ECONOMIC GEOLOGY RESEARCH UNIT

University of the Witwatersrand
Johannesburg

THE STRATIGRAPHIC AND SEDIMENTOLOGICAL DEVELOPMENT OF THE WITWATERSRAND WEST RAND BASIN IN THE KLERKSDORP AREA

M. B. WATCHORN

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UNIVERSITY OF THE WITWATERSRAND
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ABSTRACT

The West Rand Group, which is the lower subdivision of the Witwatersrand Supergroup, comprises up to 4 000 m of epiclastic sediments. At the base, the Hosptial Hill Subgroup is characterized by mature quartz-arenites, mudstones, siltstones, and minor chemical sediments. Textural trends and bimodal bipolar palaeocurrents suggest that sedimentation was controlled by the interaction between a tide-dominated coastline and a marine shelf. Facies analysis indicates that clastic detritus was derived from a northern provenance and deposited within a tectonically-active epeiric sea. The pervasive development of tidal indicators implies that the early West Rand basin probably opened to an ocean or a very large body of water.

The predominantly arenaceous Government Subgroup contains unimodal cross-stratified arkoses with numerous interbedded conglomerates. These alternate with argillaceous members within which thin diamictites are present. The postulated depositional environment is one of rapid fluvial progradation down a southerly palaeoslope. This produced a series of river-dominated deltas which built on to a shallow shelf. Periodic increases in fluvial discharge led to the formation of subaqueous debris flows, now represented by the diamictites. The decrease in energy-level along the shoreline might have been related to a decrease in the extent of the depository and simultaneous basin-closure.

The sequence and envisaged model for the Jeppestown is similar to that of the Government, except for the presence of the amygdaloidal Crown lava. Another significant difference is the development of economic deposits of gold and uranium at the base of the succession. This placer mineralization is stratigraphically restricted, and palaeocurrent analysis of the host-sediments indicates a unique source-area to the east. This switch in provenance is attributed to syndepositional tectonics. The upper contact of the Jeppestown is taken at the Commonage Reef, below which palaeocurrents revert to a southerly distribution.

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I. INTRODUCTION

The West Rand Group (previously known as the Lower Division of the Witwatersrand Supergroup) has been exploited for economic deposits of gold and uranium in the Klerksdorp area only. These placer accumulations display a distinct stratigraphic control in being confined to the lower part of the Jeppestown Subgroup. Consequently, stratigraphic and sedimentological data may provide information as to the constraints of mineralization and act as a guide for further exploration.

The current investigation was mainly field-oriented and based largely on 103 measured sections. This information was supplemented by core from five boreholes, four of which were sited in the Klerksdorp and Rietkuil areas, whereas the fifth was drilled at Mazista (Figure 1). Particular attention was focused on lithologies, textural trends, and sedimentary structures, in an attempt to reconstruct a depositional model for the northwestern portion of the West Rand depository.

The stratigraphic nomenclature adopted is broadly similar to that proposed by the South African Committee for Stratigraphy (in prep.). However, a number of stratigraphic boundaries have been redefined, in order to facilitate identification both in subsurface and in the field.

II. GEOLOGICAL SETTING

The main area of investigation is situated 140 km southwest of Johannesburg and lies between the towns of Klerksdorp in the south and Ventersdorp in the north (Figure 1). Further studies were carried out on a number of discrete outcrops to the west of Klerksdorp, broadly known as the Rietkuil and Syferfontein areas (Figure 1).

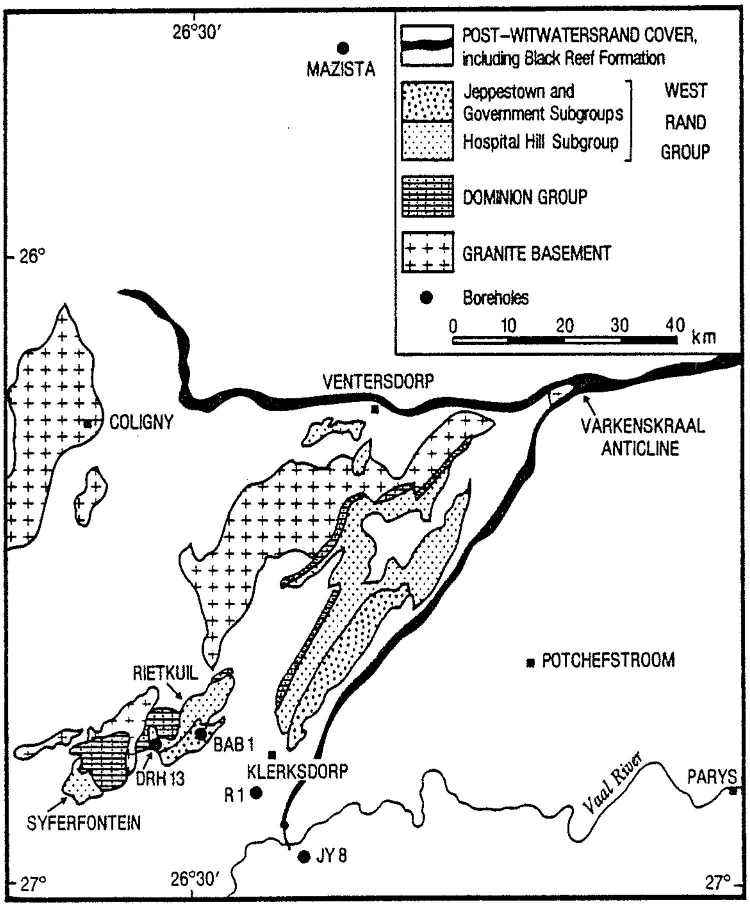

Figure 1 : General geological and locality map of the study-area.

The Witwatersrand Supergroup is subdivided into a lower, West Rand Group, consisting of 400m of arenaceous and argillaceous strata which are disconformably succeeded by the arenites and conglomerates of the 3000m-thick Central Rand Group. In the western Transvaal, the Witwatersrand Supergroup rests nonconformably on the predominantly volcanic Dominion Group. This latter sequence, which as been dated at 2800 Ma by the U-Pb method, was laid down on an earlier granite-greenstone basement that reveals an Rb-Sr age of approximately 2900 Ma (Burger and Coertze, 1973). An upper-age constraint is placed on the Witwatersrand succession by the overlying Ventersdorp Supergroup, dated at 2300 Ma (Burger and Coertze, 1973).

In the Klerksdorp-Ventersdorp region, the West Rand Group is exposed as a north-northwesterly-trending belt, on the eastern limb of the Varkenskraal anticline (Figure 1). Numerous strike-faults have resulted in repetition of the strata and, in the vicinity of Klerksdorp, may have been partially responsible for overturning the Orange Grove Formation at the base of the sequence (Nel, 1934). Deformation increases in intensity towards the west, so that a series of smaller-scale folds is developed in both the Rietkuil and Syferfontein areas. In the former, complex faulting and poor exposure complicate the geology, although refolding of the northeasterly-trending Rietkuil syncline about a later northwesterly axis indicates at least two phases of plastic deformation (Wilson et al., 1964).

The relatively-widespread lower division of the West Rand Group consists of mature quartz arenites, associated with thick argillaceous sediments and minor chemical deposits. The upper stratigraphy is exposed in the Klerksdorp and Rietkuil areas only (Figure 1), where it is dominated by arkoses and intercalated conglomerates, which are interbedded with argillites and a single lava unit. These gross vertical trends in lithology are consistent with the ideas of Brock and Pretorius (1964) who envisaged a gradual decrease in the areal extent of the Witwatersrand basin through time.

III. PREVIOUS WORK

The most significant contribution to the geology of the Klerksdorp district was made by Nel (1934) who compiled a detailed geological map of the area. He described the West Rand Group as a sequence of siliciclastic rocks and pointed out the similarities with the type-section of the Witwatersrand, documented by Mellor (1917). Nel (1934) divided the sequence into a basal Hospital Hill Subgroup, characterized by fuchsite-bearing quartz arenites and mudstones, overlain by less-mature sandstones, conglomerates, and mudstones, belonging to the Government and Jeppestown subgroups. Magnetite was noted as a common constituent of the argillites throughout the succession, whereas lenticular diamictites were unique to the Government Subgroup. These diamictites were believed to be of glacial origin, due to the presence of striated clasts, with subsequent palaeoclimatic implications.

Collender (1960) described the detailed stratigraphy of the Jeppestown and Government subgroups as revealed by subsurface drilling south of Klerksdorp and from the Rietkuil area. In the Government Subgroup, he recognized five superimposed fining-upward cycles, on which he based his stratigraphic subdivision. The base of the Jeppestown was placed at the Outer Basin Reefs at Rietkuil and the West Rand Group terminated at the Ada May Reef.

Brock and Pretorius (1964) compiled isopach maps for the West Rand basin. These indicated that the depositional axis trended north-eastwards and the depository reached its maximum extent during Hospital Hill times, when the northwestern basin-margin was situated near Ventersdorp. However, a borehole drilled by the Geological Survey at Mazista, 65km north of Ventersdorp, intersected 1500m of West Rand strata. This indicates that the basin was far more extensive than originally anticipated.

IV. STRATIGRAPHIC SUBDIVISION

The primary objective of the stratigraphic scheme adopted in the current study (Figure 2) was to be able to apply the system to field exposures, in order to correlate and compare the various West Rand outcrops. Consequently, where possible, stratigraphic boundaries were placed at easily-recognizable lithologic contacts, some of which have distinct geophysical properties. This method was subsequently applied to borehole core and found to be effective. The nomenclature proposed by the South African Committee for Stratigraphy (in. prep.) was utilized in the Klerksdorp area, in order to prevent confusion by the introduction of further unnecessary terminology.

The West Rand Group is classically subdivided into three Subgroups, the Hospital Hill, Government, and Jeppestown, within each of which three formations are identified (Figure 2). These units all display considerable lateral persistence and jointly constitute a broadly-upward-coarsening sequence.

V. THE HOSPITAL HILL SUBGROUP

The Hospital Hill assemblage is best exposed in the Klerksdorp-Ventersdorp area, where it attains a maximum thickness of 900m. It is characterized by basal and upper formations, which are dominated by mature quartz arenites, separated by an essentially-argillaceous unit, with minor arkoses and chemical sediments (Figures 2 and 3).

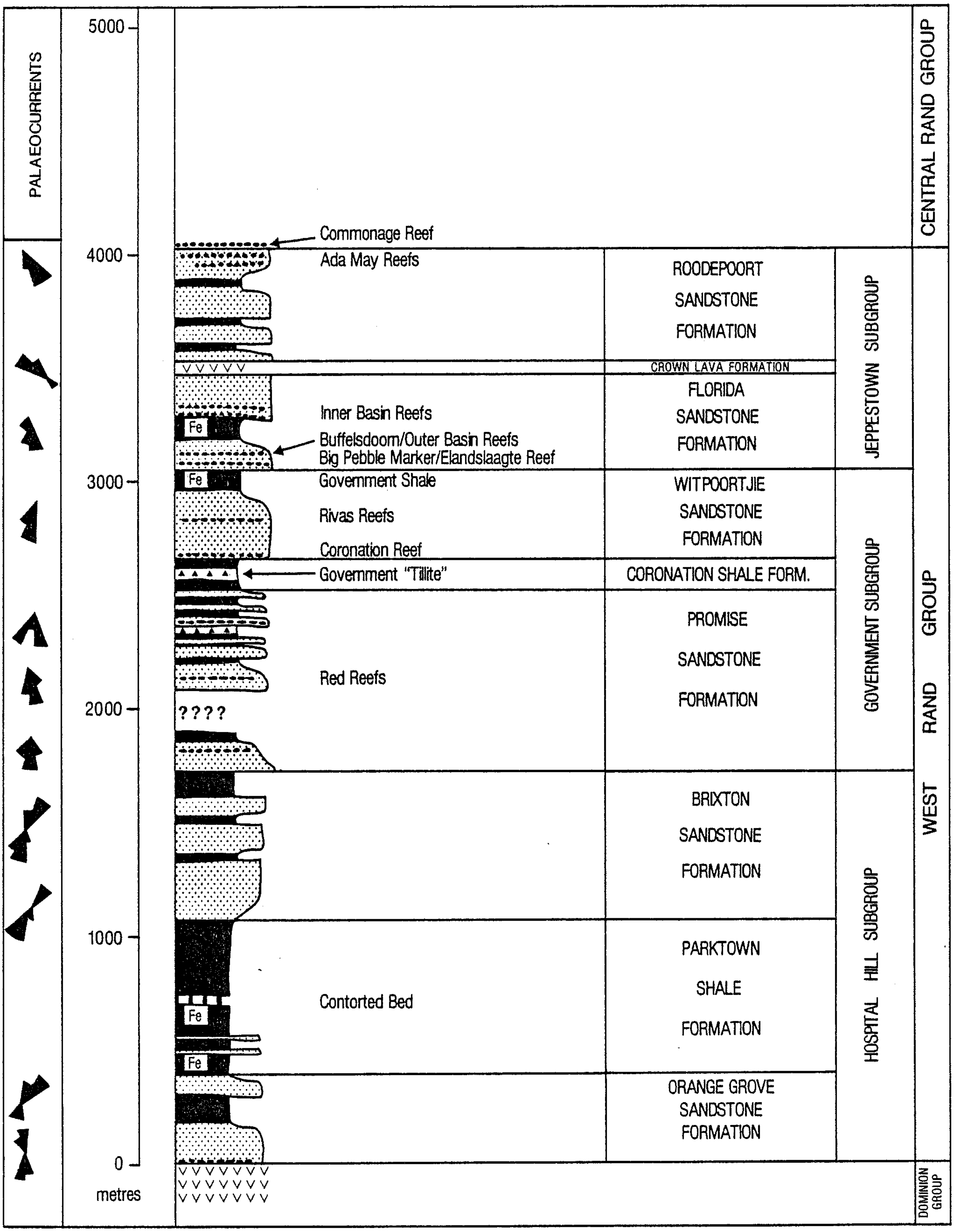

Figure 2 : Stratigraphy, textural trends, and generalized palaeocurrents of the West Rand Group in the Klerksdorp area.

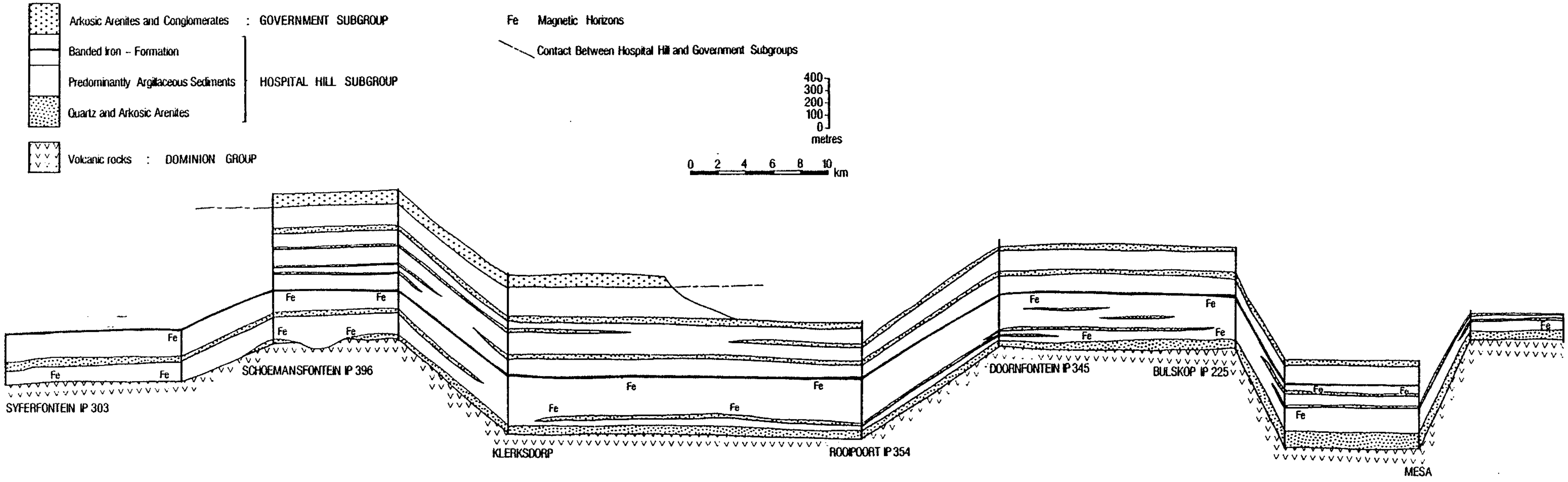

Figure 3 : Diagrammatic representation of the stratigraphy of the Hospital Hill and basal Government subgroups in the Klerksdorp district (looking towards the northwest).

A. The Orange Grove Sandstone Formation

The Orange Grove Formation initiates the West Rand basin and, in the western Transvaal, nonconformably overlies volcanic rocks belonging to the Dominion Group . When fully developed in the Klerksdorp-Ventersdorp area, the Orange Grove Formation comprises two quartz arenite units, with interbedded mudstones, arranged in a fining-upward sequence (Figure 3). In the Mazista borehole, four such sandstones are developed over a similar thickness. Within the confines of the study-area, these sandstone beds are lenticular, although the lower is by far the most persistent. However, in the Rietkuil and Syferfontein areas, this basal sandstone is only sporadically developed, and, frequently, argillaceous sediments belonging to the Parktown Formation are in direct contact with the Dominion Group (Figure 3).

The quartz arenites, which are commonly responsible for a prominent escarpment, are fine-to-medium-grained, with an irregular basal conglomerate, composed of quartz clasts in a quartzose matrix. The sandstones are well sorted and whitish in outcrop, with an occasional greenish tinge, due to the presence of fuchsite. In the south and west of the study-area, primary sedimentary structures have largely been obliterated by a penetrative cleavage and recrystallization. However, in the Ventersdorp area and the Mazista borehole, herringbone cross-stratification is common, as are trough cross-beds. Palaeocurrent data produce bimodal patterns, with asymmetric modes which vary in orientation between north-south and northeast-southwest (Figure 2). The interbedded argillites are up to 50m thick and comprise interlaminated siltstones and mudstones, with minor erosively-based sandstone laminae.

The most striking features of the Orange Grove Formation are the maturity of the sandstones and the presence of bi-directional cross-stratification. These are consistent with deposition by ebb-and-flood currents on a tide-dominated coastline. The geometry, textural trends, and distribution of the Orange Grove Formation, suggest that sediment was derived from a northern source-area and reworked as a transgressive blanket-sand within a progressively expanding basin. The intercalated argillaceous sediments are interpreted as proximal shelf deposits, which indicate that the transgression was a pulsatory event. The absence of the Orange Grove Formation at Syferfontein and its poor development in the Rietkuil area suggest that these were areas of non-deposition and represent palaeohighs during the early evolution of the West Rand basin.

B. The Parktown Shale Formation

Varying proportions of mudstones and siltstones comprise the bulk of the Parktown Formation, which has a maximum thickness of 650m (Plate 1A). Intercalated sandstones are generally arkosic in composition, except in the Syferfontein area, where an appreciable quartz arenite unit is present (Figure 3). A number of magnetic horizons are developed in the Parktown Formation, of which two are regionally significant. The lower of these occurs 50-60m above the Orange Grove Formation and is correlated with the Water Tower Slates on the Witwatersrand (Mellor, 1917). It is usually represented by a black massive mudstone, although a thin unit of banded iron-formation may be sporadically developed. The Contorted Bed is the upper magnetic horizon which is immediately underlain by a sequence of magnetic mudstones (Plate 1B). Minor magnetic cycles unrelated to these two horizons are probably only locally developed.

Sedimentary structures are rarely preserved in the interbedded arkosic sandstones, within which superimposed small-scale (50-100cm) fining-upward cycles were recorded. However, limited data from trough cross-beds suggest a unimodal southerly palaeocurrent distribution. The quartz arenites in the Syferfontein and Rietkuil areas (Figure 3) are atypical of the Parktown Formation in the western Transvaal. Palaeocurrent data produce bimodal bipolar dispersal patterns which are orientated northeast-southwest and east-west. The Contorted Bed represents the only regionally-persistent marker, as all the sandstone bodies have lenticular geometries (Figure 3).

The predominantly argillaceous sediments of the Parktown Formation were deposited from suspension on a broad shallow shelf, in response to the continued enlargement of the basin. In regions of limited clastic supply, precipitation from solution of iron and silica led to the development of magnetic mudstones and banded iron-formations. Episodic turbidity currents may have been responsible for the formation of lenticular arkosic arenites, except in the west of the study-area, where tidal sandstones were deposited in response to localized progradation. This progradation was possibly related to adjacent uplift of the Klerksdorp dome (terminology of Hunter, 1975).

C. The Brixton Sandstone Formation

The base of the 500m-thick Brixton Formation is taken at the first sandstone unit above the Contorted Bed (Figures 2 and 3). The sequence is only fully developed in the area north of Klerksdorp, where it comprises three superimposed cycles which coarsen-upwards. These cycles have interlaminated mudstones and siltstones at the base, succeeded by medium-grained quartz arenites. Strike-faulting in the Klerksdorp-Ventersdorp area obscures the geometry of these sandstone units, although they probably display some degree of lenticularity.

The quartz arenites have a conspicuous green colouration and are characterized by trough and herringbone cross-stratification, which produces a bi-directional palaeocurrent distribution (Plates 1 C,D,E). These cross-beds are oriented north-south and northeast-southwest, with the southerly mode often dominant (Figure 2). Occasional thin (20-30cm) conglomerates occur at the base of minor upward-fining sequences within the sandstones. Pebbles are composed of rounded vein quartz and chert and have a maximum diameter of one centimetre and occupy shallow scours.

Textural trends, sedimentary structures, and lithologies in the Brixton Formation suggest that this unit was deposited by the progradation of shoreline sequences into a tidal basin. The similarity of the argillaceous sediments with those in the Parktown Formation and absence of indicators of emergence imply that they accumulated on a shallow shelf. The quartz arenites were subjected to continual re-working as a series of tidal-sand bodies, whereas the conglomerates represent lag deposits in areas of intense tidal scour. Each progradational cycle was succeeded by transgression which was responsible for the redistribution of sediment as relatively persistent units. The Brixton Formation marks the beginning of a major regressive phase during the evolution of the West Rand basin.

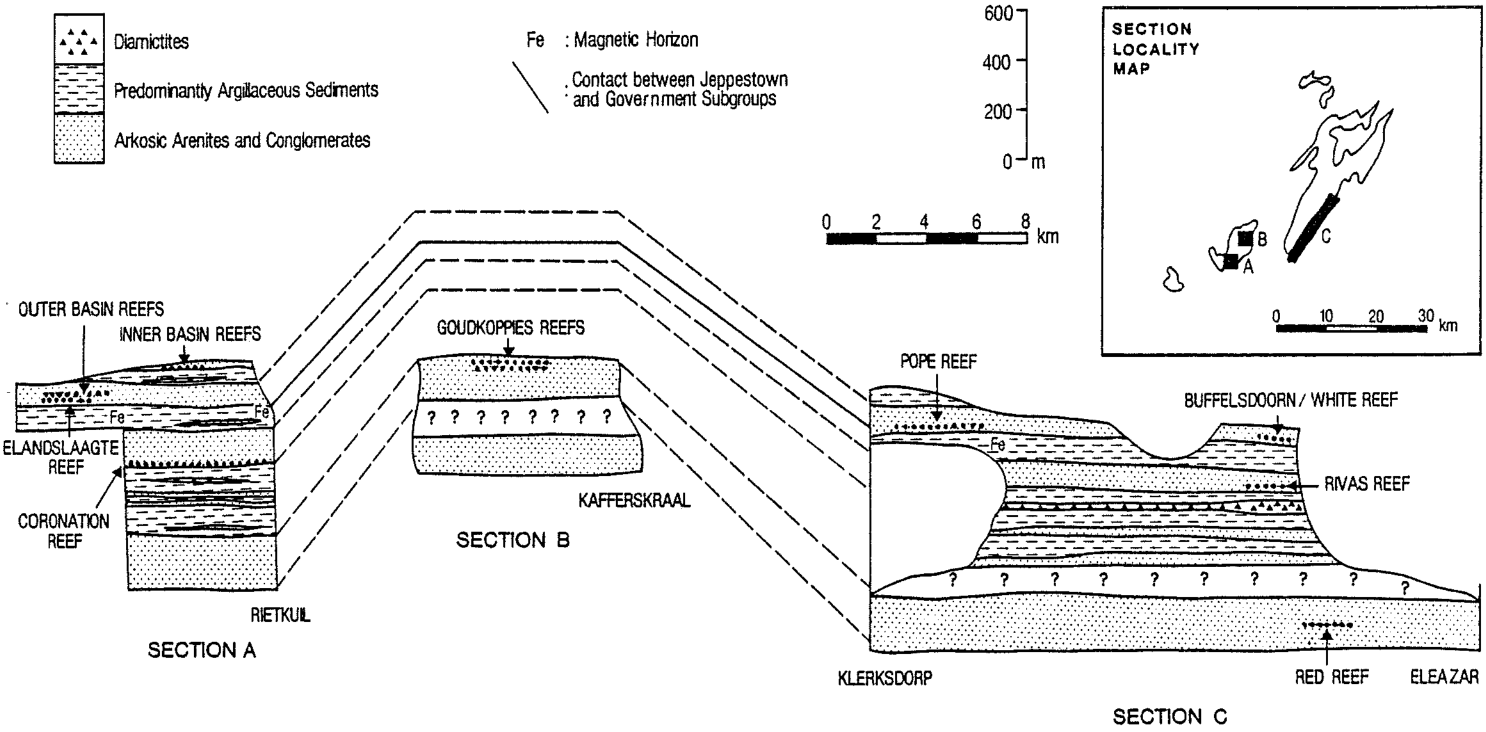

Figure 4 : Stratigraphic correlation of the Government and Jeppestown subgroups in the Klerksdorp, Kafferskraal, and Rietkuil areas. Information obtained from Borehole BAB I has been extrapolated for the Rietkuil area.

VI. THE GOVERNMENT SUBGROUP

The Government Subgroup is restricted in outcrop to the areas immediately north of Klerksdorp and Rietkuil (Figure 1). In the Western Transvaal, it is readily distinguished from the underlying Hospital Hill by the relative increase in the proportion of coarse clastics, their immaturity, and the frequency of interbedded conglomerates. The sequence comprises two formations dominated by sandstones, separated by a mainly argillaceous unit.

A. The Promise Sandstone Formation

The base of the 800m-thick Promise Formation is exposed as a prominent sandstone ridge on the farm Palmietfontein IP 374, north of Klerksdorp. It occurs at the top of an upward-fining cycle, which has a gradational lower contact with the Brixton Formation (Figure 2). The sandstone is an immature coarse-grained arkose, within which thin (15-20cm) small-pebble and granule-sized conglomerates overlie shallow scours. This unit is correlated with the uppermost sandstone bed in the Mazista borehole and crops out on Schoemansfontein IP 396 in the Kafferskraal area (Figure 4). The overlying section of the Promise Formation is not exposed and was not intersected by any of the five boreholes. However, mapping by Nel (1934) showed the tract of country to be underlain by "quartzites, shales and intrusive diabase".

The middle Promise Formation is well-developed in the Klerksdorp area, as a prominent linear ridge of arkosic arenites which host the Red Reefs (Plate 1F). This unit is correlated with exposures on Beentjieskraal IP 399 in the Rietkuil area, in addition to the sandstones at the base of Borehole BAB I. Trough cross-stratification, with solitary planar intrasets, characterizes these sandstones, which contain numerous small-pebble conglomerates (Plate 2A). Conspicuous iron staining, after pyrite, is associated with these conglomerates, and pyritic microlaminae define some foresets. Within the sandstones, fine-grained deposits are limited to occasional horizontally-laminated siltstones, which are laterally impersistent.

Exposure of the upper Promise Formation is restricted to a series of prospect pits north of Klerksdorp and, consequently, much of the stratigraphy was reconstructed from subsurface data. The sequence consists of three or four sandstone horizons, some of which are probably lenticular, separated by predominantly-argillaceous units. The sandstones have sharp erosive bases and grade upwards into the overlying mudstones and siltstones. They are generally arkosic arenites, with ill-defined trough cross-stratification and immature small-pebble conglomerates. The Promise Reef is developed at the base of one of these units, where it erosively overlies argillaceous sediments containing a diamictite horizon. The last-mentioned is correlated with the "Lower Tillite" of Nel (1934) and is composed of blackish quartz wacke, with scattered clasts of vein quartz, chert, and platey mudstone fragments. The argillaceous deposits are predominantly interlaminated mudstones and siltstones and thin interbedded sandstones, with erosive bases.

The majority of the palaeocurrent measurements were obtained from the lower Promise Formation (Figure 2). The resultant dispersal pattern is unimodal and indicates a southerly direction of progradation, which accords with limited data from the upper sequence. In terms of a depositional model for the Promise Formation, it is envisaged that sedimentation was controlled by the interplay between continental and shelf regimes. Fluvial sediments of the braided stream variety distributed sandy sediment down a uniform southerly palaeoslope. Periodic tectonic uplift led to the introduction of coarse detritus and progradation of fluvial deposits, via a low-energy coastline, directly on to a shallow shelf. Deposition in the shelf-environment was predominantly by vertical suspension, which was interrupted by the introduction of sandy storm-surges and mass-flow sediments. Gradual shifts in depositional loci or tectonically-induced transgressions produced upward-fining cycles, with negligible reworking. The base of the Promise Formation marks a dramatic reduction in the energy-level at the margin of the West Rand depository. This suggests that basin closure must have been achieved prior to the deposition of the Promise Formation.

B. The Coronation Shale Formation

This dominantly-argillaceous formation has a maximum thickness of 140 m (Figure 2). It is readily weathered and, consequently, has little surface expression, although, in borehole core, it has stratigraphic significance, in that it hosts the "Upper Tillite" of Nel (1934). This diamictite horizon is a useful marker, since it occurs at a remarkably consistent stratigraphic height. It comprises a dark grey-to-black quartz wacke, with isolated pebbles of quartz and chert. The remainder of the succession consists of interlaminated siltstones and mudstones, with minor fine sandstone laminae.

The accumulation of sediment in the Coronation Formation was controlled by suspension-settling of fine sediment on a gradually-subsiding shelf. Intercalated sandstones indicate occasional high-energy influxes of coarse sediments. The widespread nature of the diamictite and its association with shelf-deposits suggest that it was related to a catastrophic tectonic event. This was responsible for an increase in the sediment-supply and resulted in the generation of subaqueous mass-flows.

C. The Witpoortjie Sandstone Formation

The stratigraphy of the 400 m-thick Witpoortjie Formation has been reconstructed largely from subsurface data, due to its poor exposure in the study-area. It comprises a lower sandstone member, which is a coarse-to-very coarse arkosic arenite, with numerous interbedded small-pebble conglomerates.

At the base, the Coronation Reef directly overlies mudstones, whereas the Rivas Reefs probably form lenticular bodies higher in the sequence (Figure 2). These conglomerates are typically immature, containing angular clasts of quartz, chert, felsic lava, and mudstone. Associated pyrite mineralization comprises authigenic grains within a poorly-sorted arkosic matrix. The only available palaeocurrent information was obtained from a prospect pit on Palmietfontein IP 403, where trough cross-beds indicate a unimodal southerly distribution (Figure 2). These sandstones are gradationally overlain by horizontally-laminated mudstones, which display marked magnetic properties near the top. This magnetic horizon, which is locally known as "the Government Shale", provides a useful marker, in that it immediately underlies a unit of economic significance.

The arenaceous deposits of the Witpoortjie Formation were deposited on a braided alluvial plain which prograded southwards into a low-energy basin. Source-area tectonics determined the rate and type of sediment supplied and were probably the overriding factor in the development of the conglomerates. The formation was terminated by a widespread transgressive phase, with deposition on a marine shelf, where magnetite was precipitated in the distal areas.

VII. THE JEPPESTOWN SUBGROUP

Previous subdivisions of the West Rand Group in the Klerksdorp region have placed the lower stratigraphic boundary of the Jeppestown Subgroup at the base of the Inner Basin Reefs (Figure 2). However, since this scheme may be of only local significance, it is suggested that the base of the underlying sandstone unit is preferable, for the following reasons :

(1) It is underlain by a magnetic marker unit of regional persistence.

(2) It coincides with a break in sedimentation.

(3) It may be readily identified in the field.

(4) It is probably at a similar stratigraphic level as the Government Reef in the Krugersdorp and Heidelberg areas and, therefore, has regional importance.

The upper contact of the Jeppestown has conventionally been placed at the Ada May Reef, which forms a 10-20 m-thick zone of superimposed immature conglomerates. However, since many individual conglomerates are probably lenticular, it is proposed that a more suitable and readily-identifiable contact is the disconformity beneath the Commonage Reef.

Using the above criteria, the Jeppestown comprises two predominantly arenaceous formations, separated by a thin volcanic unit. Of these, only the basal sediments are exposed in the study-area, the remainder of the stratigraphy having been reconstructed from borehole data.

A. The Florida Sandstone Formation

The Florida Formation is up to 400 m thick and hosts all the previously-exploited economic deposits of gold and uranium. It consists of upper and lower sandstone members, which are separated by an intervening argillite. The lower sandstones erosively overlie the magnetic Government Shale and have an erratically-developed basal conglomerate. This conglomerate is probably the correlative of the Government Reef on the Witwatersrand. The overlying sandstones are coarse-to-very coarse-grained, with numerous scattered pebbles, pebble bands, and conglomerates. In the Rietkuil syncline, two significant conglomerate zones are developed. The lower of these, the Big Pebble Marker, contains cobble-sized clasts and is possibly the stratigraphic equivalent of the reef exploited on Elandslaagte IP 330. The overlying Outer Basin Reefs are a series of superimposed conglomerates, which were mined at the Afrikaner and Babrosco properties (Figure 2). According to Nel (1934), the mineralization is not confined to the matrices of the conglomerates, but is frequently associated with carbon stringers in the enveloping arkosic arenites. North of Klerksdorp, the Buffelsdoorn Reef is probably equivalent to the Outer Basin Reefs, since both are immediately overlain by mature quartz arenites, whereas the Pope Reef on Elandsheuvel IP 402 occurs somewhat lower in the sequence. Conspicuous pyrite mineralization is associated with trough foresets (Plate 2B) and scours, both at channel bases and within conglomerate beds.

Palaeocurrent measurements from the hanging-wall of the Outer Basin Reefs in the Rietkuil syncline (Plate 2C) generally indicate a unimodal westerly-to-northwesterly distribution (Figure 2), although a weak secondary mode towards the southeast was recorded at one station. Limited information from the Klerksdorp district suggests predominantly bimodal bipolar patterns, oriented northwest-southeast. The sedimentology of the lower Florida Formation infers fluvial progradation down a west-to-northwesterly palaeoslope. This dramatic change in provenance-area may be related to the reactivation of major structures as proposed by Brock and Pretorius (1964) and resultant updoming in the Vredefort area. Subsequent transgression promoted reworking of the fluvial deposits, to produce the mature hanging-wall sandstones associated with the Buffelsdoorn and Outer Basin reefs. Evidence of occasional flow reversals implies that tidal currents were redistributing sediment in parts of the basin.

Continued inundation resulted in a gradual upward transition into deeper-water sediments of shelf origin. These are represented by varying proportions of fine-grained sandstone, siltstone, and mudstone, some of the last-mentioned being magnetic. In the Rietkuil syncline, a lenticular unit of diamictite occurs within these shelf deposits and is thought to represent a subaqueous debris-flow (Plate 2D). The diamictite is composed of angular clasts of quartz, chert, lava, mudstone, and sandstone in a lithic wacke matrix. The geometry of the diamictite and its relationship with the shelf sediments refute a glacial origin.

The upper Florida sandstone, which is exposed only at Rietkuil, abruptly overlies the argillites. It is fundamentally a very coarse arkosic arenite, with a number of superimposed conglomerates near the base. The latter, known as the Inner Basin Reefs, have been exploited only in the Rietkuil area. Conspicuous trough cross-beds are accentuated by heavy mineral laminae and indicate a northwesterly flow direction with occasional south-easterly reversals (Figure 2). North of Klerksdorp, this unit has been excluded by the Buffelsdoorn fault, but has been intersected in subsurface, south of the town.

B. The Crown Lava Formation

The Crown Lava, formerly known as the Jeppestown amygdaloid, is one of the most reliable and persistent markers in the West Rand Group. It has been examined in borehole core only, where it has a thickness of 50m. It is predominantly a greyish-green aphanitic rock, with prominent amygdales, which are concentrically zoned and are frequently interconnected by a network of secondary calcite veinlets (Plate 2E). Amygdales are generally poorly developed or absent at the base of the Crown Lava, but increase in frequency and size upwards, where they have a maximum diameter of one centimetre. No individual lava flows could be identified, although the upper part of the unit may display considerable brecciation with admixtures of detrital quartz grains. This suggests a terminal pyroclastic event.

Petrographically, the composition of the Crown Lava could not be positively determined, due to the extreme fine grain and pervasive alteration to calcite, chlorite, opaque ore, saussurite, and epidote. However, occasional andesine phenocrysts in a microcrystalline or pilotaxic matrix suggest intermediate affinities. Amygdales consist of calcite, epidote, and chlorite.

C. The Roodepoort Sandstone Formation

The stratigraphy of the Roodepoort Formation was reconstructed from borehole data, as it is exposed only immediately below the Commonage Reef on the Klerksdorp Townlands (Plate 2F). It is up to 500m thick and is composed predominantly of arenaceous sediments. These are arranged in one upward-coarsening and three upward-fining cycles. The sandstones are medium- to-coarse-grained and range in composition from quartz to arkosic arenites. Other than the Ada May Reefs at the top of the Roodepoort Formation, only scattered pebbles and granules were observed. The three lower sandstone members all grade upwards into siltstones, mudstones, and fine-grained sandstones, representing transgressive cycles. The composition of the sandstones suggest that they were possibly deposited at the interface between continental and marginal-marine environments. These were subsequently inundated by shelf sediments, as the result of transgression.

The only palaeocurrent data from the Roodepoort Formation were obtained from the immediate footwall of the Commonage Reef. These produce a strongly unimodal distribution towards the southeast and indicate a reversion to a southerly-dipping palaeoslope (Figure 2).

VIII. SUMMARY

Deposition of the West Rand Group was initiated at the base of the Hospital Hill Subgroup by a major transgressive phase within a tide-dominated basin. Clastic detritus was derived from a scource-area situated towards the north and transported into areas of maximum subsidence. The continued expansion of the basin-limits produced an effective deepening, with sedimentation being controlled by suspension-settling and chemical precipitation on a shallow shelf. Local palaeohighs provided sufficient coarse sediment to form restricted tidal sand-bodies. Rejuvenation of the northerly source-area during the deposition of the Brixton Formation diminished the extent of the depository and was responsible for the supply of sandy sediment, which, ultimately, was redistributed during minor transgressions.

The Government Subgroup provides the first evidence of fluvial processes and indicates a dramatic decrease in the energy-level at the continental-marine boundary. The predominance of arkosic arenites, with quartz and chert pebbles, suggests that the braided streams drained a granite-greenstone highland, located towards the north. Rapid progradational events in response to reactivated uplift, resulted in fluvial deposits forming a series of fan deltas. Deposition in the shelf-environment was dominated by suspension sedimentation interrupted by periodic high energy events. Minor iron-precipitation was restricted to distal areas, whereas debris-flows probably originated in response to an increased palaeoslope.

The depositional setting of the Jeppestown Subgroup was similar to that of the Government, viz. an interplay between fluvial and marine-shelf environments. However, a significant difference in the Florida Formation, at the base of the Jeppestown, was the emergence of an easterly-to-southeasterly provenance. It is suggested that syndepositional updoming in the Vredefort area may have been responsible. Conspicuous is the fact that all previously-exploited placer deposits are confined to the Florida Formation. This indicates that the area of clastic derivation may have been of fundamental importance in producing such mineral deposits. After the widespread extrusion of the Crown Lava, the fluvial sediments of the upper Jeppestown imply the re-establishment of the northerly source-terrane.

IX. CONCLUSIONS

1. The facies distribution and palaeocurrents in the Orange Grove Formation indicate that the basin-edge was situated north of Mazista.

2. The West Rand basin reached its maximum extent during the deposition of the Parktown Formation. Thereafter, a major regressive phase commenced, upon which smaller second-order transgressive cycles were superimposed.

3. The transition from the Hospital Hill to the Government Subgroup coincided with a sudden decrease in the energy-level of the marginal-marine environment. This may be related to either basin closure or an effectual decrease in the size of the depository.

4. The higher proportion of coarse sediments in the Government and Jeppestown subgroups of the Klerksdorp district, relative to the Heidelberg and Krugersdorp areas, is probably a function of the distance from the provenance. This, in turn, may be related to syndepositional tectonics.

5. The major placer mineralization in the West Rand Group displays a distinct stratigraphic and sedimentological control.

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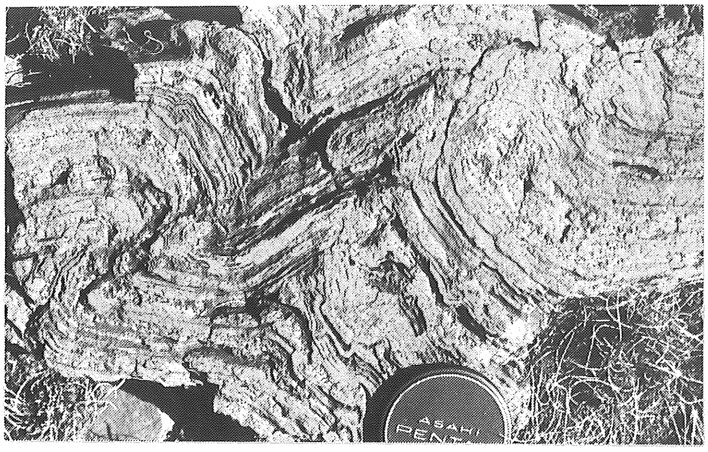
PLATE 1

A

Horizontally laminated mudstones in the Parktown Shale Formation.

B

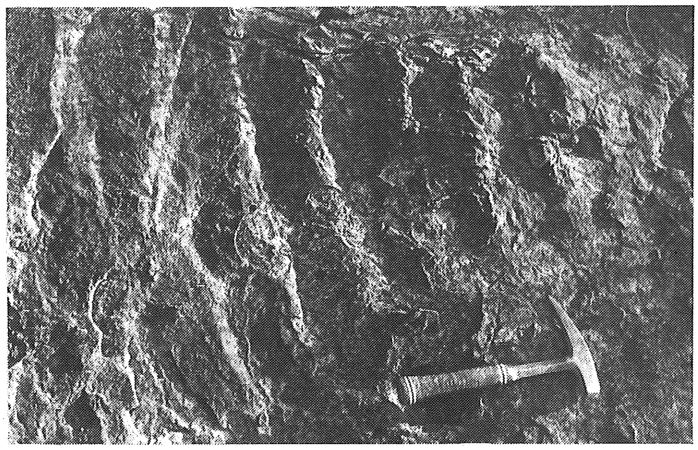


Folded Banded Iron-formation (Contorted Bed).

C

Herringbone cross stratification with mudstone drapes in the lower Brixton Formation.

D

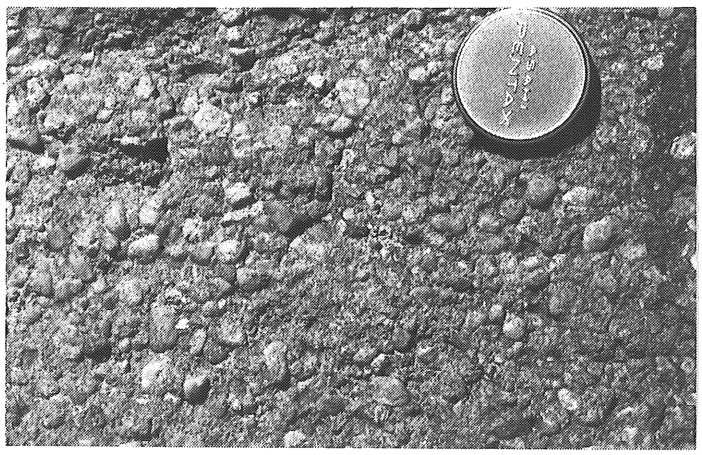


Megaripples from the lower Brixton Formation on the farm Tweelingsfontein, Ventersdorp district.

E

Plan view of trough cross-stratification in the upper Brixton Formation.

F



Small-pebble conglomerate (Red Reef) from the middle Promise Formation.

PLATE 2

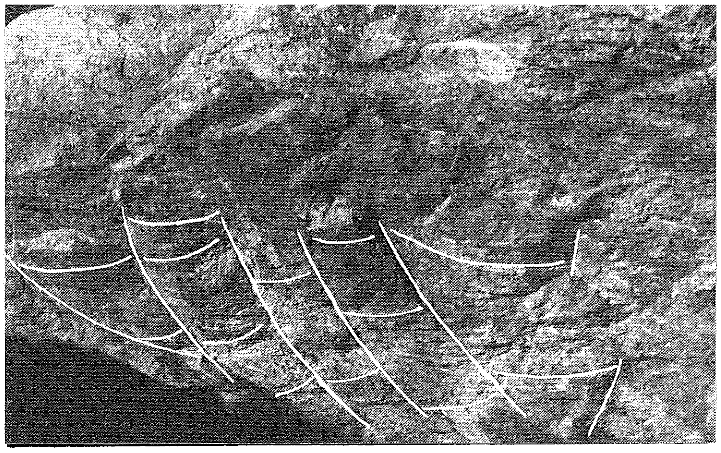
A

Graded planar foresets from the middle Promise Formation.

B

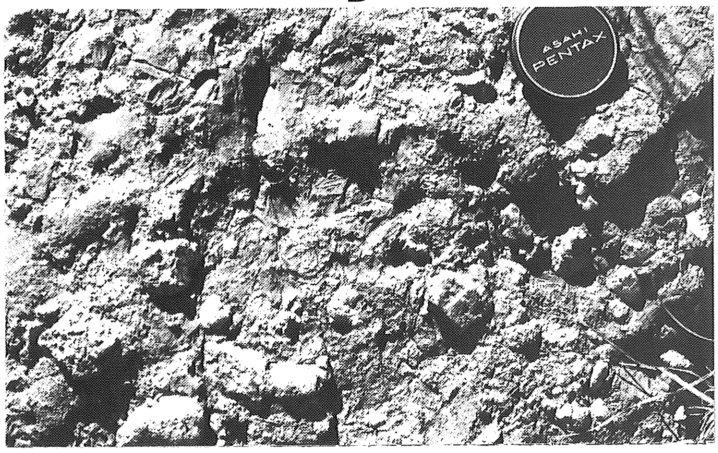
Transverse view of trough cross-stratification, with pyrite accentuating foresets. Lower Florida Formation, Rietkuil syncline.

C



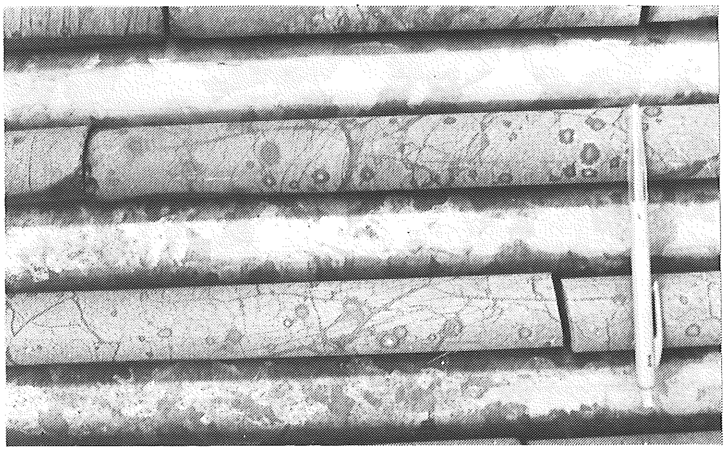
Trough cross-beds in the hanging wall of the Outer Basin Reefs, lower Florida Formation, Rietkuil.

D



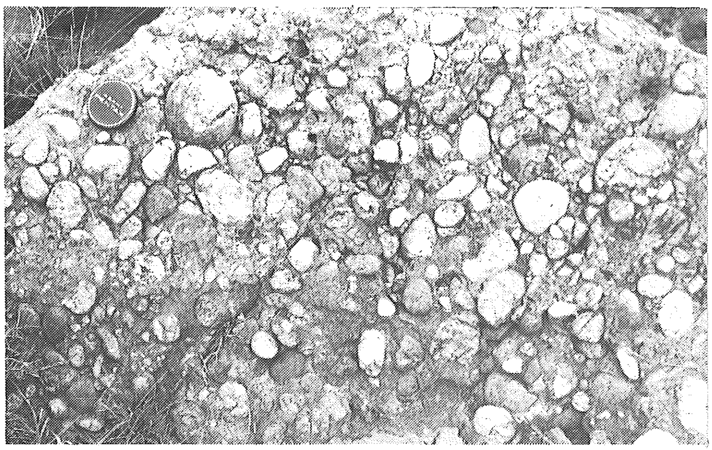
Diamictite from the middle Florida Formation, Rietkuil syncline.

E



Borehole core of amygdaloidal Crown Lava Formation. (Note concentrically-zoned amygdales and interconnecting alteration veinlets).

F



Robust Commonage Reef marking the base of the Central Rand Group.