THE GEOLOGY OF THE BEWAARKLOOF AREA

PIETERSBURG ASBESTOS FIELD

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BY

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CONTENTS

SECTION I.

INTRODUCTION

CONTENTS (Cont'd)

SECTION II

RESULTS OF PRESENT INVESTIGATION

4/......

CONTENTS (Cont'd)

SECTION I

I N T R O D U C T I O N

A. GENERAL STATEMENT

Although the two amphibole asbestos minerals amosite and crocidolite have been mined for the last forty to fifty years in the Pietersburg - Lydenburg Asbestos Field, only a few scientific papers on the geological features of the asbestos deposits have been published.

Geologists who made important early contributions to the geology of this field were Hall (1918, 1930), Peacock (1928) du Toit (1945) and Vermaas (1952). In recent years Cilliers (1961), Genis (1961), Hanekom (1966) and Fockema (1967) have published the results of their geological and petrological investigations.

This thesis is based on field and underground work carried out during 1962-63 in the Bewaarkloof - Malipsdrift area, which lies in the western portion of the asbestos field. It deals mainly with the structural features of the banded ironstone formation; the asbestos bearing horizons and their relationships with one another; and with the origin of amphibole asbestos.

The results of this investigation may prove useful in the search for concealed asbestos deposits.

B. LOCATION OF AREA

The main part of the Bewaarkloof area discussed in this paper lies 72 kilometres east of Pietersburg. The co-ordinates define the area as lying between 29° 45' and 29° 50' east and between 24° 7' and 24° 12' south (see Map 1).

The regional investigation carried out on the various asbestos workings on the adjoining farms covered roughly 130 square kilometres, with Bewaarkloof at its centre.

C. COMMUNICATIONS

The area can be reached by means of the main Pietersburg - Lydenburg road or from the Lowveld via Gravelotte and Leydsdorp.

6/......

FIGURE I

PHOTO SHOWS THE MAIN EAST-WEST VALLEY OF BEWAARKLOOF (FACING EAST).

These roads are good for the most part, except for a portion of the Leydsdorp road near The Downs. The road from Pietersburg is tarred up to Chuniespoort. Roads cut by the active mines give access to the mountain area and have yielded numerous rock exposures in this scree and bush covered country. The nearest railhead is at Pietersburg, 72 Kilometres away.

D. PHYSIOGRAPHY

1. Climate and Rainfall

The climate is cool and frost free in winter and warm to hot in the summer, with a low average rainfall of 240 millimetres annually. The rain falls mainly in the summer months, especially January and February. The area is prone to violent thunderstorms.

2. Drainage

The area is drained by the Malips River, a tributory of the Olifants River, flowing southwards with small tributories confined to narrow gullies, giving a semi-rectangular drainage pattern.

3. Vegetation and Soil Cover

Dense Acacia thornbush, Naboom and Maroela trees occupy the valleys and lower portions of the hillslopes. The higher ridges are covered with a sour grass variety, Protea bushes and "Stamvrugte bome".

The soil is a red-brown, iron rich residual loam, formed from the weathered banded ironstone and shale.

4. Relief

The terrain is extremely rugged (refer to Topographical and Geological map). The mountains rise to heights of 1800 Metres above sea level, while the lower valley floors are only in the region of 750 metres above sea level (see Fig. 1).

The main ridges have an east-west trend corresponding to the harder formations forming these ridges. The intervening softer formations again occupy the lower slopes and the valley floors.

5. Superficial Deposits

The soil development is thin, eluvium is found in the lower slope areas with extensive weathering of the ironstone, and deep alluvium in the narrow gullies.

E. GENERAL GEOLOGY OF THE PIETERSBURG ASBESTOS FIELD

1. Succession

Bewaarkloof lies in the centre of the area known as the Pietersburg Asbestos Field, which stretches from Chuniespoort in the west to the Mhlapitsi River in the east. The rocks in the area belong to the sediments of the Transvaal System. They strike approximately east-west and have been subjected to several periods of regional deformation and intrusion of igneous material.

This diversified sedimentary sequence of the Transvaal System has been sub-divided into three main series, i.e. the Black Reef, the Dolomite and the Pretoria Series (Schwellnus et al. 1962 - See Fig. 2). The banded ironstone is, because of the asbestos content, economically the most important rock group and forms part of the Dolomite Series in the Transvaal. In the Cape Province the Banded Ironstone was formerly classified as part of the Pretoria Series, but it has been suggested that it should be included with the Dolomite Series (SA Lithos, 1966; Page 10).

Recently Button (1973) has proposed that the Banded Ironstone Stage be termed the Penge Formation, the Dolomite Stage be termed the Malmani Formation and the Black Reef Series the Graskop

Formation. This entire suite of rocks is also to be known as the Olifants River Group. As these suggestions have not formally been accepted the present accepted nomenclature has been retained in this thesis.

As can be seen from the stratigraphic sequence given in Figure 2, the base of the Pretoria Series has been taken as the Bevet's Conglomerate, which marks a very distinct disconformity. The Bevet's Conglomerate contains angular and sub-angular pebbles of chert, ironstone and shale, with a coarse, gritty matrix derived solely from the older sequence just below.

Whereas the Dolomite and Pretoria Series are sharply separated by this clear and undeniable disconformity, the Black Reef Series shows a conformable relationship with the overlying Dolomite Series.

MALIPSDRIFT AREA

GEOLOGICAL FORMATIONS
(After Schwellnus et al.1962)

Transvaal System	Pretoria Series	Magaliesburg Stage	Hornfels with interbedded quartzite.
		Daspoort Stage	Quartzite, partly felspathised, leptite and minor hornfels.
			Ongeluk lava with interbedded shale and tuff.
			Ongeluk quartzite and conglomerate.
			Hornfels and shale with minor tillite, conglomerate and quartzite.
		Timeball Hill Stage	Quartzite.
			Shale, Hornfels and minor schist
			Bevet's conglomerate
	Dolomite Series	Upper Dolomite Stage	Dolomite and chert with quartzite and shale lenses.
			Shale and hornfels with dolomite layers and conglomerate.
			Dolomite.
		Banded Ironstone Stage	Banded ironstone with shale bands and asbestos.
		Main Dolomite Stage	Dolomite, chert and limestone with shale and quartzite layers, breccia and chrysotile.
	Black Reef Series		Quartzite, conglomerate, shale and dolomite
			Quartzite with conglomerate and shale layers.

Figure 2.

Intrusive Rocks:

Karroo	Dykes and sills of dolerite	
Post-Transvaal	Bushveld Igneous Complex	Granite Pegmatite veins. Magnetite and magnetite-bearing hortonolite dunite pipes. Gabbro with bands and pipes of magnetite. Pegmatitic felspathic pyroxenite (Merensky Reef) Porphyritic pyroxenite. Pipes and sheets of peridotite. Norite and anorthosite. Pyroxenite with chromitite seams. Norite.
Post-Transvaal	Diabase sills as forerunners of Bushveld Complex	

Figure 2 (Cont'd.)

2. Structure

Generally, the incompetent rock members of the Transvaal System (mostly those of the Dolomite Series) have been intensely folded along two major fold axes trending east-west and north-south to form an interfering pattern of folding (see Map 1). The more competent beds of the Black Reef and Pretoria Series, such as the quartzite, appear to have suffered very little deformation except for broad undulations. These rocks are prominently exposed as sharp ridges and dip steeply to the south at angles generally exceeding 40°. Figure 3 schematically indicates the competency of the quartzite members, with folding of the less competent dolomite and iron formation in between.

Apart from the folding of the incompetent formations, the stresses were also relieved by faulting of the more competent members such as the quartzite beds of the Timeball Hill and Daspoort Stages of the Pretoria Series.

3. Intrusive Rocks

The sedimentary sequence was invaded by a suite of basic, ultrabasic, and acid rocks of the Bushveld Igneous Complex. The result is that it is only around the periphery of the Bushveld Complex where these formations are found outcropping, and are parallel to the edge of this intrusion. Hypabyssal rocks occur in the form of diabase sills and dolerite dykes and are found mainly in the Black Reef and Dolomite Series. The sills are usually concordant, occasional minor transgressions are observed. The dykes, which clearly post-date the sills and are probably of Karroo age intruded along joint and fault planes conforming with the overall structural pattern of the area.

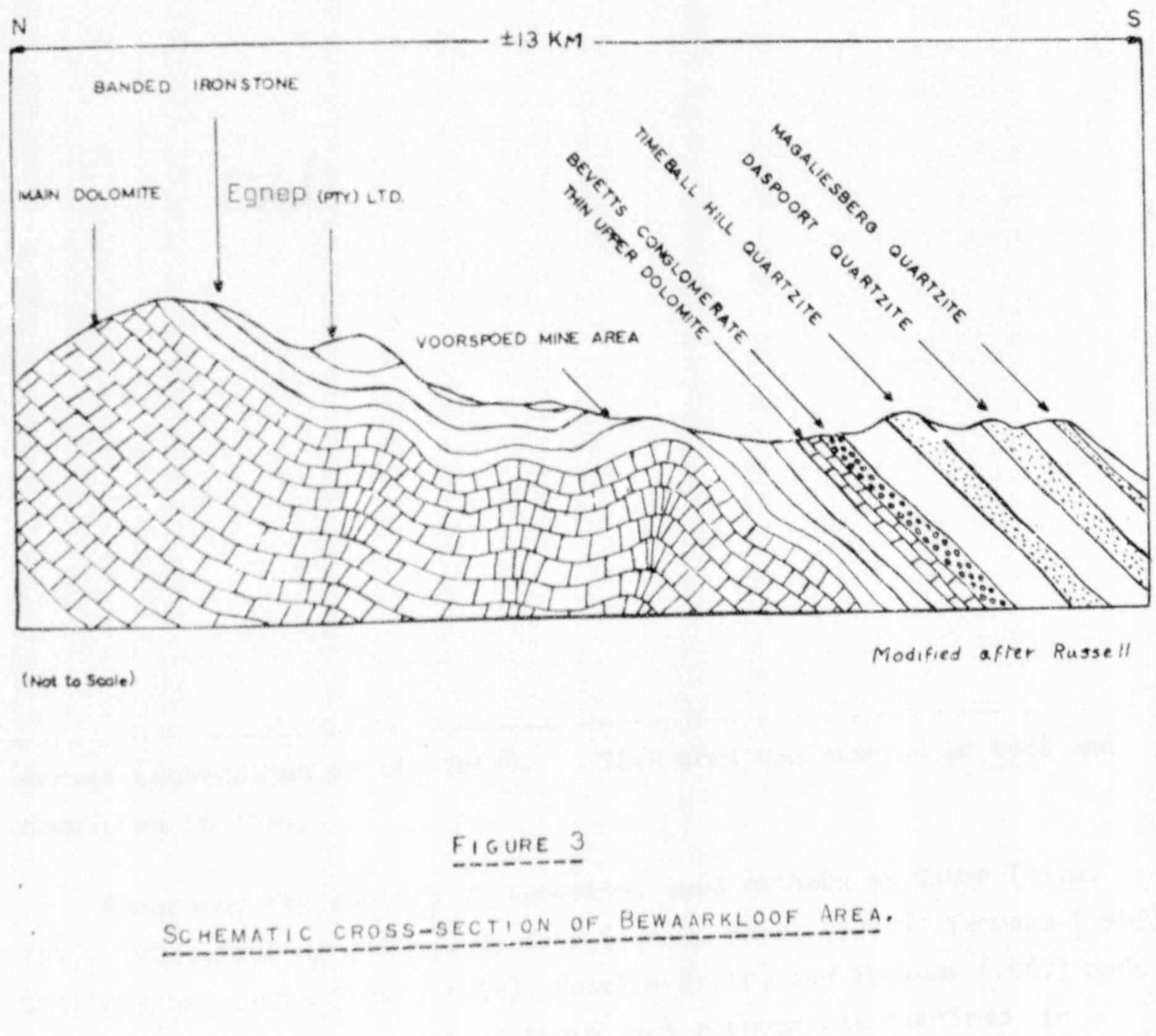

FIGURE 3

SCHEMATIC CROSS-SECTION OF BEWAARKLOOF AREA.

4. Metamorphism

There is a c... absence of metamorphic effects in the Black Reef and lower portions of the Dolomite Series. Most of the metamorphism can be observed near diabase sills, dolerite dykes and major faults.

In the banded ironstone amphibole minerals have been abundantly developed in the form of cross-fibre amosite and crocidolite, needles and rosettes of grunerite and riebeckite.

In the Pretoria Series an increase in the metamorphism as the result of the Bushveld Igneous Intrusion, from bottom to top is clearly noticeable. At the base of this succession, andalusite hornfels is found in the footwall shaly formations, and more predominantly so in the vicinity of the Wonderkop fault area. Higher up in the succession (and nearer the Bushveld Complex), garnet, staurolite and sillimanite hornfels are abundantly present. The quartzite beds of the Pretoria Series have been re-crystallised to a coarse, granular rock.

F. PREVIOUS WORK

The area was mapped by Hall between 1907 and 1911 and described in the Annual Reports of the Geological Survey for 1914 and 1918. Hall (1930) further re-investigated the asbestos deposits in the Transvaal twelve years after the initial survey and described the asbestos deposits and features of the asbestos.

Recently the area was re-mapped and described by the Geological Survey (Schwellnus et al, 1962). This work was started in 1948 and completed in 1956.

Regarding the genesis of asbestos, such authors as Taber (1916, 1917, 1924),Peacock (1928), du Toit (1945), Miles (1942), Vermaas (1952) Cilliers and Genis (1961, 1964), Hanekom (1966) and Fockema (1967) made notable contributions, most of their work however was confined to crocidolite asbestos only occurring in the Northern Cape. Hall and to some extent Du Toit covered the amosite and crocidolite asbestos occurrences of the Pietersberg Asbestos Field

G. THE PRESENT INVESTIGATION

1. General

Both du Toit (1945) and Vermaas (1952) emphasised the close relationship between folding and fibre development. Later Cilliers and Genis, (1964) suggested that there is no genetic relationship between asbestos and the folds. It was thus considered that if a detailed geological and structural investigation of the area were made, some kind of pattern might emerge which could throw more light on the subject and which could assist in future exploration and possibly underground development.

2. Aims of Present Investigation

Within the area, the following projects were undertaken :-

(a) To correlate accurately all the coutcropping fibre exposures scattered along the mountain slopes at different elevations and to tie in this information with the various underground workings on amosite and crocidolite.

(b) To compile a map of the geological and structural parameters.

(c) To give a broad and very general description of the fine siltstone and laminated iron formation, but without detailed petrological work.

(d) To investigate the features of the amphi[illegible] fibre zones, horizons and seams, and to note their relatio[illegible] folding.

(e) To attempt some explanation for the gen[illegible] the asbestos and the formation of economic deposits.

It was realised at the initial stages of this investigation that to carry out the detailed wotk in this area, an accurate topographical base map was required. This base map on a scale of 1: 3,600, (approx. 1 cm to 225 metres), with 25 feet (7,5 metre) contour intervals, was compiled by Mr. H. Meyer of the Witwaterand University, from aerial photographs obtained from the Government Trigonometrical Survey.

As the base map and sections were compiled before the introduction of the metric system, the writer has indicated both English and metric scales and measurements on the maps and in the text where it was deemed necessary.

To this map was added geological and detailed structural information by means of a new mapping technique which involved a light weight meridan compass (simplified theodolite), staff and clino-rule. The orthodox structural mapping method, using aerial photographs and a magnetic compass, could not be used in the highly magnetic ironstone formations. The stations and the geological and structural information were graphically plotted on the base map by means of the resection method. Once the station was defined, structural and geological data were read off as angular relationships. Bedding plane dips and plunges of the folds were measured by means of a clino-rule.

WORK ACCOMPLISHED

Work in this area was started early in anuary, 1962. On completion of a general reconnaissance survey of the area, detailed geological and structural recordings were commenced. This work covered a period of approximately twelve months. The recordings were subsequently plotted on an equal area Schmidt Stereonet. The plots clearly display the various structural observations noted in the course of mapping.

In addition to this, the nature of the different fibre seams and bands was carefully noted. Underground workings of the surrounding mines were also visited and numerous orientated samples were taken. From these samples accurate measurements were recorded of the tension cracks and joints filled with cross-fibre asbestos, calcite, quartz and siderite. Numerous measurements were also recorded on the orientation of the interbedded amphibole fibre bands and seams. A total of 1,600 measurements were made of the various aspects mentioned above.