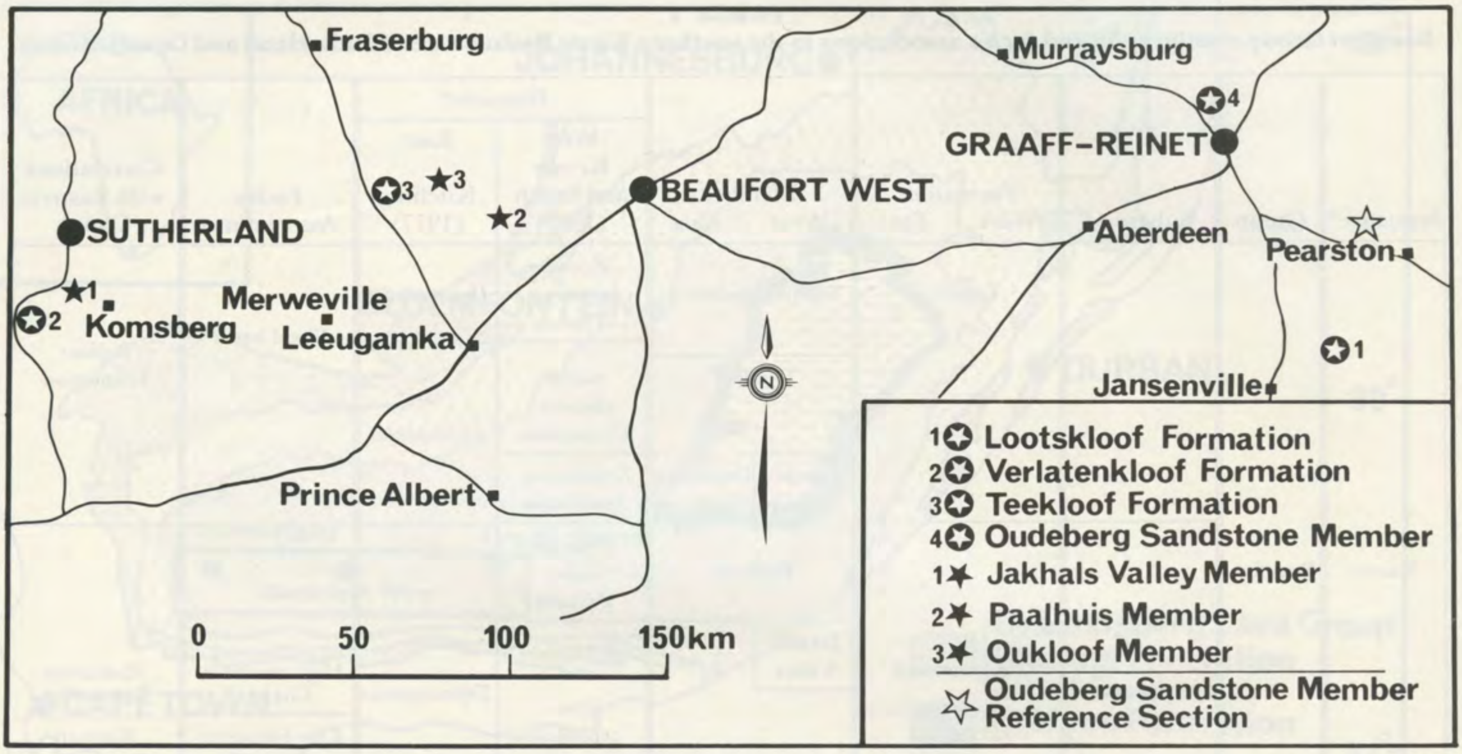

Figure 2. Location of stratotypes and reference section.

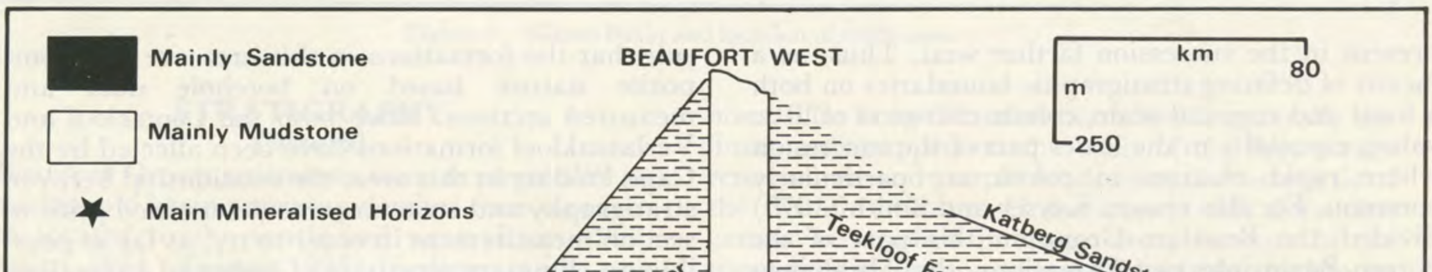

Figure 3. Generalised lithostratigraphic relations in the southern Karoo Basin between Graaff-Reinet and Sutherland.

and the increased red coloration of the mudstones (Turner 1978). The formation coincides with the lower part of the Abrahamskraal Subgroup (table 1). Chert bands are, however, not regarded as being diagnostic of the formation because they are absent in the Lootskloof section, and throughout most of the western part of the outcrop investigated, and occasional chert lenses have been found in the overlying formation.

Lithologically the formation consists of sandstones and subordinate interbedded siltstones and mudstones (figs. 5, 6). The sandstones attain thicknesses of up to 25 m, and are predominatly fine-grained, dark grey and calcareous. Many of them have a characteristically speckled appearance on both fresh and weathered surfaces, particularly in the eastern part of the basin around Jansenville and Graaff-Reinet. Characteristic sedimentary structures in the sandstones are horizontal lamination, ripple cross-lamination and cross-bedding (fig. 5). Sole structures, mudcracks, sandstone dykes and rill marks are present but less common. The sandstones are interbedded with mudstone and siltstone pellet conglomerates (sometimes associated with plant material and vertebrate bones), and contain pyrite and large brown-weathering calcareous nodules and lenses.

The argillaceous sediments consist of bluish-grey, occasionally maroon and purple mudstones and silty mudstones, interbedded with ripple cross-laminated greenish-grey siltstones. The mudstones

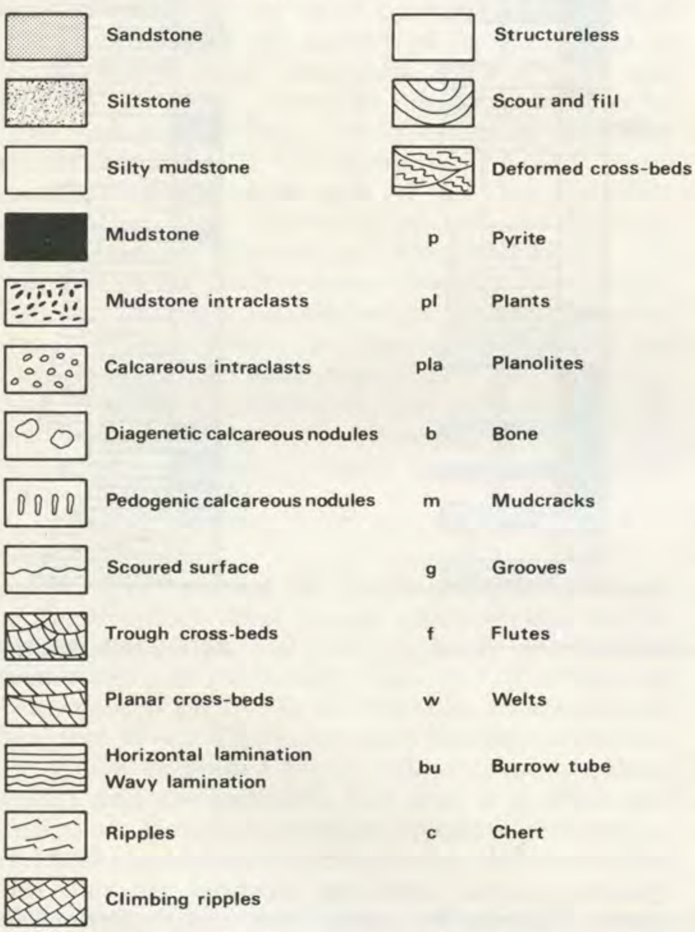

Figure 4. Key to measured sections.

contain calcareous nodules from 3 to 6 cm in diameter, which locally form nodular layers. Siltstones also occur as gradational units between the thicker sandstones (those more than 3 m) and mudstones, and may be ripple cross-laminated or horizontally laminated. Towards the top of the formation the following changes occur: (1) the ratio of sandstone to mudstones decreases (from 1 : 1 at the base to 1 : 4 at the top); (2) the sandstones become more lenticular and less speckled in appearance; (3) the maroon and red coloured mudstones become more common; (4) the number of calcareous nodules in the mudstones increases; and (5) the chert bands become less common. Biostratigraphically the formation falls within the Dinocephalian Assemblage Zone which is of Middle to Upper Permian age and comprises the lowermost part of the Beaufort Group in the southern Karoo Basin, west of longitude 25°E (Keyser and Smith 1979). It corresponds approximately with the low sinuosity channel facies association of Turner (1978) (table 1).

Verlatenkloof Formation

This formation is well exposed along the escarpment between Verlatenkloof and Ouberg Pass, south of Sutherland. The stratotype is located on the east side of Verlatenkloof (fig. 2) where the measured section is about 1 000 m thick (fig. 7). The top of the formation is not encountered in this area and when traced eastwards it thins to about 400 m in the vicinity of Beaufort West, thickening slightly in the Graaff-Reinet area to about 600 m (fig. 3). However, exposure in the east is generally poor (especially on the Camdeboo Flats between Aberdeen and Pearston) with the result that an understanding of the formation in this area is based mainly on borehole data, augmented by a few measured sections from road cuttings and river valleys.

The formation is underlain by the Lootskloof Formation (fig. 3), and merges laterally with the Middleton Formation east of Pearston (table 1). Moving eastwards across the basin from the Beaufort West area the formation is overlain by the Teekloof Formation and the Oudeberg Sandstone Member at the base of the Teekloof Formation (fig. 3). Lithologically the Verlatenkloof Formation consists of mudstone and silty mudstone with subordinate interbeds of siltstone and sandstone (fig. 8). It shows a lower degree of diagenesis than the underlying Lootskloof Formation and is less resistant to weathering. The mudstones are bluish grey to maroon or red, the red coloration becoming more pronounced towards the top of the formation, for example, at Libertas along the foothills of the escarpment west of Pearston. Calcareous nodules occur in the mudstones, sometimes concentrated into nodular layers. Chert lenses and septarian nodules have also been recorded from the mudstones, but according to Keyser and Smith (1979) the cherts differ from those in the overlying formation in that they are generally green, and also pink weathering.

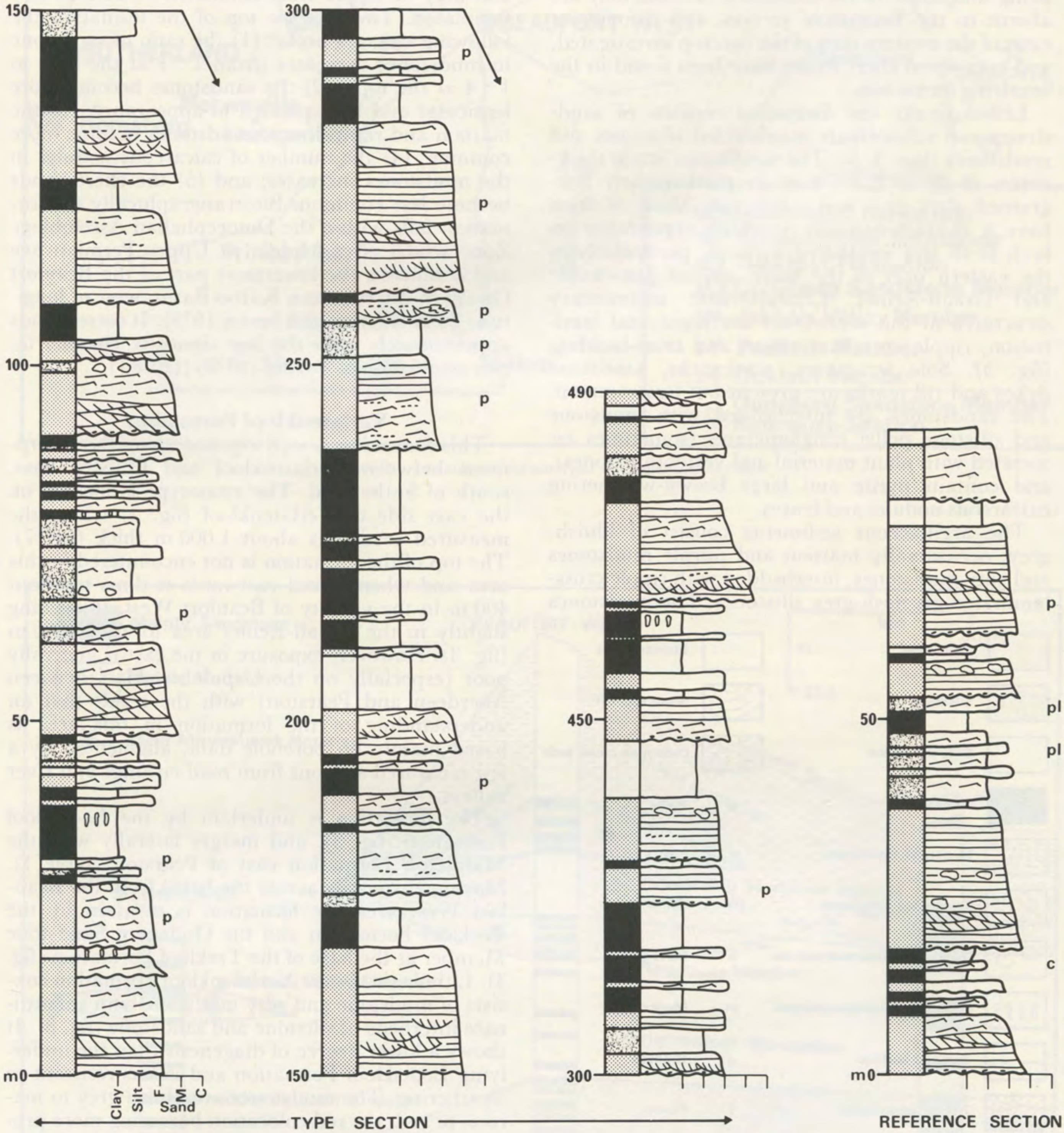

Figure 5. Type section and reference section of the Lootskloof Formation. The reference section is located at the foot of Verlatenkloof Pass, and is conformably overlain by the Verlatenkloof Formation (see fig. 2 for location).

Figure 6. Thick, laterally persistent sandstones interbedded with subordinate amounts of siltstone and mudstone, Lootskloof Formation, south of Pearston.

Siltstones are typically greenish-grey and characterised by ripple cross-lamination, horizontal lamination, lenticular bedding, burrows, root marks and purple red mottling. The siltstones occur as thin lenticular beds with scoured bases and gradational tops within the mudstones, or they form part of fining-upward sequences comprising sandstone, siltstone and mudstone. The sandstones are fine- to very fine-grained, greyish-green and structured mainly by horizontal lamination and ripple cross-lamination. They differ from the sandstones in the underlying formation in that they are slightly finer-grained, thinner, and more markedly lenticular in character. Within the middle of the formation in Verlatenkloof is an unusually thick (30 m) and laterally persistent sandstone that provides a useful local marker, here designated the middle sandstone marker (figs. 3, 7). The formation broadly corresponds with the upper part of the Dinocephalian Assemblage Zone, extending up into the *Pristerognathus-Diictodon* Assemblage Zone. However, the presence of the *Pristerognathus-Diictodon* Assemblage Zone is not firmly established in the Graaff-Reinet area, although Keyser and Smith (1979) record the *Tropidostoma-Endothiodon* Assemblage Zone outcropping south of Graaff-Reinet and extending to the east beyond Pearston. The formation is equivalent to the high sinuosity channel facies association of Turner (1978) (table 1).

Paalhuis Member

The upper part of the Verlatenkloof Formation in the Beaufort West area is characterised by the presence of about 140 m of regularly interbedded sandstones and mudstones (figs. 3, 7, 9) which are well exposed on the farm Paalhuis, 45 km west of Beaufort West. The sandstones weather a distinctive yellow or golden-brown colour (zone of golden sands) and are generally less than 8 m thick and lenticular. However, abutting contacts between individual sandstones sometimes give the impression that they are laterally persistent units, especially when seen from a distance. Horizontal laminations, ripple cross-laminations and cross-bedding are the dominant internal sedimentary structures. Calcareous pods and lenses are infrequently present within the sandstones, which also contain trace fossils *(Planolites?)* and possible pustular algal mats (Turner 1979). The interbedded mudstones are bluish-grey to maroon and locally silty in character with occasional calcareous nodules. The mudstones are massive and unlaminated and locally contain burrow tubes. Biostratigraphically the member falls within the *Pristerognathus-Diictodon* Assemblage Zone, and is the most important mineralised horizon in the succession, containing about 90 per cent of all known uranium occurrences. The member is possibly equivalent to the Poortjie Sandstone (Rossouw and De Villiers 1953) and includes the Rietkuil sandstone and the Rystkuil sandstone.

Jakhals Valley Member

A prominent feature of the formation in the west is the presence of about 110 m of interbedded sandstones and mudstones (figs. 3, 7) which are well exposed along the edge of the escarpment south of Sutherland on the farm Jakhals Valley. The sandstones are much thicker (25 m) than those in adjacent parts of the formation and form resistant ledges which stand out from the more easily weathered mudstones. These ledges are clearly visible on aerial photographs and form a distinct geomorphological expression of the member in this area. The sandstones are fine-grained and pale grey, often with a distinct speckled appearance similar to some of the sandstones in the Lootskloof Formation. They contain mudstone lenses, intraformational conglomerates, calcareous nodules and a little pyrite. Clasts within the conglomerates include mudstone, silty mudstone and reworked small calcareous nodules. The sandstones are locally rich in plant material and profusely cross-bedded, and are well exposed at the top of Verlatenkloof. Other structures present in the sandstones include horizontal lamination and ripple cross-lamination. The mudstones are bluish-grey to maroon in colour and contain minor interbeds of siltstone and fine sandstone up to 30 cm thick. The siltstone and sandstone interbeds fine upwards and are internally structured by horizontal lamination and ripple cross-lamination. The member wedges out to the east between Komsberg and Merweville (fig. 2); a similar wedging effect occurs west of Sutherland (fig. 3).

Teekloof Formation

This formation is named for exposures in Teekloof Pass, 30 km south of Fraserburg (fig. 2) where it attains a thickness of about 1 000 m. Details of the stratotype are given by Keyser and Smith (1979) and are not repeated here. The top of the formation is not encountered in the Beaufort West area where it is underlain by the Verlatenkloof Formation. Eastwards, between Graaff-Reinet and Pearston, the Teekloof Formation is underlain by the Verlatenkloof Formation (Paalhuis Member?)

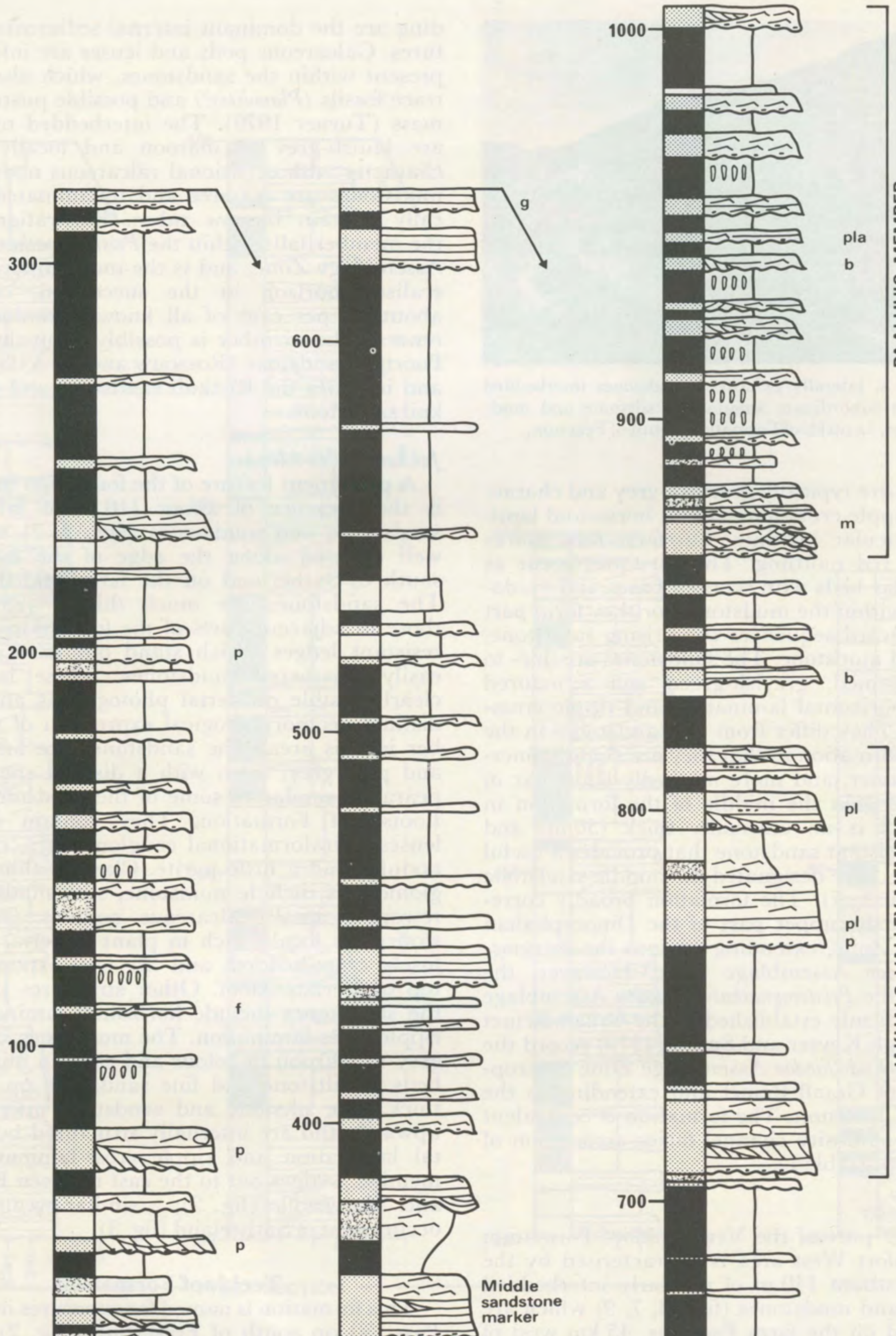

Figure 7. Type section of the Verlatenkloof Formation showing the nature and location of the Jakhals Valley Member and Paalhuis Member of the Formation.

Figure 8. Mudstones and silty mudstones with subordinate interbeds of sandstone and siltstone, Verlatenkloof Formation, west of Verlatenkloof, Sutherland District.

Figure 9. Thin sandstones and interbedded mudstones of the Paalhuis Member of the Verlatenkloof Formation (a) along the lower slopes of Gifberg, west of Beaufort West. The top of the Paalhuis Member is defined by a small plateau feature (b), overlain by the slope-forming mudstones of the Teekloof Formation (c), which contains a prominent sandy horizon, the Oukloof Member (d), towards the top (see fig. 11). The mountain is capped by a thick dolerite sheet (e).

and overlain by the Katberg Sandstone Formation (fig. 3). Between Fraserburg and Sutherland the formation appears to wedge out, whilst to the east it grades laterally into the Balfour Formation (table 1).

The formation consists predominantly of maroon and bluish-grey, massive, and locally silty mudstone with occasional interbeds of siltstone and fine-grained sandstone (Fig. 9). The mudstones are much more prominent than in the formation below, forming sequences up to 30 m thick between the siltstone and sandstone beds. Calcareous nodules are common in the mudstones, often concentrated into nodular layers and associated with vertebrate fossils (Kitching 1977). "Desert roses", representing pseudomorphs of calcite after gypsum are characteristic of the formation, especially in the east where they form distinct horizons (Keyser 1966).

The sandstones are generally less than 3 m thick (Turner 1978), fine-grained and graded, with a scoured base that is commonly associated with fine mudstone clasts. Internally, the sandstones are horizontally laminated and ripple cross-laminated with the tops of the beds frequently ripple-marked. The siltstone beds are less than 1 m thick. They have sharp or slightly scoured bases, internal cross-lamination, and grade into silty mudstone and mudstone at the top. Desiccation cracks are common along the bases of siltstone and sandstone beds which are less common and thinner than most arenaceous divisions in the Verlatenkloof Formation. The formation falls within the *Tropidostoma-Endothiodon*, *Aulacephalodon-Cistecephalus*, and *Dicynodon lacerticeps-Whaitsia* Assemblage Zones, and is equivalent to the flood basin facies association of Turner (1978) (table 1).

Oukloof Member

This member is particularly well exposed in Oukloof Pass, 39 km south of Fraserburg (fig. 2) where it attains a thickness of about 125 km (fig. 10). It consists of 28 m thick laterally persistent (more than 1 km) sandstones with minor amounts of mudstone and silty mudstone (figs. 10, 11). The sandstones are grey to yellow-grey, fine- to medium-grained, interbedded with mudstone pellet conglomerates and contain occasional bone fragments. Characteristic internal sedimentary structures are horizontal lamination, ripple cross-lamination and cross-bedding. The sandstones form prominent cliffs and ledges between the less resistant argillaceous strata. Mudstones and silty mudstones are typically bluish-grey or maroon and contain calcareous nodules and occasional burrow tubes (fig. 10). The member falls within the *Aulacephalodon-Cistecephalus* Assemblage Zone of Keyser and Smith (1979).

Recently Stear (1980) informally introduced the terms Hoedemaker and Steenkampsberg member for the mudstone-dominated sequences below and above the Oukloof Member. The Hoedemaker member coincides with the *Tropidostoma-Endothiodon*

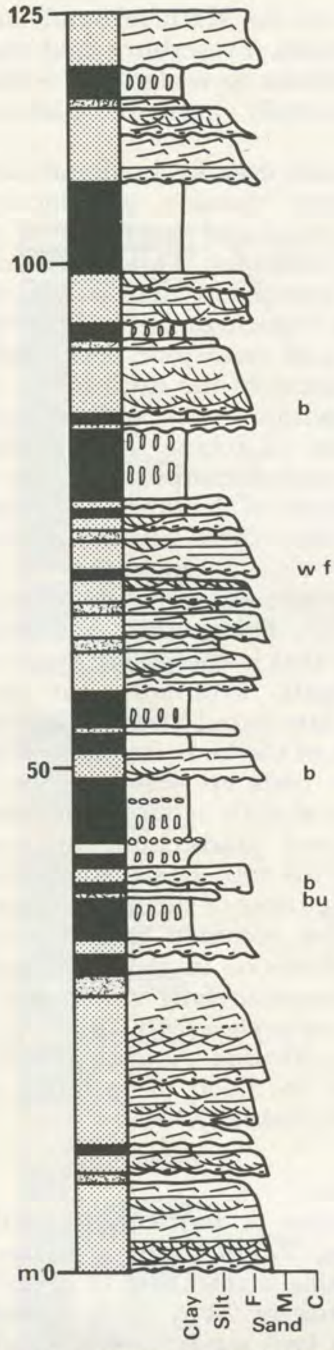

Figure 10. Type section of the Oukloof Member of the Teekloof Formation.

Assemblage Zone and the Steenkampsberg member with the *Dicynodon lacerticeps-Whaitsia* Assemblage Zone and the uppper part of the *Aulacephalodon-Cistecephalus* Assemblage Zone (table 1).

Oudeberg Sandstone Member

The name Oudeberg Sandstone was first used by Keyser (1973) for exposures of Beaufort Group strata to the north-east of Oudeberg Pass between Graaff-Reinet and Murraysburg (fig. 2). Within the pass itself the section is faulted and extensively intruded by dolerite, making it unsuitable as a stratotype. Good exposures occur farther east towards Pearston, particularly along the foothills of the escarpment on the farm Libertas where a reference section was measured (fig. 12).

Figure 11. Thick laterally persistent sandstones with subordinate mudstones and siltstones of the Oukloof Member, Oukloof Pass, south of Fraserburg. The base of the member is the base of the lowermost laterally persistent sandstone.

The member, which is about 120 m thick, defines the base of the Teekloof Formation, and is underlain by the Verlatenkloof Formation (fig. 3). It consists of sandstones with minor amounts of mudstones and silty mudstone (fig. 12). Individual sandstones are laterally persistent and attain thicknesses of up to 20 m, particularly in the lower and middle part of the formation (fig. 12). They are fine- to medium-grained sandstones structured by horizontal lamination, ripple cross-lamination and occasional cross-bedding. Mudpellet conglomerates, pyrite and plant material are present in the sandstones, which weather out from the softer more argillaceous formations above and below to form prominent ledge features (fig. 13). The formation dips eastwards at about 2–3°, probably as a result of an underlying dolerite intrusion. Its upper and lower boundaries are taken at the first and last appearance of thick, laterally persistent sandstones. The formation wedges out between Graaff-Reinet and Aberdeen; to the east its extent is uncertain, but it probably extends as far as East London. The formation falls within the *Tropidostoma-Endothiodon* Assemblage Zone of Keyser and Smith (1979), which places it stratigraphically just below the Oukloof Member of the Teekloof Formation in the Beaufort West area (table 1). The formation represents a sandstone dominated fluviatile sequence at the base of the floodbasin facies association (table 1) which has been compared to the low sinuosity channel facies association of Turner (1978).

CONCLUSIONS

The proposed lithostratigraphic subdivision of the Beaufort Group in the southern Karoo Basin between Graaff-Reinet and Sutherland, and its relationship to the established biostratigraphy (Keyser and Smith 1979) and facies patterns (Turner 1978, 1979,) enables the more important uranium mineralised horizons in the succession to be fixed and correlated with greater accuracy. For

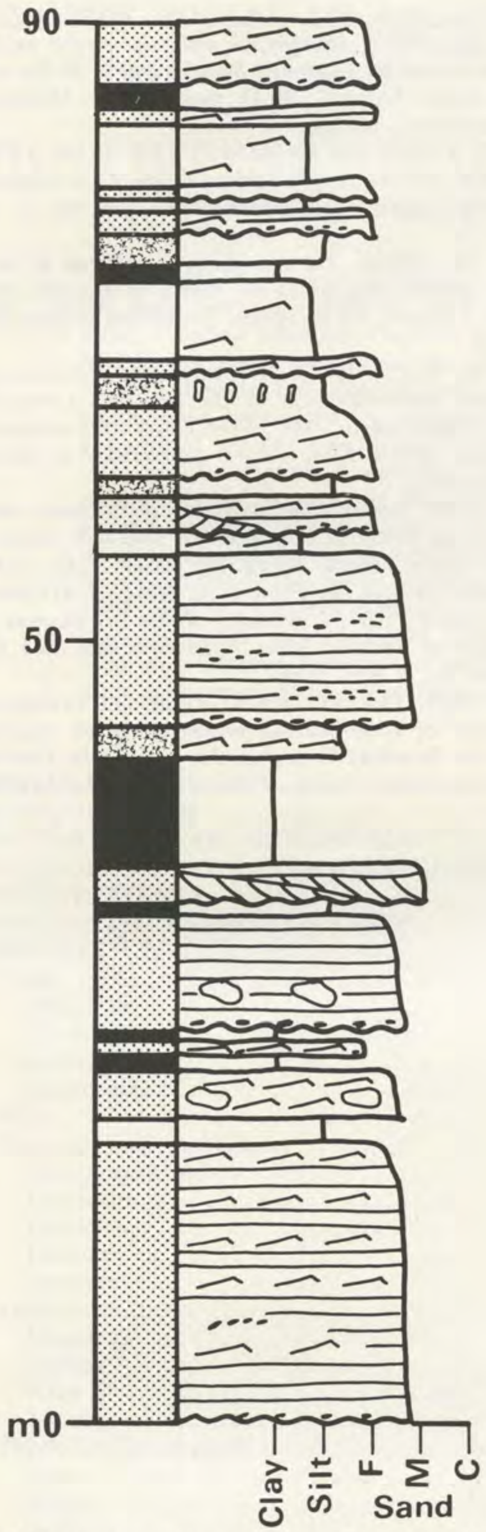

Figure 12. Reference section of the Oudeberg Sandstone Member of the Teekloof Formation.

example, in the Beaufort West area the most important mineralised horizon (containing 90 per cent of all known uranium occurrences) coincides approximately with the Paalhuis Member at the top of the Verlatenkloof Formation which falls within the *Pristerognathus-Diictodon* Assemblage Zone (Keyser and Smith 1979) and the top of the high sinuosity channel facies association (Turner 1978, 1979) (fig. 3). The base of this member includes the Rietkuil and possibly the Rystkuil sand-

Figure 13. Prominent, ledge-forming sandstones of the Oudeberg Sandstone Member, between Graaff-Reinet and Pearston. The sandstones are located at the base of the Teekloof Formation along the contact with the underlying Verlatenkloof Formation which forms the lower slopes of the mountain and the flats in the foreground. Capping the mountain is a thick dolerite sheet.

stones, two of the most important mineralised sandstones in the Beaufort West area. Westwards, the extent of the Paalhuis Member is uncertain; it may wedge out or extend around the outcrop towards the north as depicted on the geological map of Sutherland. Nevertheless, the *Pristerognathus-Diictodon* Assemblage Zone is still present and suggests that biostratigraphically the main mineralised horizon at Sutherland is the same as that around Beaufort West, whether it coincides with the Paalhuis Member or not.

Important occurrences of uranium mineralisation occur within the Oukloof Member of the Teekloof Formation (fig. 3), especially south of Fraserburg, although they tend to be more localised than those in the Paalhuis Member of the Verlatenkloof Formation. Other important occurrences of uranium mineralisation are associated with the sandy Jakhals Valley Member lower down in the Verlatenkloof Formation (fig. 3) along the edge of the escarpment south of Sutherland (Turner 1975). The way in which the main mineralised horizon relates to areas farther east is not firmly established because of the poor outcrop and lack of adequate borehole and biostratigraphic control. However, recent vertebrate finds in Beaufort sandstones along the Bullrivier in the Jansenville District, in an area that is extensively mineralised, indicate the presence of the Dinocephalian Assemblage Zone (Turner 1981). This suggests that the main mineralised horizon in this area occurs lower in the succession than around Beaufort West.

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