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PETROGRAPHIC AND MINERAGRAPHIC INVESTIGATIONS
OF THE ARCHAEOAN GOLD PLACERS AT MOUNT ROBERT
IN THE PIETERSBURG GREENSTONE BELT,
NORTHERN TRANSVAAL

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INFORMATION CIRCULAR No. 114

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by

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ABSTRACT

The fossil gold placer on Mount Robert near Potgietersrus, Northern Transvaal, occurs in the Uitkyk Formation. This formation consists of arenaceous rocks with interlayered conglomerates and shales, and occurs at the top of the Archaean Pietersburg Sequence which forms the Pietersburg greenstone belt.

The host rock of the placer gold occurrence consists of polymitic conglomerates. Fragments in this conglomerate indicate that the provenance area consisted of acid porphyritic lava, chert, banded iron-formation, quartzite, basic lava, vein quartz, and shale. It is suggested that the Uitkyk sediments were transported over short distances and originated from the erosion of a greenstone terrain.

The mineralogy of the ore is relatively simple and resembles that of the much younger Witwatersrand basket. Rounded allogenic, and, to a lesser extent, idiomorphic-to-hypidiomorphic authigenic pyrite, form the main constituents. Less abundant, but genetically interesting, ore minerals which have so far been found are leucoxene-rutile, chromite, molybdenite, zircon, carbonaceous matter, and brannerite.

The Mount Robert placer gold occurrence can be regarded as a primitive forerunner of the Witwatersrand Goldfield. Ineffective sedimentary enrichment processes and an environment unfavourable for the development of life-forms which could have acted as biogenic gold and uranium concentrators, are regarded as possible reasons for the low gold contents and scarcity of uranium-bearing minerals in the Uitkyk conglomerates.

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INTRODUCTION

The nature and genesis of Archaean gold mineralization throughout the world has attracted the interest of many investigators (Boyle, 1959; 1961; Goodwin, 1965; Viljoen, Saager and Viljoen, 1969; Saager, 1973b, 1976; Sawkins and Rye, 1974; Anhaeusser, 1976a, b; Fripp, 1976). This interest is readily understandable if one keeps in mind the importance of the Archaean as a gold producing era in the history of the earth and the far reaching similarities of the metallogenetic processes which were operative during this time (Hutchinson, Ridler and Suffel, 1971; Anhaeusser, 1976a, b).

A survey of the literature relating to Archaean gold mineralization reveals that most reported investigations deal either with structurally controlled quartz-vein type deposits (gold-quartz lode deposits), or with occurrences associated with carbonate, oxide, or sulphide facies iron-formations. Studies of Archaean gold occurrences in conglomeratic or quartzitic sedimentary rocks, which may be regarded as auriferous placer deposits, are, however, extremely limited (Wilson and Martin, 1964; Stagman, 1961; Gregory, 1906; Mennell, 1905). The main reason for the general lack of interest in these deposits centres around the fact that very little gold has ever been recovered from them. The available evidence suggests that during the Archaean the sedimentological conditions appear to have been unfavourable for the formation of extensive auriferous placer ores. Not only were these deposits restricted in size but, in almost all cases, the majority of them did not survive later erosion.

During the course of researching the gold deposits within the greenstone belts of the Kaapvaal craton, the authors examined the gold placer deposit at Mount Robert on the farm Amatava 41KS, near Potgietersrus in the Northern Transvaal. This deposit occurs in the Archaean conglomerates of the Uitkyk Formation in the Pietersburg greenstone belt. The geology and structure of the Uitkyk Formation has been described by Goetz (1885); Hall (1908); Willemse (1938); Van Rooyen (1947) and Grobler (1972), but little attention has been paid to the mineralogical and geochemical aspects of the gold mineralization contained in the Uitkyk conglomerate. For this reason it was decided to investigate the ore in more detail. Apart from providing a better insight into Archaean metallogeny, it was considered that an investigation might also be of some help in understanding the formation of gold- and uranium-bearing Precambrian quartz-pebble conglomerates, of which the Mount Robert deposit can be considered a forerunner.

Several attempts have been made in the past to explore the economic mineralization potential of the conglomerates on Mount Robert, and this has resulted in the excavation of numerous trenches and prospecting pits. During an extensive exploration programme conducted by Rand Mines Limited, Johannesburg, a detailed geological map of Mount Robert was prepared by A.L. Zietsman (this map is contained in the thesis by Grobler, 1972). No information relating to the mineralogy and geochemistry of the ore was made available following this exploration project.

All attempts to mine the gold have so far failed, possibly due to a combination of (i) the erratic distribution of the gold, (ii) its generally low grade, and (iii) high development and access costs.

REGIONAL GEOLOGY

The Pietersburg Schist Belt, in common with the major greenstone belts of the Kaapvaal craton, constitutes a thick sequence of generally mildly metamorphosed volcano-sedimentary rocks which belong to the Archaean *Swaziland Supergroup*. A simplified geological map of the Pietersburg greenstone belt is given in Figure 1.

Lead isotopic investigations carried out by Saager and Köppel (1976), on the samples from the base of the Swaziland succession in the Barberton greenstone belt yielded a maximum age of 3 800 m.y. for this sequence, whereas Jahn and Shih (1974) using the Rb-Sr method, obtained an age of metamorphism of 3 500 m.y. for similar rocks, again from the basal units in the Barberton area. Although no age determinations are yet available from the Pietersburg region it is considered likely that comparable ages may exist for this greenstone occurrence.

The Pietersburg Schist Belt takes the form of a narrow northeast-striking synclinorial greenstone remnant situated within the expanse of granitic rocks that form the bulk of the craton. These granitic rocks are considered to be younger than the greenstone assemblage and are responsible for the dynamo-thermal metamorphism of the volcano-sedimentary pile.

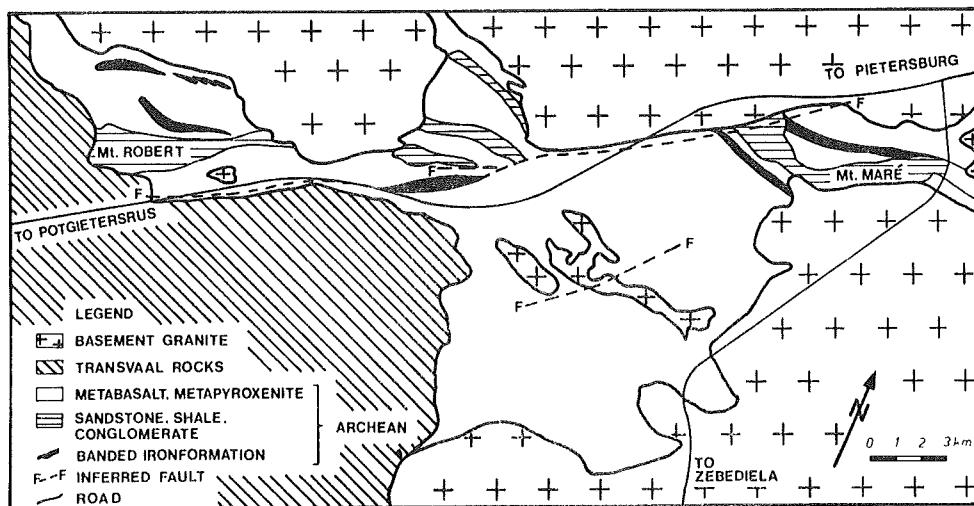


Figure 1 : Schematized geological map of the Pietersburg Schist Belt. Compiled from Grobler (1972) and Willemse (1938).

Early geological and economic accounts of the greenstone terrain in the Pietersburg area are those of Goetz (1885), Hall (1908), and Willemse (1938). Van Rooyen (1947) mapped the successions northeast of Potgietersrus and proposed the name Uitkyk Formation for the sedimentary rocks forming Mount Robert. He correlated the Uitkyk Formation with the Witwatersrand System.

As a result of detailed studies in the well-preserved and well-exposed Swaziland succession in the Barberton region, a geological and petrogenetical model for the Barberton greenstone belt has been established (Anhaeusser, 1969, 1971, 1973, 1975; Viljoen and Viljoen, 1969, 1971). According to this model, the basal units of the Swaziland Supergroup in the Barberton Mountain Land consist of a succession of generally mafic to ultramafic volcanic rock types collectively termed the *Lower Ultramafic Unit*. Cyclically alternating mafic to felsic volcanic rocks, referred to as the *Mafic-to-Felsic Unit* occur above the Lower Ultramafic Unit. The volcanic rocks, in turn, are succeeded by a thick layer of sediments, the *Sedimentary Unit*. In the Barberton Mountain Land this unit is divided into a lower argillaceous Fig Tree Group and an overlying arenaceous Moodies Group.

In the Pietersburg Schist Belt, Grobler (1972) was able to recognize a similar lithological succession which he termed the *Pietersburg Sequence*. The correlation of the Pietersburg Sequence with that of the Swaziland succession in the Barberton area is given in Table 1.

The *Landsberghoek-Formation*, at the base of the Pietersburg Sequence, is not as well-preserved as the Lower Ultramafic Unit in the Barberton Mountain Land and consequently very little is known of the ultramafic rocks in the Pietersburg Schist Belt.

The *Eersteling Formation*, considered to be the equivalent of the Mafic-to-Felsic Unit, contains numerous gold-lode occurrences of the same type as those described from the Barberton Mountain Land (de Villiers, 1957; Viljoen et al., 1969; Saager, 1973a, 1973b; Saager and Köppel, 1976).

These gold deposits have been mined intermittently since 1871 when South Africa's first reef gold was discovered on the farm Eersteling 17 KS. The Sedimentary Unit of the Pietersburg Sequence (the *Uitkyk Formation*) unconformably overlies the volcanic assemblages. As opposed to Van Rooyen (1947), who regarded the Uitkyk Formation as being of Dominion Reef and Witwatersrand age, Pretorius et al. (1965) and Grobler (1972) correlated the Uitkyk with the Moodies Group in the Barberton area. Grobler (1972) stressed, however, that the Uitkyk Formation does not contain volcanic units, jaspillite, or banded iron-formations, as are present in the Moodies Group. Furthermore, no argillaceous sediments like those of the Fig Tree Group in the Barberton area, have been recorded in the Pietersburg Sequence.

Grobler (1972) also maintained that the sediments of the Uitkyk Formation were deposited in an elongated basin subsequent to the deformation of the underlying rocks. Several reasons were also offered for correlating the Uitkyk Formation with the Moodies succession of Archean age.

TABLE 1

LITHOSTRATIGRAPHIC CORRELATION OF THE SWAZILAND SUPERGROUP IN THE
BARBERTON MOUNTAIN LAND AND THE PIETERSBURG SEQUENCE IN THE
PIETERSBURG GREENSTONE BELT, NORTHERN TRANSVAAL

SWAZILAND SUPERGROUP (Barberton Mountain Land)	PIETERSBURG SEQUENCE (Pietersburg Greenstone Belt)
MOODIES GROUP	UITKYK FORMATION
FIG TREE GROUP	
ONVERWACHT GROUP GELUK SUBGROUP (Mafic-to-Felsic Unit)	EERSTELING FORMATION
TJAKASTAD SUBGROUP (Lower Ultramafic Unit)	LANDSBERGHOEK FORMATION

(Modified after Grobler, 1972)

HOST ROCKS OF THE ORE

The host rocks of the gold occurrences consist of different types of arenites, among which lithic sandstones and lithic greywackes predominate. Interbedded with these are discontinuous shale layers and conglomerate lenses. The gold prospects are situated in immature, poorly sorted, polymictic conglomerates. The matrix is silt- and clay-sized and made up of chlorite, quartz, chloritoid, muscovite, leucoxene, rutile, and isolated biotite needles. Chloritoid forms euhedral poikiloblasts up to 1 millimetre long, with inclusions of quartz (Plate 1A). Winkler (1975) reported that chloritoid forms during low-grade and very low-grade metamorphism and requires a high Fe/Mg-ratio, high Al, and low K, Na, and Ca contents. Muscovite is of equal crystal size to chloritoid and occurs as laths or long, slender needles which are often deformed.

The clasts are subangular to rounded and have diameters ranging from a few millimetres up to 30 cm. They comprise differently coloured vein quartz, green, red or banded chert, quartzites, banded iron-formation, shale, and altered basic lava. Pyrite, leucoxene, chromite, and zircon occur as heavy minerals and distinct layers in the conglomerates.

Indications of metamorphic overprinting of the host rocks are rare. The matrix itself shows no signs of recrystallization, and point contacts between clastic fragments are still well-preserved (Plate 1B). Authigenic chloritoid and muscovite indicate, however, that the host rocks have been mildly, thermally affected. Epitaxial overgrowths of chlorite on detrital pyrite grains and leucoxene (Plate 1C), in the form of pressure fringes, are indicative of low post-diagenetic pressure. The chlorite rims are often assymetrically arranged and their width is in the range of 0,02 mm to 0,2 mm. Spry (1969) maintained that no major deductions, concerning the metamorphic history of the host rock, should be made from the presence of pressure fringes, as these represent only an insignificant part of the total strain. The great variety of detrital material in the conglomerate reveals that the source areas were manifold :

1. The presence of numerous quartzitic fragments indicates that a metamorphosed provenance area was eroded. The quartzitic fragments display unmistakable signs of recrystallization and pressure solution (Plate 1D), in contrast to the host rock, where such structures were not observed. Stylolitic contacts (Plate 1E), as well as porphyroclastic and ribbon texture are also common in the fragments, pointing to an intensively sheared source terrain of quartzitic composition.
2. The presence of detrital quartz phenocrysts reveals that some of the material was derived from the erosion of porphyritic acid lavas. The phenocrysts exhibit euhedral outlines and deep corrosion contacts. The embayments are filled by sericite which formed in the volcanic source area. Corrosion contacts develop when early crystallized quartz insets react with the remaining acid silica melt. The quartz porphyries frequently show inclusions of euhedral, zoned zircon.

3. Angular fragments, composed of chlorite and varying amounts of quartz, are considered to represent altered basic volcanics. These fragments are often surrounded by a thin film of opaque minerals. The intergrowth pattern of chlorite and quartz in the fragments is distinctly different from that in the conglomerate matrix. The quartz grains within the fragments are equidimensional and evenly distributed, and they possess a noticeable orientation, while the quartz grains of the conglomerate matrix are angular, poorly sorted, and non-orientated.
4. Due to their resistance, chert, banded iron-formation, and vein quartz clasts are the most abundant fragments. Most of the chert fragments are well-banded and contain thin layers of pyrite. These pyritic banded chert fragments may grade into sulphide facies banded iron-formations. The presence of chemical sediments, which in the Archaean are often associated with submarine-volcanic activity, point to the erosion of rocks deposited in such an environment.
5. Large shale fragments are commonly observed in outcrops. Their size ranges from 2 to 20 cm in diameter. It is concluded that the shale fragments could not have survived long transporting distances, and that the fragments encountered are of intraformational origin.

From the various types of debris, it is concluded that the Uitkyk sedimentary rocks were derived from the erosion of a greenstone assemblage. Poor sorting and angular shapes point to short transportation distances and rapidly changing energy transporting sources. The deductions made from this petrographic study are in agreement with those of Grobler (1972) who suggested that the Uitkyk Formation was deposited in a rapidly subsiding trough, the sedimentary fragments having been derived from the underlying greenstone assemblage.

ORE MINERALOGY

Ore mineral investigations of the Mount Robert gold occurrence have not been undertaken previously. As part of the present study polished sections were prepared from pyritic conglomerates collected in the open workings and prospecting trenches on Mount Robert. The ore minerals observed are listed in Table 2. A comparison of the minerals listed in this table, with the ore minerals described from the Witwatersrand deposit (Feather and Koen, 1975), shows that the Witwatersrand contains a greater variety of opaque minerals than the conglomerates from Mount Robert. Although further investigations could ultimately add to the list of minerals shown in Table 2, the difference in the variety of ore minerals found in the two deposits remains noteworthy. This disparity in the number of ore minerals also provides possible support for arguments maintaining that a genetic difference exists between the two gold occurrences.

TABLE 2
ORE MINERALS IN PYRITIC CONGLOMERATES FROM THE MOUNT ROBERT GOLD OCCURRENCES,
LISTED IN ORDER OF ABUNDANCE

Mineral	Remarks
pyrite	authigenic and allochthonous
rutile	allochthonous; more often alterations of Ti-minerals
leucoxene	lamellae of primary magnetite/ilmenite intergrowth
chromite	allochthonous
zircon	allochthonous; inclusions in detrital quartz-porphyries
chalcocite	inclusions in pyrite
gold	inclusions in pyrite and as particles in the matrix
machinawite	exsolutions in chalcocite
sphalerite	inclusions in pyrite
ilmenite	allochthonous
pentlandite	inclusions in pyrite
molybdenite	detrital aggregates of tabular crystals
magnetite	allochthonous
carbonaceous matter	occurs rarely; abraded outlines, allochthonous
brannerite	extremely rare, allochthonous
galena (?)	inclusions in brannerite

The ore minerals may be divided into three broad groups, which are :

1. authigenic minerals,
2. minerals of allogenic origin, and
3. minerals which occur both as allogenic and authigenic grains.

1. Pyrite

Pyrite is by far the most abundant sulphide mineral and it may be either of authigenic or allogenic origin. Allogenic pyrite is predominant and forms well-defined layers of abraded and crushed pyrite debris (Plate 1F). Detrital pyrite measures from 0,05 to 5 mm in diameter. Saager (1970), following a suggestion by Ramdohr (1955), classified the pyrites of the Basal Reef in the Witwatersrand deposit according to their morphology. The following main groups were defined :

1. rounded pyrite,
2. idiomorphic pyrite, and
3. xenomorphic pyrite.

It was found, in this study, that the classification of Saager (1970) could also be applied to the pyrites in the auriferous conglomerates from Mount Robert. Xenomorphic pyrite, which in the Witwatersrand was mobilized during periods of metamorphism, and which produced the healing of fractured detrital constituents as well as forming veinlets, appears to be absent in the Mount Robert ore. Rounded porous pyrite and rounded concretionary pyrite constitutes the bulk of the ores from Mount Robert, while rounded compact pyrite is rare.

In the following section the various pyrite types are described :

Compact or porous rounded pyrite is of detrital origin and often forms well-defined layers of varying grain size. In the Mount Robert ore, pyrite commonly exhibits cataclastic texture (Plate 2A) which is pronounced in these layers. This observation suggests that the pyrite was shattered either during transport, sedimentation, or compaction.

Rounded concretionary pyrite may sometimes be confused with rounded porous pyrite as the textures of these two types grade into one another. Generally, however, rounded concretionary pyrite (Plate 2B) is larger than rounded porous pyrite and displays skeletal-type growth textures. Furthermore, rounded concretionary pyrite frequently contains inclusions of chloritoid porphyroblasts (Plate 2C). In most cases these chloritoid crystals extend into the matrix, while in other examples they are abraded at the periphery of the pyrite grain. This indicates that in some cases the rounded concretionary pyrite was transported together with its chloritoid inclusions. It is interesting to note that identical pyrite/chloritoid associations have also been observed in the Witwatersrand ores and it is concluded that these grains are intraformational clasts.

Pseudomorphic pyrite is considered to represent the sulphurized product of black sand minerals (Plate 2D). Almost identical grain size and morphological similarities suggest that this type of pyrite is a pseudomorph after leucoxene. Furthermore, different stages of pyritization of rutile were observed. Alterations of ilmenite to pyrite are common and take place in the presence of H₂S, or in a reducing environment, respectively (Gruner, 1959; Austin, 1960; Carroll, 1960). According to Carroll (1960), this process may even operate at low temperatures in unconsolidated sediments.

Idiomorphic or hypidiomorphic encrustations around detrital pyrite grains are frequently encountered. These encrustations generally make it impossible to recognize the detrital core and often most of what looks like authigenic pyrite is of detrital origin. Pyrite forming encrustations were probably developed during a mild metamorphic overprint event or during diagenesis.

2. Rutile

Rutile is a major constituent of the ore and most of it represents alterations of titanium minerals. According to Austin (1959), Golding (1961), and Dimanche and Bartholomé (1976), ilmenite alters to rutile under reducing conditions. During very mild metamorphic overprints, rutile recrystallizes readily to form large crystals (Tröger, 1967). Large rutile crystals commonly display well-developed twins. In many cases, pyrite can be seen to have replaced rutile. In advanced stages of replacement, only small rutile remnants remain in the pyrite pseudomorphs (Plate 2E).

3. Leucoxene

Leucoxene is considered to represent the alteration products of titaniferous black sand minerals. It is frequently associated with layers of detrital pyrite. Leucoxene, although displaying fragile structures, is always well-rounded, indicating abrasion of the primary mineral (mostly ilmenite/magnetite) prior to the leucoxene alteration. The textures of primary ilmenite lamellae, parallel to the (111)-plane of a magnetite host, are often preserved. In such cases, the magnetite portion has been removed and the ilmenite component, although largely altered to leucoxene, still retains a primary

cloth-like texture (Plate 2F). Dimanche and Bartholomé (1976) and others showed that under reducing conditions magnetite and hematite dissolve while ilmenite is stable. Examples of ilmeno-magnetite alterations similar to those described above, are illustrated by Dimanche and Bartholomé (1976).

4. Chromite, Zircon, Magnetite, and Ilmenite

The four minerals listed under this heading are minor detrital constituents of the conglomerate. Chromite is often fractured and has grain sizes ranging from 0,1 mm to 0,3 mm. Zircon occurs as fragments of large crystals which may originate from a granitic source. In addition, euhedral zoned zircons were found as inclusions in quartz phenocrysts which derived from eroded porphyritic lavas. The amount of magnetite and ilmenite is insignificant, and the few grains encountered were so small that their identification was both difficult and ambiguous.

5. Chalcopyrite, Pyrrhotite, Mackinawite, Sphalerite, Pentlandite and Gold

The minerals listed in the above heading all form inclusions in detrital pyrite grains. Among the most common are composite inclusions of chalcopyrite and pyrrhotite (Plate 3B). Occasionally, pyrrhotite was found to have exsolved pentlandite, the latter occurring as small flakes in the pyrrhotite. This feature suggests that the host pyrite, together with the pyrrhotite-pentlandite association, formed at a temperature of above 400°C (Naldrett, Craig and Kullerud, 1967).

In a few cases, mackinawite inclusions were recorded in chalcopyrite. According to Craig and Schot (1974), little is known about the thermal stability of mackinawite. Clark (1966), and Schot et al (1972) showed that the upper stability of mackinawite increases markedly with increasing substitution of Fe (+ Cr) by Ni, Co, and Cu, the transformation temperature depending on the availability of Ni, Co, and Cu. Schot et al (1972) determined these elements in naturally occurring mackinawite exsolutions and obtained transformation temperatures ranging from 140°C to 420°C. The Ni, Co, and Cu content of mackinawite exsolutions observed in the Mount Robert conglomerates was not determined, with the result that no statement regarding the temperature of formation of the chalcopyrite/mackinawite paragenesis can be made.

Gold occurs as inclusions in pyrite, and as rare particles in the conglomerate matrix (Plate 3C). Gold inclusions are also often associated with chalcopyrite. The diameter of gold droplets locked in detrital pyrite ranges from 0,01 mm to 0,05 mm. Veinlets and stringers of native gold, formed by mobilization, and which are common in the Witwatersrand ore, were also found in the samples investigated from Mount Robert.

6. Molybdenite

Molybdenite was, surprisingly, found as a very rare mineral in two polished sections of the conglomeratic Uitkyk ore. It is an allochthonous, detrital constituent, suggestive of a pegmatitic-pneumatolytic, or granitic source terrain. In one case it forms a well-rounded (0,3 mm diameter) aggregate of curved plates showing undulatory extinction under crossed nicols (Plate 3D). The second sample showed a molybdenite clast crushed, probably during deposition, by a quartz pebble. The presence of molybdenite in the Uitkyk ore points to very short transport distances. In the Witwatersrand sediments, for which Hallbauer (1977) suggests transport distances of 30 km, molybdenite has been observed as primary inclusions in detrital pyrite only (Saager, 1969; Feather and Koen, 1975).

7. Carbonaceous Matter

Carbonaceous material was noted in a few polished sections and occurs as rare, rounded, distinctly abraded, aggregates possessing diameters of 0,2 to 0,4 mm. The colour of the carbonaceous matter is dark grey with a bluish tint and closely resembles that of 'thucholite' from the Witwatersrand basin. The Vickers hardness of carbonaceous matter from Mount Robert is slightly lower than that of Witwatersrand thucolite, the values being ±55 and ±90, respectively.

In the Mount Robert samples, the observed aggregates of carbonaceous matter are built up of oval-shaped structures (Plate 3E), which resemble columnar carbon sectioned at right angles to column growth. Snyman (1965) and Feather and Koen (1975) reported similar structures in 'thucholite' from the Witwatersrand and interpreted them as remnants of algal colonies.

Hallbauer (1975) carried out a detailed investigation of the carbon of the Witwatersrand and concluded that the Witwatersrand carbon occurs as the fossilized remains of Precambrian plants. He suggested that a well-differentiated plant life may have been in existence during Witwatersrand times, including bacteria, algae, fungi and lichen-like plants. The carbon from Mount Robert is still being investigated but preliminary electron microprobe studies have shown a low content and irregular distribution of uranium. Microscopically, no uraninite or galena inclusions or remnants could be detected in the carbonaceous matter. It is noteworthy, however, that the boundaries of the oval structures are demarcated by gangue and small pyrite and gold grains.

8. Brannerite

Only one grain of brannerite was recorded in the ores examined and this formed a rounded particle with a diameter of 0,3 mm. The mineral's texture is inhomogeneous and it displays different

shades of dark grey. Minute inclusions of a light grey mineral occurs in the brannerite and possesses a high reflectivity. This has tentatively been identified as radiogenic galena. Rutile is another mineral closely associated with the brannerite.

CONCLUSIONS AND DISCUSSIONS

The petrographic and mineragraphic investigations in the Mount Robert area have shown that the conglomeratic host rocks of the Amatava gold occurrences were derived from the erosion of various rock types, including quartzites, shales, chemical sediments, acid porphyritic rocks, basic lavas, and quartz veins. These rocks represent the typical constituents of a granite-greenstone terrain. The transport distances of the detrital material was short and metamorphism of the sediments was mild.

The conspicuous absence of feldspar, which should be present in lithic sandstones transported over short distances, poses a problem. Austin (1960) observed, in Jurassic sandstones from New Mexico, that ilmenite, magnetite, and feldspar alter readily under reducing conditions. Extensive ilmenite alteration and the preservation of detrital pyrite are suggestive of reducing conditions in the Mount Robert deposits, and it is suggested that feldspar suffered complete alteration in this reducing environment. This corresponds with the generally accepted idea of the presence of an oxygen-free atmosphere in the early Precambrian. Furthermore, such an atmosphere would be expected to have allowed for the preservation of pyrite during its transport and sedimentation leading ultimately, to the formation of a pyrite placer deposit in the depositional basin of the Uitkyk sediments. The heavy mineral assemblage of the conglomerates from the Amatava gold mine, the composition of the rock-building constituents, and the texture of the conglomerates, were found to be in many ways similar to those of the considerably younger, Proterozoic gold and uranium-bearing quartz-pebble conglomerates of the Witwatersrand. Therefore, one may reasonably assume that the processes operating in the formation of the Uitkyk and Witwatersrand sediments were similar. Most likely, they both originated from the erosion of a similar hinterland.

Pretorius (1974) suggested that the Witwatersrand succession was a regressive, intra-cratonic basin. The regressive nature of the basin edge resulted in repeated re-working of the fluvial fan thereby leading to the eventual enrichment of the heavy minerals (including gold), from concentrations that were originally extremely low.

Investigations undertaken by the authors indicate gold-values of less than 500 ppb in banded iron-formations and komatiitic lavas from the Pietersburg Schist Belt. The erratic distribution of the heavy minerals in the Uitkyk conglomerates, and the low contents of gold and heavy minerals in the Amatava ores, suggest that the concentration processes operating during the formation of the Uitkyk Formation were not as efficient as those which were operative during the deposition of the Witwatersrand blanket. The transport of gold as organically protected colloids, and the ability of Precambrian plants to dissolve and redeposit gold and uranium has been suggested by Hallbauer (1975). Still another gold concentrating process was proposed by Pretorius (1966, 1974) and Saager (1973b) who suggested that, in the Witwatersrand basin, algal mats behaved in a manner similar to a corduroy table, and acted as traps for gold during the subsequent washing-over of fine, gold-bearing sandy material.

Carbonaceous matter in the Uitkyk Formation occurs extremely rarely, and therefore, the above-mentioned biogenic concentration processes were not present in the Uitkyk basin. This may be of great significance and could provide the explanation as to why the low and erratic gold values (as well as the apparent absence of uranium minerals) occur in the Mount Robert deposits.

It furthermore appears that the Mount Robert deposits might be regarded as only an embryonic Witwatersrand type deposit.

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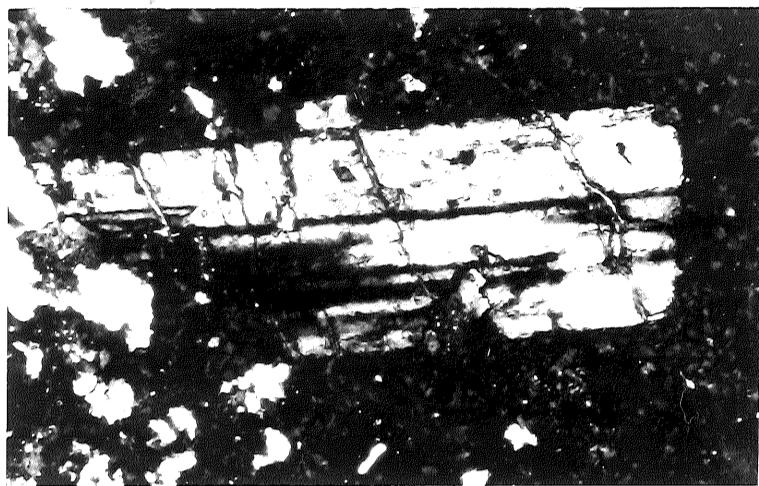
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PLATE 1

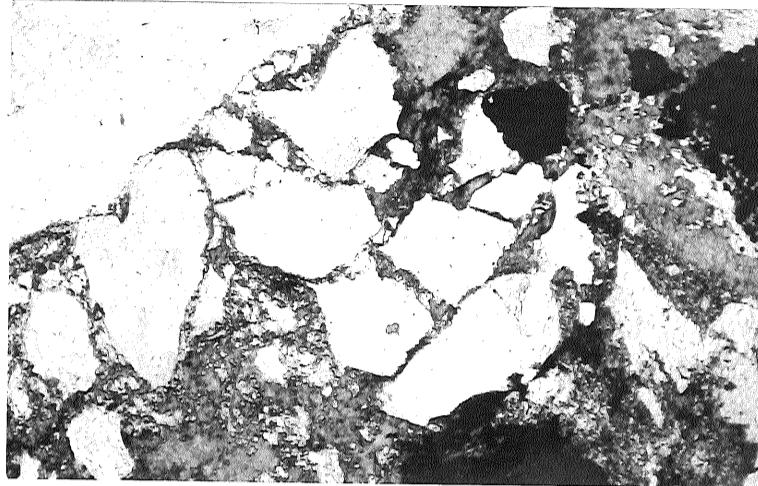
- A. Chloritoid porphyroblast in quartz-sand matrix of the conglomerate from Mount Robert. Small inclusions in chloritoid are quartz. Transmitted light, crossed nicols, 130 x.
- B. Angular quartz fragments, displaying point contacts, in chloritic matrix. Black opaque grains are pyrite. Transmitted light, parallel nicols, 130 x.
- C. Leucoxene alterations in conglomerate from Mount Robert, displaying pressure fringes of chlorite. Matrix consists of chlorite (grey) and fine-grained quartz (white). Transmitted light, parallel nicols, 130 x.
- D. Portion of detrital quartzitic fragment from a metamorphosed source terrain. Despite advanced recrystallisation in the pebble, the original outlines of the individual quartz grains are clearly visible. The conglomerate matrix itself is free of recrystallisation. Transmitted light, crossed nicols, 60 x.
- E. Stylolitic contacts between quartz grains in a quartzitic pebble. As the conglomerate matrix is free of pressure phenomenae, this texture, which results from pressure solution, indicates that this conglomeratic fragment was subjected to pressure prior to its deposition. Transmitted light, crossed nicols, 130 x.
- F. Portion of a layer of poorly sorted, angular, detrital pyrite, showing pronounced shattering. Reflected light, oil immersion, 240 x.

PLATE 1

A



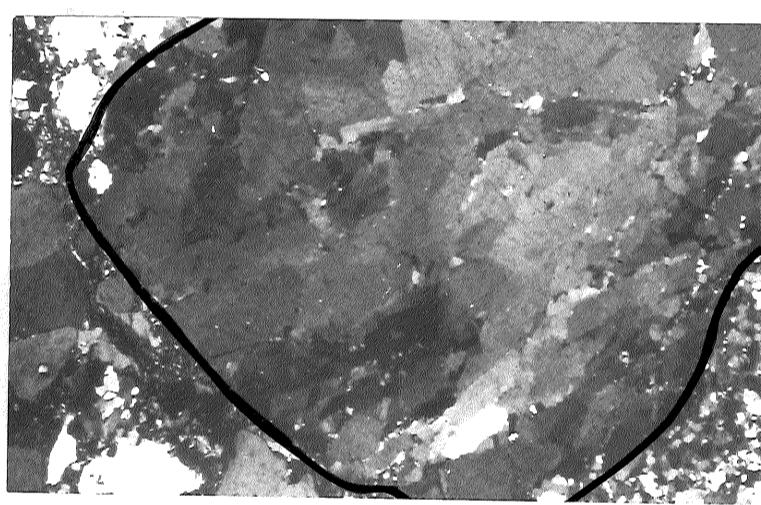
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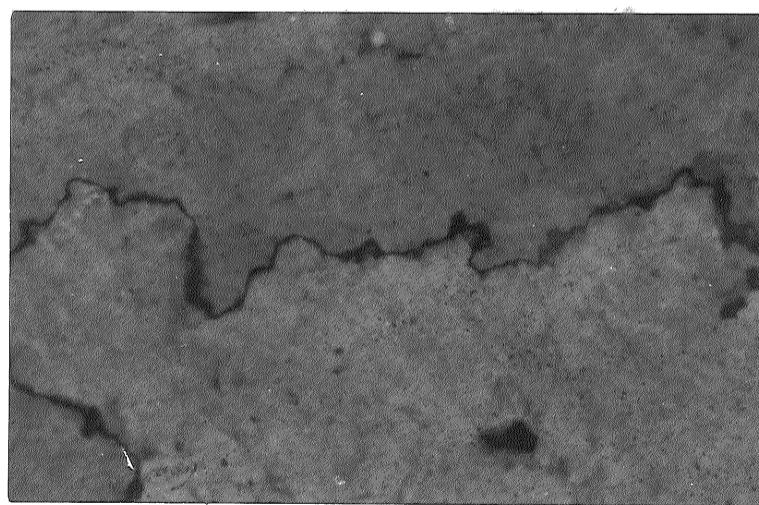
C



D



E



F

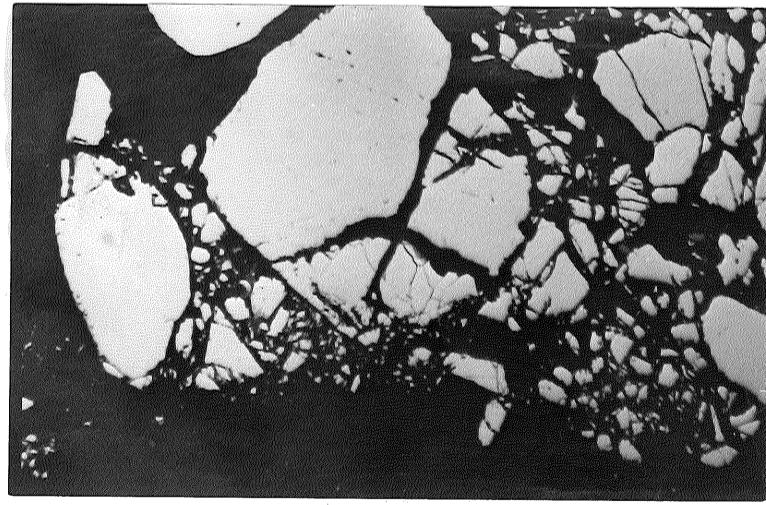
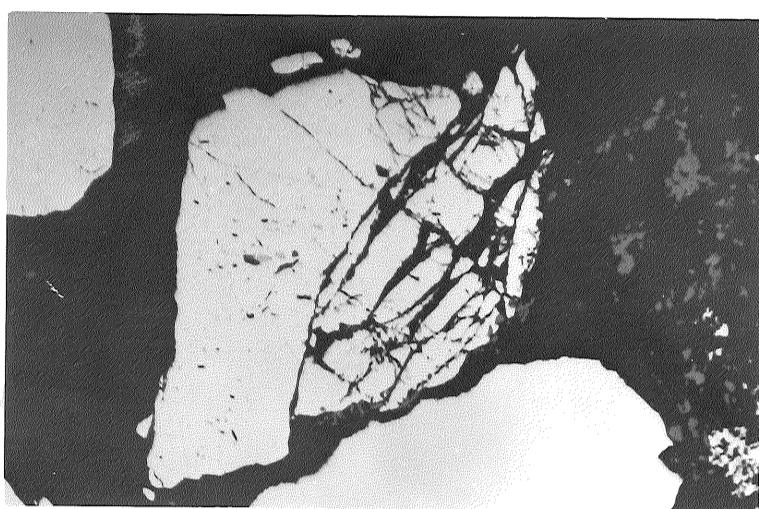


PLATE 2

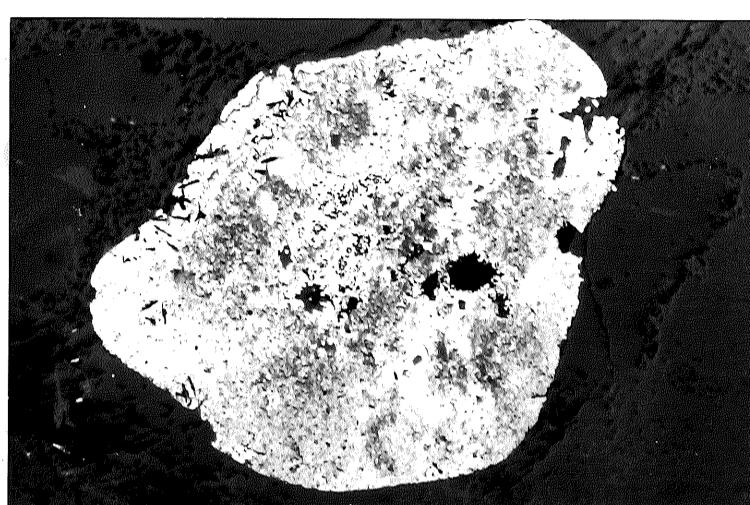
- A. Cataclastic texture in detrital pyrite. Pyrite grain (centre) shows inclusions of pyrrhotite (dark grey, centre of uncrushed pyrite portion). Rutile (dark grey, right) is abundant in conglomerate from Mount Robert. Reflected light, oil immersion, 240 x.
- B. Rounded concretionary pyrite of detrital origin. Note the pressure fringes of chlorite, which is assymetrically developed. The dark grey needles in the pyrite are chloritoid porphyroblasts; the round inclusions are quartz. Reflected light, 240 x.
- C. Portion of rounded concretionary pyrite with chloritoid porphyroblasts. The extruding porphyroblasts were abraded with the pyrite during transport and, therefore, it appears that the pyrite/chloritoid association represents an intraformational clast. Reflected light, oil immersion, 240 x.
- D. Pyritized rutile aggregate. The texture of the pyrite pseudomorph suggests that the replaced rutile was itself a pseudomorph of a pre-existing mineral, possibly ilmeno-magnetite. Reflected light, oil immersion, 240 x.
- E. Replacement of rutile (dark grey, in gangue and within pyrite) by pyrite. Reflected light, oil immersion, 240 x.
- F. Alteration of ilmeno-magnetite. The magnetite portion has been dissolved, while the ilmenite lamellae have been altered to leucoxene. The original (111) orientation of the ilmenite lamellae is still displayed. Reflected light, oil immersion, 400 x.

PLATE 2

A



B



C



D



E



F

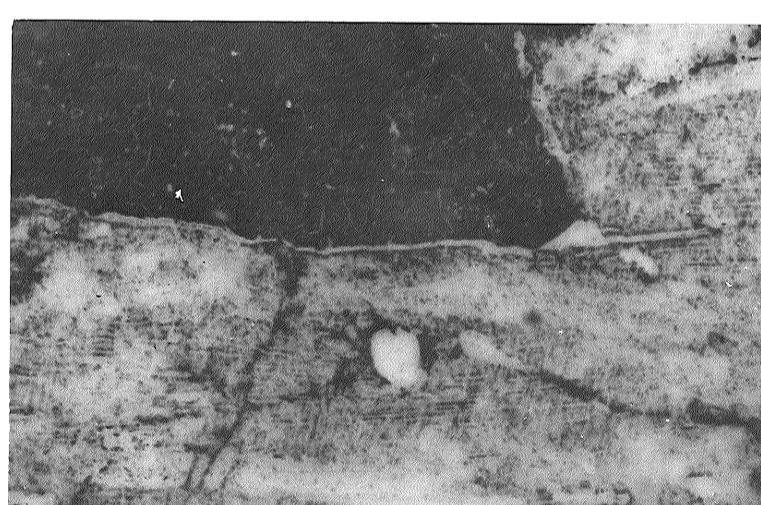
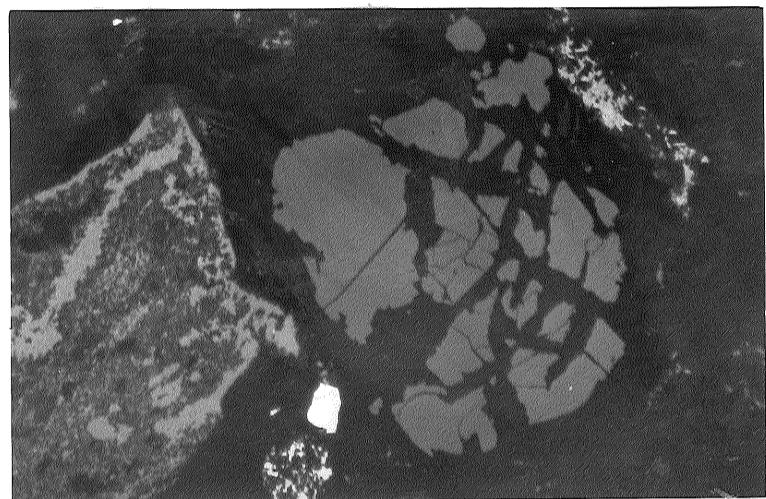


PLATE 3

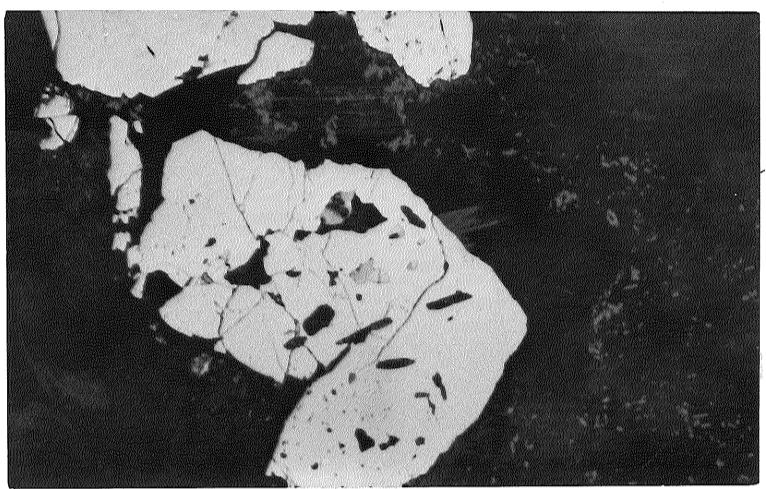
- A. Fractured chromite (centre), leucoxene (light grey, left hand side of photograph) and minor pyrite (white, between leucoxene and chromite). Chromite is a rare heavy mineral in the conglomerates from Mount Robert, and in most cases it has been fractured. Reflected light, oil immersion, 240 x.
- B. Inclusions of chalcopyrite (light grey) and pyrrhotite (dark grey) in detrital pyrite. Small rutile needles (dark grey) are abundant in the matrix. Reflected light, oil immersion, 240 x.
- C. Gold particles in the conglomerate matrix. Reflected light, oil immersion, 240 x.
- D. Detrital molybdenite aggregate and leucoxene (light grey, lower right hand corner of photograph). Reflected light, oil immersion, 240 x.
- E. Carbonaceous matter. Oval-shaped structures could resemble columnar carbon sectioned at right angles to column growth. Reflected light, oil immersion, 240 x.

PLATE 3

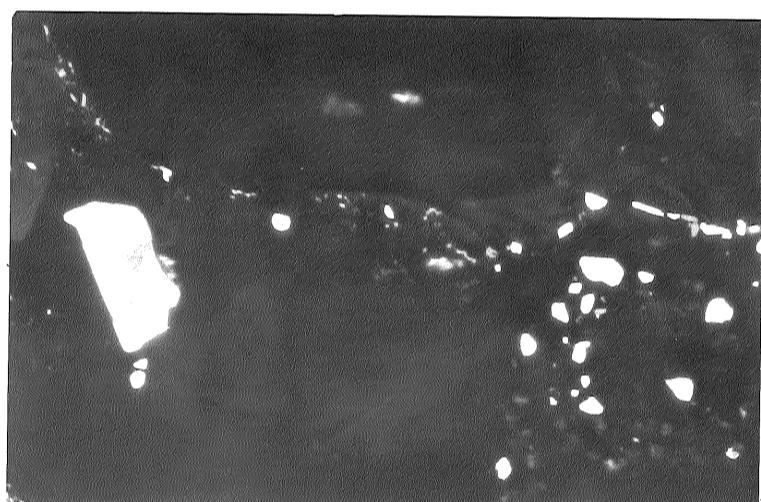
A



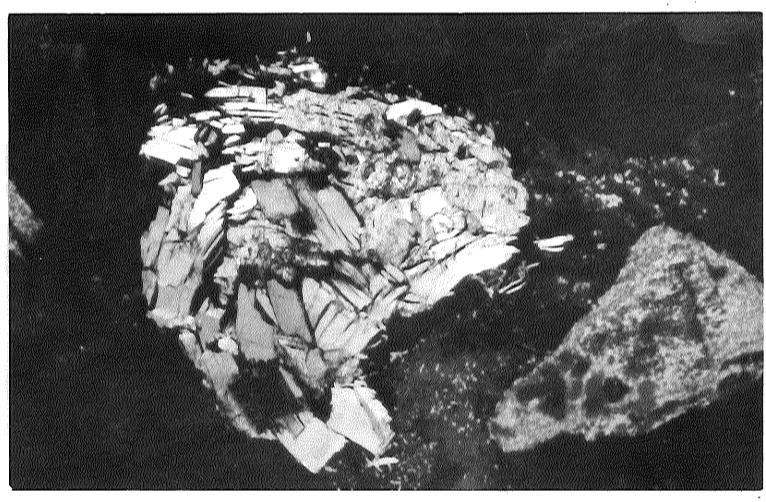
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