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TITLE : THE MACERAL COMPOSITION OF THE COMMERCIALLY AVAILABLE PRODUCTS PREPARED BY COLLIERIES IN THE REPUBLIC OF SOUTH AFRICA

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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

REPORT NO. 20 OF 1978

THE MACERAL COMPOSITION OF THE COMMERCIALLY AVAILABLE PRODUCTS PREPARED BY COLLIERIES IN THE REPUBLIC OF SOUTH AFRICA

ABSTRACT

One hundred-and-eighty-eight commercially available products prepared by 55 collieries in the Republic of South Africa were petrographically analysed.

Only 25% of the products contained over 50% of vitrinite and 60% of them contained vitrinite varying between 30 and 50%. Examination of the ratios in which the bright components occur to the dull components (i.e. reactives: inerts) shows that the brights were dominant in only 39% of the products. In 52% of the products examined the dull dominated the bright components in the ratio of 1,1 - 1,6:1.

Examination of the coal seams shows that the No. 5 Seam from which blend coking coal is produced in places contains the brightest coal followed in a descending order of brightness by the coking coals of the Central Klip River area, Paulpietersburg and Vryheid.

They contain ratios of bright to dull components varying between 3,4 - 1,7:1. Of the non-coking coals, those from the Ermelo coalfield are the brightest with a ratio of 1,7:1. The coals of the Northern Klip River and the Witbank No. 4 Seam are very similar in maceral composition with nearly equal amounts of bright and dull components. The Witbank No. 2 Seam, the Utrecht and Southern Klip River seams consist of fairly dull coal while those of the Orange Free State coalfield are very dull.

Exinites occur in fairly low quantities in South African coals and 82% of the products examined contained 6% and less exinitic material. The exinite content of OFS coals does not differ greatly from those in the Transvaal but the Natal coals contain considerably less exinite and values of less than 1% are not uncommon.

CONTENTS

INDEX TO COLLIERIES

COLLIERY	TABLE(S)	SECTION
Natal Navigation	16, 22	6.3
Navigation (SACE)	1, 2	6.1
Newcastle-Platberg	17, 22	6.3
New Clydesdale	4, 7	6.1
New Largo	6, 7, 24	6.1
New Wakefield	1	6.1
New Springfield	14, 24	6.2
Optimum	6, 7, 24	6.1
Phoenix	5, 7	6.1
Sigma	14, 25	6.2
South Witbank	3	6.1
Spitzkop	11	6.1
Springbok (No. 2 Seam Sec.)	4, 7	6.1
Springbok (No. 5 Seam Sec.)	1, 2	6.1
Springbok (Hope Sec.)	1, 2	6.1
Star	15	6.3
Tavistock	4, 7	6.1
Tendega	20, 22	6.3
Transvaal Navigation	4, 7	6.1
Tweefontein	5, 7	6.1
Union	11	6.1
Usutu	11, 24	6.1
Umgala	18, 22	6.3
Utrecht	18	6.3
Van Dyks Drift	4, 7, 8, 9, 10	6.1
Vierfontein	14, 24	6.2
Vryheid Coronation	19, 22	6.3
Waterpan	5, 7	6.1
Witbank Consolidated (WCCM)	3	6.1
Wolvekrans	5, 7	6.1
Zimbutu	18, 23	6.3

1.0 INTRODUCTION

This report is based on reports Nos. 10 of 1974, 20 of 1974 and 20 of 1975 which deal with the maceral composition of the commercially available products prepared by the collieries in the Transvaal, Orange Free State and Natal, respectively.

Since the appearance of the reports a number of new collieries have come into production or are on the point of doing so at the time of writing and the export of low-ash coals as well as power station smalls from a number of collieries have reached such considerable proportions that all available information on these collieries and products have, wherever possible, also been included in the report.

The report deals with most of the collieries in the Transvaal, Natal and the Orange Free State. A small number of collieries were not included, the reason being that they have either ceased production or that there were not sufficient petrographic data available at the time they closed down. One major colliery producing coal in the Transvaal, namely New Springfield, was included with the Orange Free State collieries by virtue of its geographic position and the type of coal they are mining.

1.1 PRESENTATION OF RESULTS

The petrographic data presented in this report are based on 448 product samples. The individual analysis and sample number of each product have not been included in the report but the mean values calculated from the number of samples taken of each product are given in Section 6 at the end of the report.

As the result of the many collieries involved and the considerable amounts of analytical data presented, an alphabetical list to the collieries are given on pages 4 and 5 together with a reference to the number of the Table where the analytical details may be found.

A number of three-point diagrams illustrating the maceral composition of the coals on a visible mineral matter free basis and to which reference is made in the text is given.

Three plans numbered 1, 2, and 3 showing the approximate positions of the collieries and the neighbouring towns precede each section dealing with the coals of the Transvaal, Orange Free State and Natal respectively. A list of the collieries and their corresponding numbers on the plan are given on the plans for the OFS and Natal collieries. A list of the Transvaal collieries follows immediately after the plan.

The details appearing in each Section are given in the contents.

1.2 GENERAL CONSIDERATIONS

In the comparison and evaluation of the results, allowance must be made for a number of factors. Thus, the coal in a seam may vary in quality and petrographic composition over a relatively short distance. It also follows that collieries applying mechanical mining methods may show greater variation, by reason of the restricted areas mined, than those where hand loading is applied over larger areas at the same time and where greater discrimination is practised in mining.

The position is further complicated by the fact that certain collieries mine up to three seams contemporaneously and the coal is transported to a single stockpile from which the washing plant is fed. Thus a washed product may consist of coal representing more than one seam in variable proportions as the result of stoppages underground and size segregation in the stockpile. Many collieries also practise selective mining in order to satisfy the demand for a certain quality of coal. At times, some collieries also resort to top-coaling, often resulting in the production of a poorer quality coal than their normal run-of-mine product. Some collieries do not possess cleaning plants and therefore prepares products not always consistent in quality.

Considering these factors, it is logical to expect that the analyses of products prepared from the same coal seam may vary, and, on a smaller scale, that variations can occur in the products prepared by a specific colliery. It was decided that if the vitrinite contents of three analyses of any given product carried out at intervals differ within reasonable limits from each other, the analyses can be regarded as being typical of that product. A variation of not more than 5% was aimed at but this could not invariably be obtained.

8/.......

1.3 THE SIGNIFICANCE OF A MACERAL ANALYSIS

Macerals are the elementary coal components that can be recognized under a microscope. There are a considerable number of them but they can be divided into two main categories namely chemically reactive and chemically inert macerals. The former have a lower carbon to hydrogen ratio than the latter.

The reactive macerals can be sub-divided into two groups viz. vitrinites and exinites (also known as sporinites). The vitrinites are represented by the vitrains and exinites by the clarains of the older nomenclature originally introduced by Stopes. The former represents the bright coal in a hand specimen and the latter, coal with a silky lustre. The inertinites are represented by the durains (black and grey) and fusain. Durains appear dull black in a hand specimen and fusain has a charcoal like appearance. At least 90% of the durains found in South African coals are of the grey variety which is appreciably less reactive than black durain by virtue of the fact that it is composed of intimately mixed vitrinite and semi-fusinite and the latter of exinite and semi-fusinite. Semi-fusinite is the predominant component of the inert maceral group with fusinite as the most important of the minor components.

The system of three groups of macerals is conventional and a convenient simplification since the macerals belonging to each group have very similar chemical properties.

Mineral matter in coal has no genetic relationship to the macerals. It acts as a diluent and may have other adverse influences, such as the lowering of the ash-fusion temperature, abrasion of boiler tubes, etc. Thus in the evaluation of a coal the mineral matter must also be taken into account.

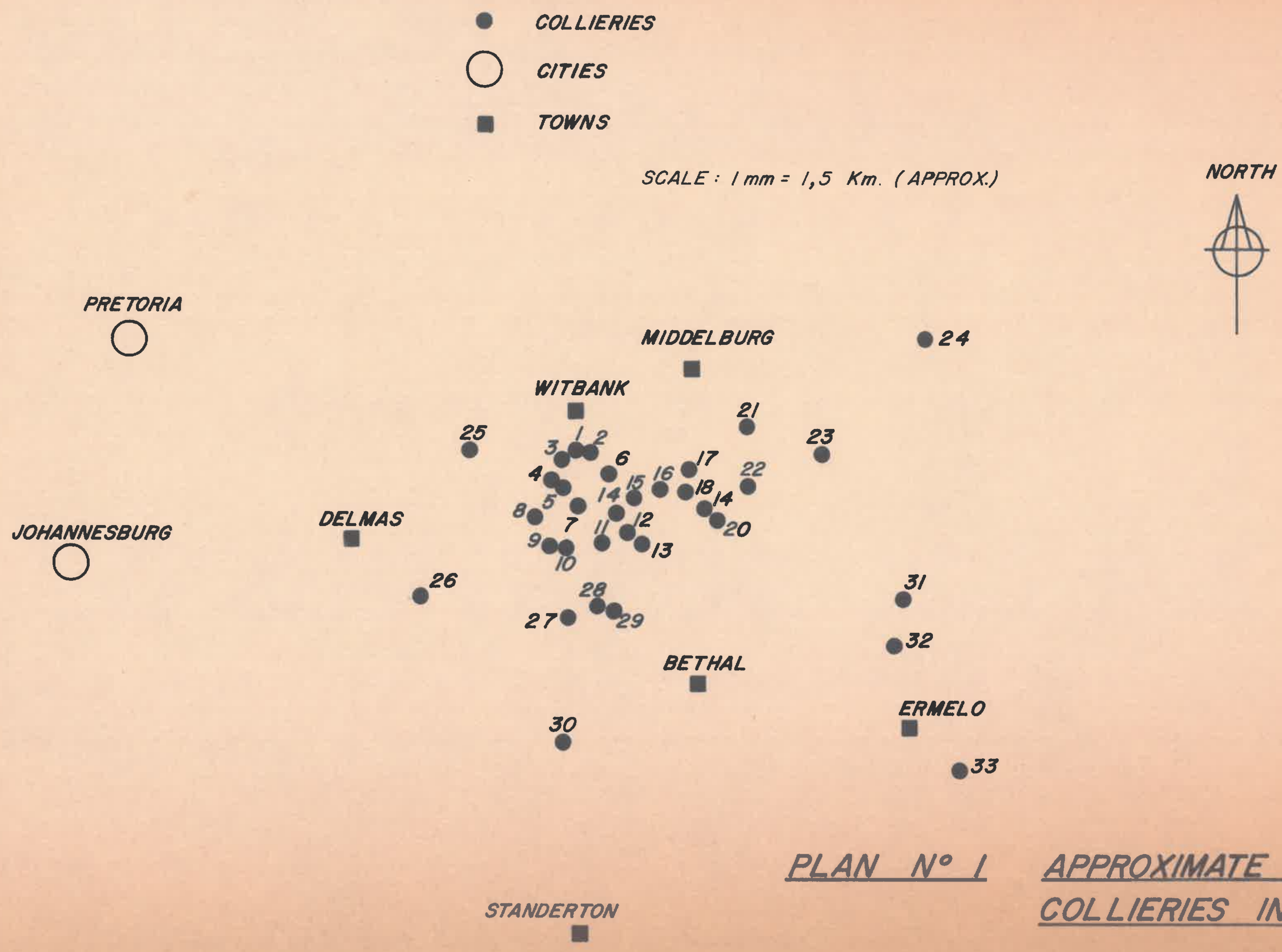
In this report the terms "vitrinite", "exinite", "inertinite" and "visible mineral matter" are used as collective terms for a number of macerals and minerals respectively.

For the assessment of a coal on a petrographical basis, the ratio of reactive to inert constituents is important. Reactive macerals are the essential components of a coking coal.

9/.......

LIST OF COLLIERIES SHOWN ON PLAN NO. 1

1. Navigation (SACE)
2. Landau
3. Greenside
4. Waterpan
5. Tweefontein
6. Wolvekrans
7. Phoenix
8. WCCM (Witbank Consolidated Coal Mines)
9. South Witbank
10. Tavistock
11. Albion
12. New Clydesdale
13. Transvaal Navigation
14. Van Dyks Drift
15. Springbok
16. Douglas
17. Bank
18. Blesbok
19. Blinkpan
20. Koornfontein
21. Eikeboom
22. Optimum
23. Arnot
24. Belfast
25. New Largo
26. Delmas
27. Anglo Power Kriel
28. Wakefield
29. Kriel
30. Bosjesspruit
31. Union
32. Spitzkop
33. Usutu



PLAN N° 1 APPROXIMATE POSITIONS OF COLLIERIES IN TRANSVAAL

2.0 SECTION 2 - TRANSVAAL COALS

2.1 GENERAL CONSIDERATIONS

The main coal-bearing areas at present being exploited are situated in the districts of Witbank - Middelburg - Bethal and Ermelo.

In the first three mentioned districts which adjoin, four of the five seams viz. Nos. 1, 2, 4 and 5 are mined. No. 3 Seam is very thin and nowhere exploited. Nos. 1 and 5 Seams are not everywhere present. No. 1 Seam is worked in conjunction with No. 2. No. 5 Seam consists in places of blend coking coal where it is extensively mined for metallurgical purposes.

There are a number of coal seams present in the Ermelo coalfield which cannot be satisfactorily correlated with the Witbank - Middelburg - Bethal seams. However, Seam B, C, Lower C and Upper C are extensively mined.

2.2 PRODUCTS DERIVED FROM THE NO. 5 SEAM

This seam contains more bright coal over its entire thickness than any other seam in the coalfield. It consists of very bright coal at its base with a dull upper portion containing thin bright bands. In places it is uniformly bright over the whole seam. In the areas where it is best developed, the average thickness is about 1,8 m.

Coal from seven collieries was petrographically analysed. Five collieries, namely Greenside, Navigation (SACE), Springbok (No. 5 Seam Section), Springbok (Hope Section) and Blesbok produce blend coking coal. In addition, Springbok (No. 5 Seam Section) and Hope Section also produce gas coal while Navigation (SACE) also produces a middling product. Kriel and New Wakefield collieries produce a number of products ranging in size grades from round coal to duff; they do not clean their coal mechanically and apply handpicking only. The coal has no coking properties.

Table 1 gives the mean maceral composition of the No. 5 Seam products prepared by the various collieries.

TABLE 1

THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE COLLIERIES MINING THE NO. 5 SEAM

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Greenside	65,0	6,9	25,2	2,9	2,6
Navigation (SACE)	66,5	5,1	23,7	4,7	2,5
Springbok (No. 5 Sec.)	72,4	4,9	20,0	2,7	3,4
Springbok (Hope Sec.)	67,3	7,1	23,2	2,4	2,9
Blesbok	63,5	8,3	25,8	2,4	2,5
Kriel	67,5	8,5	16,8	7,2	3,2
New Wakefield	67,1	10,2	17,7	5,0	3,4
Mean	67,0	7,3	21,8	3,9	2,9
Mean (Visible mineral matter free)	69,7	7,6	22,7	-	3,4

From a petrographic point of view, the results recorded in Table 1 are very similar. The seam is characterized by high amounts of vitrinites, higher than usual amounts of exinites and relatively low amounts of inertinites, thus giving high ratios of reactives to inertinites.

With the exception of the bright coal seams of the Waterberg and Soutpansberg coalfields, the No. 5 Seam contains the most reactive coals in the Republic.

Three collieries producing blend coking coals also prepare an additional product for the market. The maceral composition of these products are recorded in Table 2.

TABLE 2

PETROGRAPHIC COMPOSITION OF ADDITIONAL PRODUCTS PREPARED BY THREE COLLIERIES MINING THE NO. 5 SEAM

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Navigation SACE Middlings	20,9	8,1	63,5	7,5	0,4
Springbok (No. 5 Sec.) Gas Coal	54,0	8,5	33,3	4,2	1,7
Springbok (Hope Sec.) Gas Coal	62,3	5,0	28,4	4,3	2,1

As the result of two-stage washing, Navigation (SACE) produces a middling product having a very inferior maceral composition the ratio of reactive to inert constituents being only 0,4. The gas coals produced by Springbok (No. 5 Section) and Hope Section consist of material having relatively high ratios of reactives to inerts and are inferior only to the blend coking coals listed in Table 1.

2.3 THE PRODUCTS DERIVED FROM THE NO. 4 SEAM COAL

The No. 4 Seam shows more variation in thickness and quality than any other seam in the Witbank-Middelburg coalfield. Sometimes it is split into several parts. The Lower No. 4 or No. 4 where there is no parting, is mined extensively mostly in conjunction with the No. 2 Seam.

It consists of dull to dull lustrous coal with a number of bright bands. The seam is mined by about ten different collieries in the Witbank area but only four collieries mine the seam exclusively. These consist of two old established collieries namely South Witbank and Witbank Consolidated Coal Mines (WCCM) and two new collieries which started producing in 1976 and 1977 namely Anglo Power Kriel and Bosjesspruit. The new collieries produce only one unwashed product each while the older collieries produce a number of washed products.

The petrographic composition of the coals produced by these collieries are recorded in Table 3.

13/.......

TABLE 3

THE PETROGRAPHIC COMPOSITION OF THE PRODUCTS PREPARED BY THE COLLIERIES MINING THE NO. 4 SEAM

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives/Inerts
South Witbank	43,1	4,4	44,7	7,8	0,9:1
WCCM	47,7	6,1	39,7	6,5	1,2:1
Anglo Power Kriel	28,4	4,1	58,5	9,0	0,5:1
Bosjesspruit	26,2	4,9	60,4	8,5	0,5:1

The visible minerals in the Anglo Power Kriel and Bosjesspruit products are of the same order as those for South Witbank and WCCM. It appears as if the No. 4 Seam tends to become duller in the southern direction. Hence the lower vitrinite and higher inertinite content.

2.4 PRODUCTS DERIVED FROM THE NO. 2 SEAM

The No. 2 Seam is the principal working seam in the Witbank-Middelburg coalfield. It is generally about 6 m thick and consists of about 1 m of bright coal at the base, followed by mixed, mainly dull coal with some bright bands merging into dull coal at the top. In a number of places up to nearly 1 m of bright coal appears at the top of the seam.

At least 22 major collieries produce coal from the No. 2 Seam. They can be subdivided into three categories, viz. collieries producing coal exclusively from the No. 2 Seam, collieries producing coal from No. 2, No. 4 and/or No. 1 Seam and collieries producing coal from No. 2 (and No. 4) Seam for the generation of electricity.

2.4.1 Collieries producing coal from No. 2 Seam only

The mean maceral composition of the products prepared by the collieries mining the No. 2 Seam exclusively are recorded in Table 4.

TABLE 4

THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY COLLIERIES MINING THE NO. 2 SEAM ONLY

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Albion	32,3	4,9	57,4	5,4	0,6:1
Bank	35,5	4,9	55,8	3,8	0,7:1
Belfast	30,3	2,8	56,2	10,7	0,5:1
Delmas	41,1	4,5	48,5	5,9	0,8:1
Douglas	38,9	3,1	53,0	5,0	0,7:1
Eikeboom	31,9	5,7	56,8	5,6	0,6:1
Koornfontein	49,9	4,4	40,9	4,8	1,2:1
New Clydesdale	32,8	3,9	59,3	4,0	0,6:1
Springbok	39,9	3,7	51,5	4,9	0,8:1
Tavistock	40,4	3,7	50,1	5,8	0,8:1
Transvaal Navigation	33,6	5,4	56,9	4,1	0,6:1
Van Dyks Drift+	41,1	4,2	50,3	4,4	0,8:1
Mean	37,3	4,3	53,0	5,4	0,7:1
Mean (visible min. mat. free)	39,4	4,6	56,0	-	0,8:1

+The colliery has since gone over to two-stage washing and the petrographic composition of the products currently being prepared is recorded in Section 6.1.

Four collieries, viz. Belfast, New Clydesdale, Springbok and Van Dyks Drift, do not wash their coal. Belfast is a small colliery operating on the margin of the coalfield and its products can not be regarded as being representative of what can normally be expected of the coals from the No. 2 Seam.

2.4.2 Collieries producing coal from the No. 2 Seam and other seams

A number of collieries mine other seams (No. 4 and/or No. 1) in addition to the No. 2 Seam.

The maceral composition of their products, which consist of mixtures, is recorded in Table 5.

TABLE 5

THE MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY COLLIERIES MINING OTHER SEAMS IN ADDITION TO NO. 2 SEAM

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Greenside	40,6	4,1	49,6	5,7	0,8:1
Landau+	40,7	2,9	51,8	4,6	0,8:1
Phoenix	45,2	4,2	46,1	4,5	1,0:1
Tweefontein	43,7	4,4	48,2	3,7	0,9:1
Waterpan	31,6	5,4	56,9	6,1	0,6:1
Wolvekrans	37,4	3,3	53,5	5,8	0,7:1
Mean	39,8	4,1	51,0	5,1	0,8:1
Mean (visible mineral matter free)	41,9	4,3	53,8	-	0,9:1

+Landau often mines only the No. 2 Seam, so that this colliery may well fall into Table 4. However, the No. 1 Seam has been mined intermittently.

If the results recorded in Table 5 are compared with those in Table 4, it can be noted that the vitrinites are slightly higher and the inertinites lower than those recorded in Table 4. The ratios of reactives to inerts are therefore also slightly higher. Since the maceral composition of the No. 4 Seam has been found to be somewhat better than that of the No. 2 Seam in terms of a higher ratio of reactive to inert macerals, it thus appears that the slightly better values recorded in Table 5, may be due to the fact that a proportion of the No. 4 Seam coal has been included in the products.

The lower values in respect of vitrinite recorded in Table 4 cannot be explained on the basis of the fact that four of the collieries listed are not in possession of coal cleaning plants.

.16/......

Table 5A gives a comparison of the mean values of the products mined by the collieries listed in Tables 4 and 5 where the four collieries, viz. Belfast, New Clydesdale, Springbok and Van Dyks Drift+, which are not in possession of coal cleaning plants, have been omitted.

TABLE 5A

COMPARISON OF THE MEAN VALUES OBTAINED ON THE WASHED COALS DERIVED FROM THE NO. 2 SEAM ONLY AND THE COMBINED PRODUCTS FROM SEAMS NOS. 2, 4 AND 1. (UNWASHED PRODUCTS EXCLUDED)

Seams	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
No. 2 (washed)	38,0	4,6	52,4	5,0	0,7:1
Nos. 2, 4 and 1 (washed)	39,8	4,1	51,0	5,1	0,8:1

Even with the exclusion of the unwashed coals, the No. 2 Seam washed coal is still slightly inferior in maceral composition in comparison with those of the combined Nos. 2, 4 and 1 washed products.

2.4.3 The maceral composition of coal from the No. 2 and No. 4 Seams used for the generation of electricity

Four collieries supply coal from either the No. 2 Seam or No. 2 combined with No. 4, No. 1 and 2A. The maceral composition of these coals are recorded in Table 6.

17/......

+A washing plant has been installed since the samples averaged in Table 4, were taken.

TABLE 6

THE MACERAL COMPOSITION OF THE NO. 2 SEAM AND COMBINATIONS OF NOS. 2, 1, 4 AND 2A SUPPLIED TO POWER STATIONS

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Arnot	2	23,3	3,4	60,1	13,2	0,4:1
Blinkpan	2, 4	40,5	3,0	48,8	7,7	0,8:1
New Largo	2, 4	28,6	3,9	55,1	12,4	0,5:1
Optimum	2, 2A, 1	37,4	6,7	43,5	12,4	0,8:1
Mean		32,5	4,3	51,8	11,4	0,6:1
Mean (Visible mineral matter free)		36,7	4,8	58,5	-	0,7:1

No washing is carried out at any of these collieries. At Blinkpan a McNally drum is used to eliminate some of the shaly coal. The coals are characterised by their high visible mineral matter contents. Arnot Colliery is situated fairly close to Belfast Colliery, and the maceral composition of the coals produced by them is very similar. The values recorded for Blinkpan and Optimum coals are fairly typical of No. 2 Seam coal.

The value reported for New Largo Colliery is the mean value for the crushed and cobble coal which differed very little in petrographic composition, the latter containing only 2,3% more vitrinite than the crushed coal used for power generation.

The values recorded for the products of New Largo and Arnot collieries are the lowest found in the entire Witbank-Middelburg coalfield. These collieries operate on the margin of the coalfield, and the lower values are therefore not out of place.

2.4.4 Summary of the mean petrographic values obtained on the No. 2 Seam coals

Table 7 contains a summary of the mean values obtained on the products prepared from the No. 2 Seam (and other seams mined in conjunction with it), calculated on a visible mineral matter free basis and arranged in a descending order of vitrinite content.

The Table shows that only three collieries, viz. Koornfontein, Phoenix and Optimum, produce coal of which the ratios of reactives to inerts are 1,0:1 or higher. The other 19 collieries investigated prepared coals having ratios ranging from 0,9:1 to 0,4:1. Of these, roughly 80% prepared products having ratios ranging between 0,9 to 0,7:1.

The exinites in the products are fairly constant and if they are added to the corresponding vitrinites to give the total reactive constituents, the order in which the collieries appear in Table 7 does not change significantly. The only notable exception is Optimum, which by virtue of the high amount of exinite, moves up seven places.

It is noteworthy that in a number of cases collieries adjoining each other, or collieries covering a certain area, tend to give comparable results. Examples are, for instance, the two adjoining collieries Phoenix and Tweefontein. They also fall inside a triangular area with Greenside at the apex and a base line joining Tavistock and Van Dyks Drift, which all gave results of the same order. Other examples are the adjoining collieries New Clydesdale, Transvaal Navigation and Albion, on the one hand and Springbok and Douglas on the other hand.

TABLE 7

THE COLLIERIES MINING THE NO. 2 SEAM (AND THE NO. 2 SEAM IN COMBINATION WITH OTHER SEAMS) ARRANGED IN A DESCENDING ORDER OF THE VITRINITE IN THEIR PRODUCTS

Colliery	Seam(s) mined	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Koornfontein	2	52,4	4,6	43,0	1,3:1
Phoenix	2, 4	47,3	4,4	48,3	1,1:1
Tweefontein	2, 4	45,3	4,6	50,1	0,9:1
Blinkpan	2, 1	43,8	3,3	52,9	0,9:1
Delmas	2, 4	43,7	4,8	51,5	0,9:1
Greenside	2, 1	43,1	4,3	52,6	0,9:1
Van Dyks Drift	2	43,0	4,4	52,6	0,9:1
Tavistock	2	42,9	3,9	53,2	0,9:1
Landau	2, 1	42,7	3,0	54,3	0,8:1
Optimum	2, 2A, 1	42,6	7,6	49,8	1,0:1
Springbok	2	41,9	3,9	54,2	0,8:1
Douglas	2	40,9	3,4	55,7	0,8:1
Wolvekrans	2, 4, 1	39,7	3,5	56,8	0,8:1
Bank	2	36,9	5,1	58,0	0,7:1
Transvaal Navigation	2	35,0	5,6	59,4	0,7:1
Albion	2	34,1	5,2	60,7	0,7:1
New Clydesdale	2	34,0	4,1	61,9	0,6:1
Belfast	2	33,9	3,1	63,0	0,6:1
Eikeboom	2	33,8	6,0	60,2	0,7:1
Waterpan	2, 4, 1	33,6	5,8	60,6	0,7:1
New Largo	2, 4	32,6	4,5	62,9	0,6:1
Arnot	2	26,7	3,9	69,4	0,4:1
Mean	-	39,5	4,5	56,0	0,8:1

2.4.5 Low-ash coals and middlings

Five collieries produce low-ash coals and middlings from the No. 2 Seam by two stage washing. Both products are exported; the latter product under the name of Power Station Smalls (PSS).

2.4.5.1 Low-ash product

Table 8 gives a summary of the values obtained on the low-ash products prepared by the collieries.

TABLE 8

LOW-ASH PRODUCTS

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Bank	42,6	4,9	51,6	0,9	0,9:1
Greenside	60,9	6,6	30,0	2,5	2,1:1
Haasfontein	59,3	5,0	34,6	1,1	1,8:1
Landau	54,9	5,3	38,2	1,6	1,5:1
Van Dyks Drift	56,3	4,7	37,4	1,6	1,6:1
Mean	54,8	5,3	38,4	1,5	1,5:1

The vitrinite contents of the low-ash coals are considerably higher than those of their counterparts recorded in Table 7. This is particularly true for Greenside, Landau and Van Dyks Drift collieries. The lowest increases are recorded for Bank and Haasfontein which amounted to 5,7% and 6,9%. With the exception of these two collieries the averange increase for the other two collieries amounted to 14,3%.

2.4.5.2 Middlings or power station smalls

The values obtained on the middling products are recorded in Table 9.

TABLE 9

MIDDLING PRODUCTS

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Bank	29,5	6,4	60,3	3,8	0,6:1
Greenside	30,7	5,2	59,5	4,6	0,6:1
Haasfontein	35,9	6,2	48,2	9,7	0,7:1
Landau	26,6	6,1	62,5	4,8	0,5:1
Van Dyks Drift	30,6	6,7	58,1	4,6	0,6:1
Mean	30,7	6,1	57,7	5,5	0,6:1

The maceral composition of the middling products prepared by the five collieries is very similar and of the same order. In comparison with the middling product prepared by Navigation (SACE) recorded in Table 2, it can be noted that the products derived from the above collieries are considerably superior in maceral composition.

2.4.5.3 Maceral reconstitution of the No. 2 Seam

Since the maceral composition of the low-ash coals and middlings produced by each colliery is known, it is possible to calculate the composition of the coal produced by each colliery prior to two stage washing. The yields of the low-ash and middlings are not known and may vary from one colliery to another. Assuming the proportions are equal, straight averages were used for the calculation of the results recorded in Table 10.

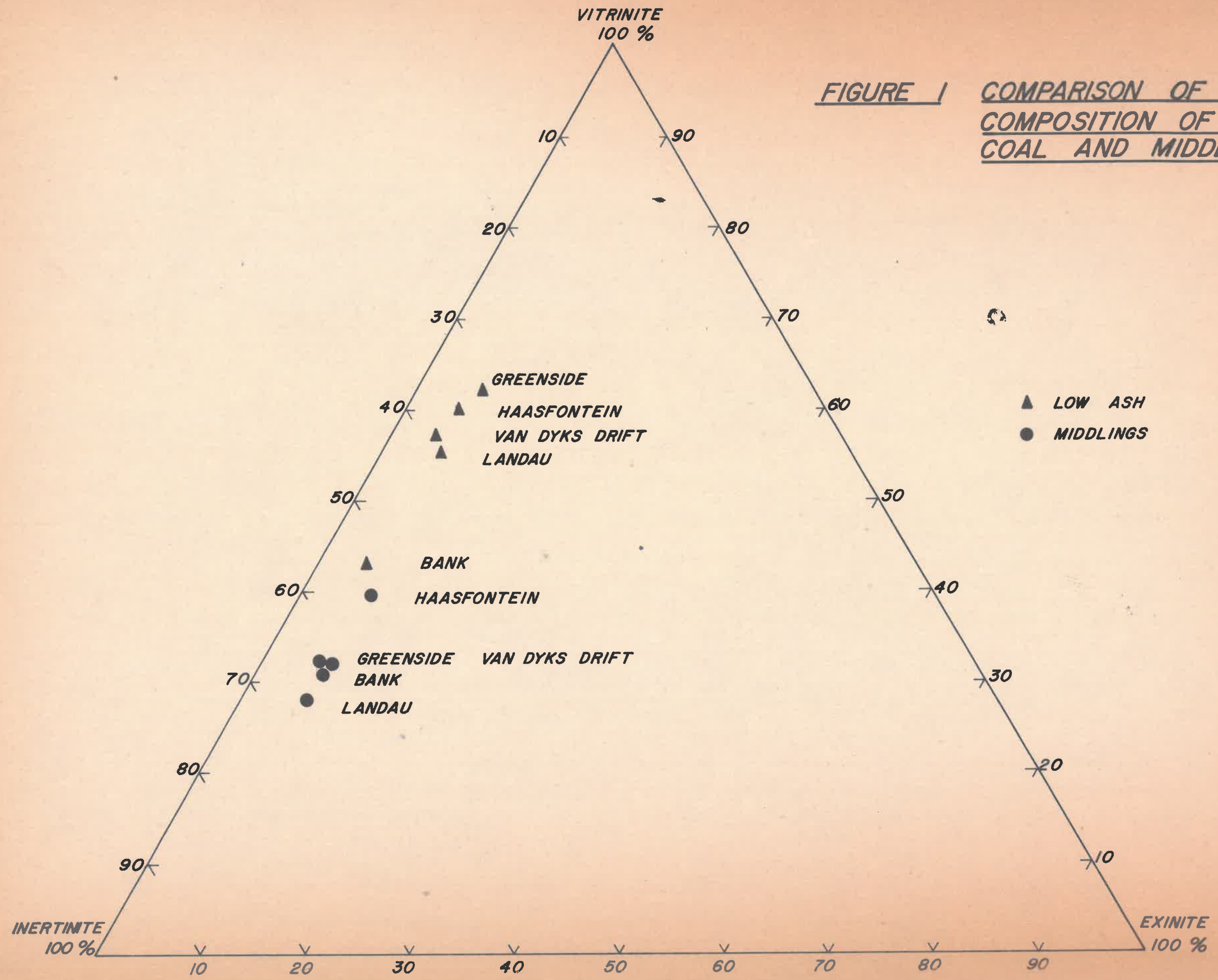


FIGURE 1 COMPARISON OF THE MACERAL COMPOSITION OF THE LOW ASH COAL AND MIDDLINGS

TABLE 10

THE MACERAL COMPOSITION OF THE NO. 2 SEAM AS MINED BY EACH COLLIERY CALCULATED FROM THE VALUES OF THE LOW-ASH AND MIDDLING PRODUCTS ON A VISIBLE MINERAL MATTER FREE BASIS

Colliery	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Bank	36,9	5,8	57,3	0,7:1
Greenside	47,5	6,1	46,4	1,2:1
Haasfontein (formerly Koornfontein)	50,3	5,9	43,8	1,3:1
Landau	42,1	5,9	52,0	0,9:1
Van Dyks Drift	44,9	5,9	49,2	1,0:1

If the vitrinite values are compared with the corresponding values appearing in Table 7 a fairly close agreement can be noted. For Bank the values are similar and for Haasfontein, Landau and Van Dyks Drift the values are within 2,1%. The calculated value for Greenside is 4,4% higher than that recorded in Table 7.

The maceral composition of the low-ash coals and the middlings are graphically illustrated in Figure 1.

2.5 THE PETROGRAPHIC COMPOSITION OF THE PRODUCTS FROM THE ERMELO COALFIELD

The Ermelo coals are, by South African standards, essentially bright coals. Products prepared by three collieries, viz. Union, Spitzkop and Usutu, were investigated. The latter colliery produces coal for the generation of electricity. The other two collieries supply coal for the general market.

The mean petrographic composition of the products is recorded in Table 11.

TABLE 11

THE MEAN PETROGRAPHIC COMPOSITION OF THE PRODUCTS PREPARED FROM THE ERMELO COALS

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Spitzkop	B, C	51,3	5,9	37,0	5,8	1,3:1
Union	Lower C	55,4	5,1	32,6	6,9	1,5:1
Usutu	B, Upper C	50,5	8,2	35,7	5,6	1,4:1
Mean		52,4	6,4	35,1	6,1	1,4:1
Mean (Visible mineral matter free)		55,8	6,8	37,4	-	1,7:1

The values indicate that the products derived from the Ermelo coals are in terms of reactives: inerts, superior to the products prepared from the Witbank-Middelburg Nos. 2 and 4 Seams and are inferior only to those prepared from the No. 5 Seams (gas coals and middlings excluded).

SUMMARY OF THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE TRANSVAAL COLLIERIES CALCULATED ON A VISIBLE MINERAL MATTER FREE BASIS

Table 12 gives the mean maceral composition of all the products from each seam calculated on a visible mineral matter free basis:

TABLE 12

MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED FROM THE COAL SEAMS IN THE TRANSVAAL

Seams	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Witbank No. 5	69,7	7,6	22,7	3,4 :1
Witbank No. 4+	48,9	5,7	45,4	1,2 :1
Witbank No. 2	39,5	4,5	56,0	0,8 :1
Ermelo	55,8	6,8	37,4	1,7 :1

+Only WCCM and South Witbank. The average of all four collieries is very similar to the No. 2 Seam (V - 39,4%, E - 5,3%, I - 55,3%).

24/......

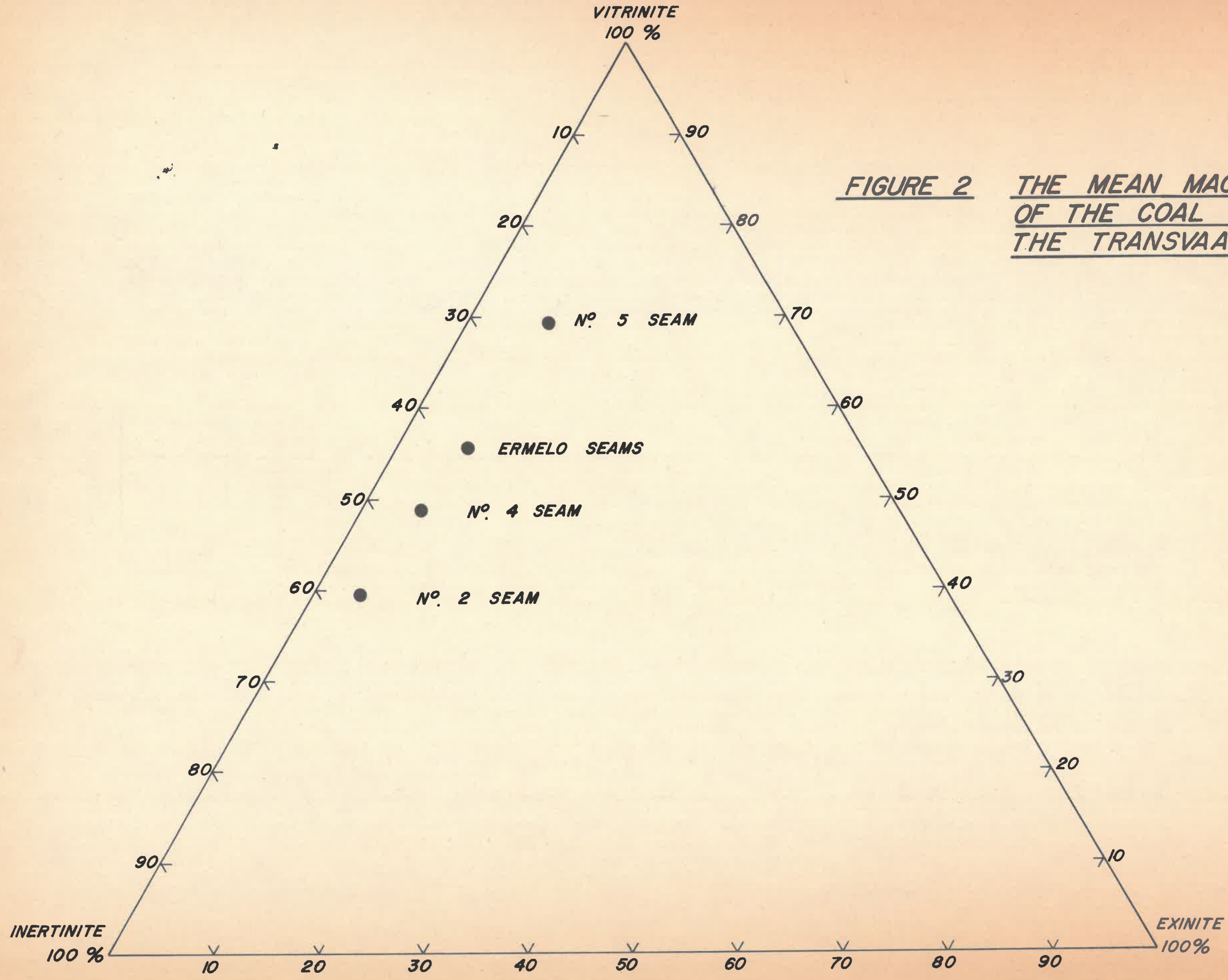


FIGURE 2 THE MEAN MACERAL COMPOSITION OF THE COAL SEAMS MINED IN THE TRANSVAAL

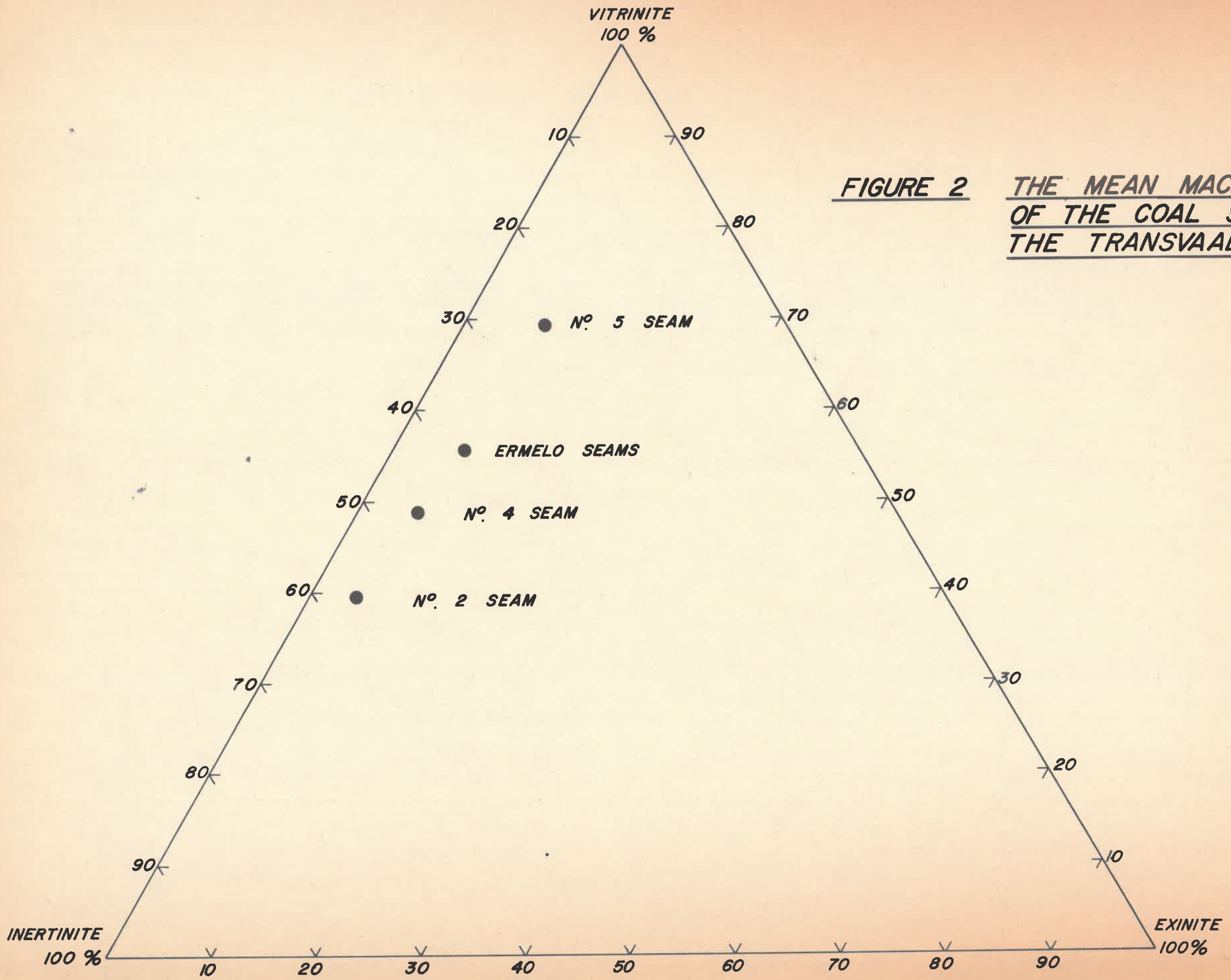


FIGURE 2 THE MEAN MACERAL COMPOSITION OF THE COAL SEAMS MINED IN THE TRANSVAAL

The mean maceral composition of the products prepared from the various coal seams in the Transvaal are graphically illustrated in Figure 2.

3.0 SECTION 3 - THE PRODUCTS PREPARED BY THE COLLIERIES IN THE ORANGE FREE STATE

3.1 GENERAL INFORMATION

Five major collieries produce about 20% of the Republic's total annual production from 7 shafts. Four of the collieries are situated just south of the Vaal River and one is situated in the Transvaal between Heidelberg and Villiers. This colliery mines the same seams as those in the OFS and is therefore grouped together with the Free State collieries.

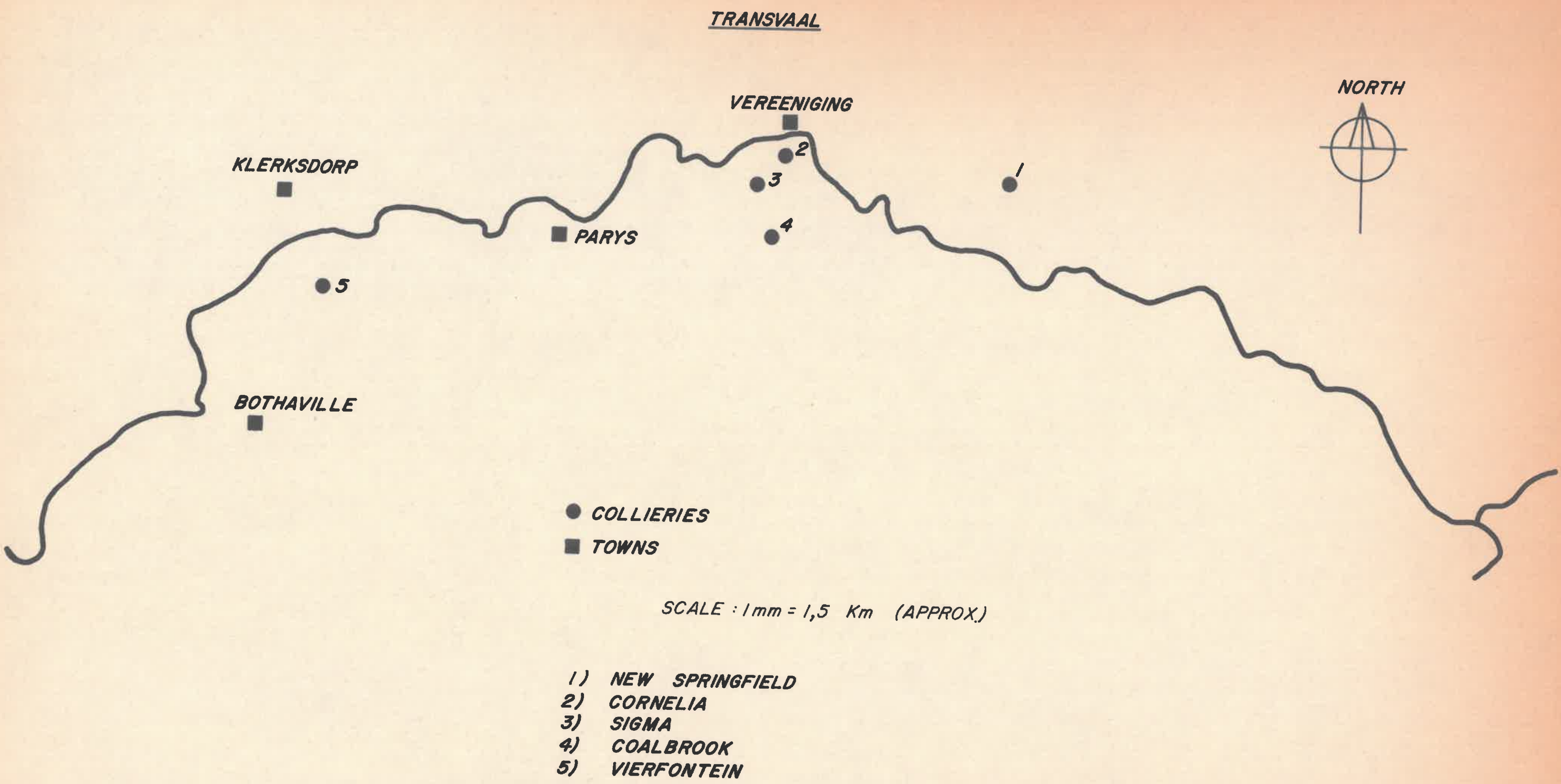
About 95% of the coal produced from the coalfield is utilized for the generation of electricity and for gasification. The average annual production per shaft in this coalfield amounts to over two million metric tons, and for this reason each shaft is treated in the report as a separate colliery. They are distinguished in the Tables as Bertha I and Bertha II for Cornelia colliery and Coalbrook No. 2 and No. 3 for Coalbrook colliery. About 25% of the coal produced by Cornelia colliery is sold on the general market.

There are three thick seams present in the coalfield but the Top and Bottom Seams (Nos. 3 and 1, respectively) tend to become thinner in places and cannot be economically exploited everywhere. The coal is of the lowest rank mined in the Republic and is of a low grade.

3.2 DISCUSSION OF RESULTS

Four of the seven collieries investigated are in possession of coal cleaning plants. They are Bertha I, Bertha II, New Springfield and Vierfontein.

Table 13 gives a comparison of the mean values obtained on the washed products from the above collieries and the unwashed products produced by Sigma and Coalbrook Nos. 2 and 3.



PLAN Nº 2 APPROXIMATE POSITIONS OF THE COLLIERIES IN THE O.F.S. COALFIELD

TABLE 13

COMPARISON OF THE MEAN PETROGRAPHIC COMPOSITION OF WASHED AND UNWASHED PRODUCTS

Type of coal	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Washed	27,8	3,9	54,1	14,2	0,5:1
V.m.m.f.+	32,4	4,5	63,1	-	0,6:1
Unwashed	24,5	2,6	57,5	15,4	0,4:1
V.m.m.f.+	29,0	3,1	67,9	-	0,5:1

+Visible mineral matter free.

By petrographic standards, the cleaning of the coal did not influence the values appreciably. The vitrinite content of the washed coal is slightly higher than that of the unwashed coal but the amounts of mineral matter in both coals remain virtually the same. Inspection of the mean values obtained for the products as recorded in Section 6.2, shows that, with the exception of the coal produced by Sigma, which gave a relatively high value, the mean values obtained on the products of the other collieries are very similar, the variation being less than 4%. This confirms the microscopical observation that the mineral matter is finely dispersed through the coal. The results on a visible mineral matter free basis are very similar and the ratio of reactives to inerts for the washed coals are only slightly higher than for the unwashed coals. The similarity in petrographic composition may also indicate that not all the coals are sent through the washing plants, particularly the mixed smalls.

3.3 THE SIMILARITY IN MACERAL COMPOSITION BETWEEN THE PRODUCTS PREPARED BY THE COLLIERIES IN THE ORANGE FREE STATE COALFIELD

The similarity in maceral composition between the products prepared by the collieries situated in the Orange Free State coalfield becomes even more apparent when the collieries are arranged in a descending order of the vitrinite contents on a visible mineral matter free basis. These results are recorded in Table 14.

26/......

TABLE 14

COLLIERIES ARRANGED IN A DESCENDING ORDER OF VITRINITE CONTENT ON A VISIBLE MINERAL MATTER FREE BASIS

Colliery	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Vierfontein	35,4	6,2	58,4	0,7:1
Bertha I	34,6	3,7	61,7	0,6:1
Bertha II	31,6	6,4	62,0	0,6:1
Sigma	31,0	3,1	65,9	0,5:1
Coalbrook No. 3	29,3	3,5	67,2	0,5:1
Coalbrook No. 2	28,6	2,9	68,5	0,5:1
New Springfield	27,6	2,1	70,3	0,4:1
Mean	31,1	4,1	64,8	0,5:1

The greatest variation in petrographic composition exists between the products prepared by Vierfontein, situated in the Western extremity, and New Springfield in the eastern extremity of the coalfield. The variation amounts to only 7,8% in vitrinite, which is relatively small but creates the impression that the coal seams decline in vitrinite content towards the east.

However,the collieries in the Vereeniging-Sasolburg area produce coal of very similar maceral composition. With the exception of Bertha I the products of which are only slightly inferior to those produced by Vierfontein, four collieries namely Bertha II, Coalbrook Nos. 2 and 3 and Sigma, produce coal varying only 3% in vitrinite content.

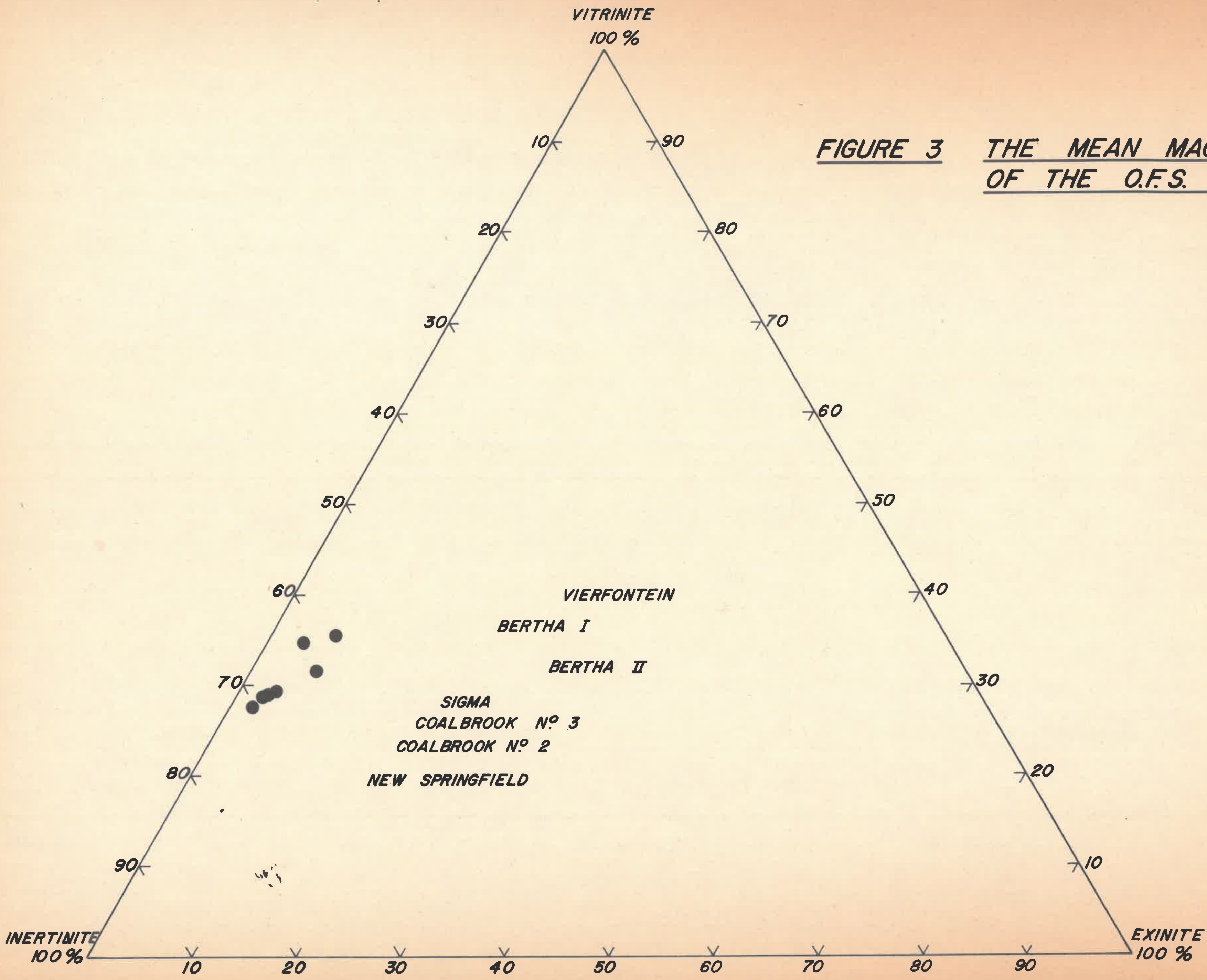
The mean maceral composition on a visible mineral matter free basis of the products prepared by the Orange Free State collieries is graphically represented in Figure 3.

4.0 SECTION 4 - NATAL COALS

4.1 GENERAL CONSIDERATIONS

One hundred-and-twenty-nine products prepared by 15 collieries were examined. No work was undertaken on the products prepared by the anthracite collie-

FIGURE 3 THE MEAN MACERAL COMPOSITION OF THE O.F.S. COAL



ries by virtue of the fact that the macerals cannot be distinguished in coals having such high reflectance levels as are commonly found in anthracites.

The collieries producing the coal can conveniently be divided into six areas. The coals belonging to each area have very similar maceral compositions.

The collieries and seams mined can be summarized as follows:

AREA	COLLIERY	SEAMS MINED
Northern Klip River	Ballengeich	Top, Bottom
	Kilbarchan	Top
	Ingagane	Top
	Star	Top
Central Klip River	Durban Navigation	Top, Bottom
	Natal Navigation	Bottom
	Indumeni	Bottom
Southern Klip River	Newcastle-Platberg	Top
Utrecht	Umgala	Alfred
	Utrecht	Main or Upper Gus
	Zimbutu	Alfred
Paulpietersburg	Dumbe	Coking
	Tendega	Coking
Vryheid	Hlobane	Alfred, Gus, Dundas, Coking
	Vryheid Coronation	Gus, Upper and Lower Dundas

In Natal the position is somewhat different from that in the Transvaal and Orange Free State, where only relatively small differences in petrographic composition were found in the products prepared by any single colliery, which make the calculation of the mean value of the coal produced by the colliery straightforward. With a number of products prepared by certain collieries in Natal, particularly those producing coal for the general market in addition to their main product, namely coking coal, considerable variations in maceral composition occur.

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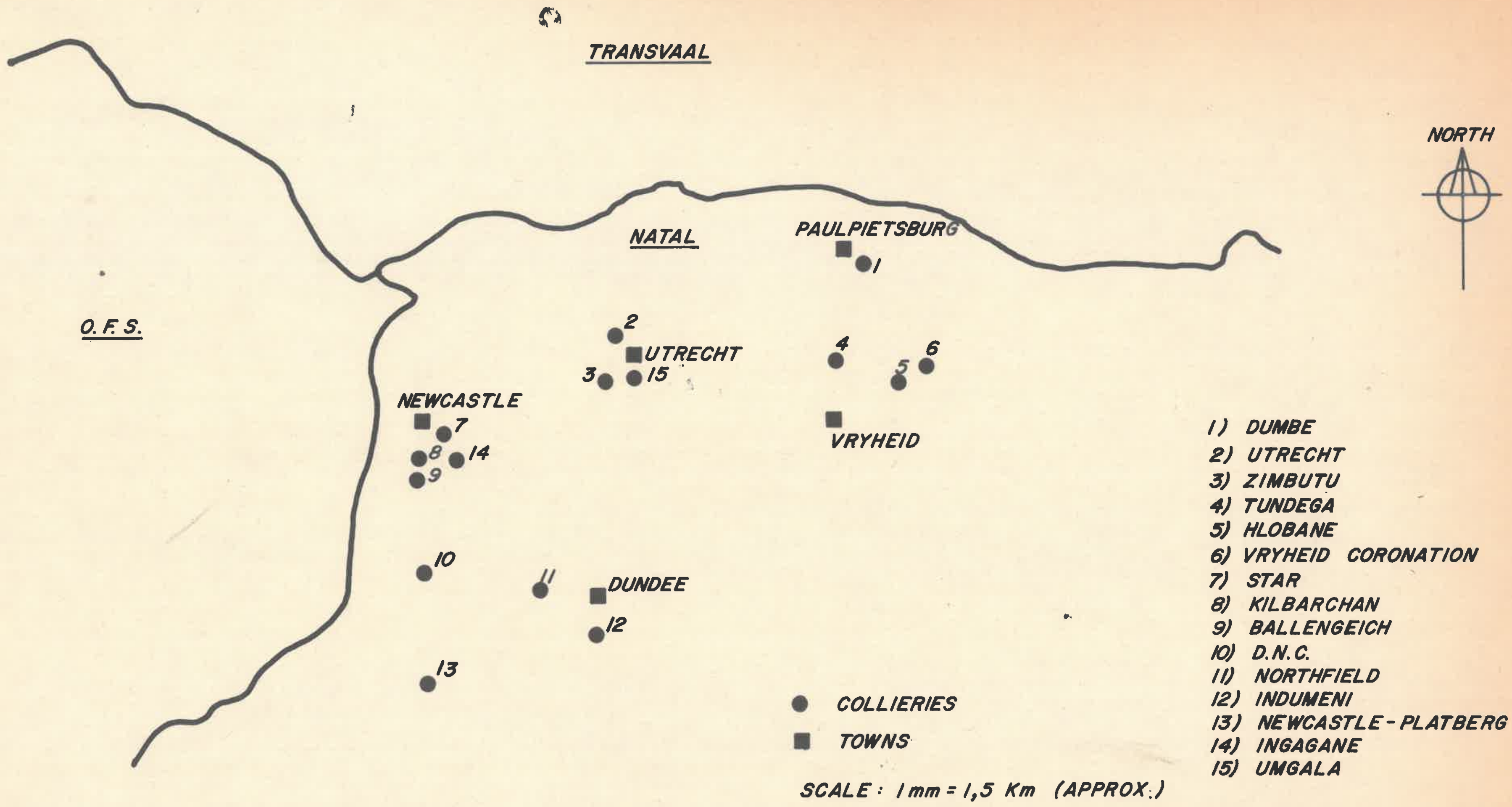


PLAN N° 3 APPROXIMATE POSITION OF THE COLLIERIES IN NATAL

Thus, in order to arrive at values representative of the whole output of the colliery, it was necessary to calculate them on a weighted basis. For this purpose the latest production figures available for the collieries concerned were used. The results must be regarded as estimated as all the samples were not necessarily taken during that particular year. It can be noted in the Tables where this applies, the averages are given as "weighted mean" values.

4.2 THE COALS OF THE NORTHERN KLIP RIVER AREA

There are four producing collieries in this area. Three of them, Ballengeich, Kilbarchan and Ingagane are situated fairly near to each other in an area some 24 km south of Newcastle. Star colliery is situated very near to the town and produces coal in limited quantities from the old Newcastle colliery workings.

The mean petrographic values obtained on the prepared products are recorded in Table 15.

TABLE 15

MEAN PETROGRAPHIC COMPOSITION OF THE PRODUCTS PREPARED IN THE NORTHERN KLIP RIVER AREA

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Ballengeich	Top Bottom	44,9	3,4	46,3	5,4	0,9:1
Kilbarchan	Top	43,5	2,1	44,5	9,9	0,9:1
Ingagane	Top	48,1	2,9	43,4	5,6	1,0:1
Star+	Top	53,1	4,1	34,2	8,6	1,3:1
Mean		45,5	2,8	44,7	7,0	0,9:1
Mean V.m.m.f.		48,9	3,0	48,1	-	1,1:1

+Star colliery was not included in the calculation of mean values. See text.

The coal produced by Star colliery is superior in maceral composition to that mined by the other three collieries. However, it is a very small concern and was responsible for only 0,1% of the total output in this area. The colliery has since closed down and the results were, for obvious reasons, not included in the calculation of the mean values.

4.3 THE COALS OF THE CENTRAL KLIP RIVER AREA

There are three collieries in this area and they lie roughly in a line. Durban Navigation is situated near Dannhauser, Natal Navigation near Glencoe, and Indumeni is a few kilometres south of Dundee. Durban Navigation and Indumeni produce coking coal exclusively, while Natal Navigation produced, in addition to coking coal, a number of other products ranging from rounds to peas. Lately the position has changed and they are at present producing coking coal and smalls.

The mean values obtained on the products prepared by these collieries, are recorded in Table 16.

TABLE 16

MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED IN THE CENTRAL KLIP RIVER AREA

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Durban Navigation	Top Bottom	55,3	3,1	37,4	4,2	1,4:1
Indumeni	Bottom	72,1	0,9	22,6	4,4	2,7:1
Natal Navigation	Top Bottom	59,9	1,2	33,4	5,5	1,6:1
Mean		62,5	1,7	31,1	4,7	1,8:1
Mean V.m.m.f.		65,6	1,8	32,6	-	2,1:1

Durban Navigation and Natal Navigation (Northfield) produce coal of a fairly similar maceral composition, although that from the latter colliery has a slightly higher ratio of reactive to inert constituents. The coal produced by Indumeni is superior in composition to that produced by the other two collieries and contains at present the highest ratio of reactive to inert material of all the coals produced in Natal.

4.4 THE COALS OF THE SOUTHERN KLIP RIVER AREA

This area is at present represented by only one producing colliery namely Newcastle-Platberg. Two other collieries in the area, Elandslaagte and Natal Steam, ceased operating many years ago.

The mean petrographic values obtained on the products prepared by Newcastle-Platberg are recorded in Table 17.

TABLE 17

MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED IN THE SOUTHERN KLIP RIVER AREA

Colliery	Seam mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Newcastle-Platberg	Top	35,5	1,0	56,3	7,2	0,6:1
Mean V.m.m.f.		38,1	1,1	60,6	-	0,7:1

The mean values obtained on the products prepared by this colliery, indicate that the maceral composition of the coal in the southern extremity of the coalfield is somewhat inferior to that produced in the northern extremity. The ratios of reactive to inert constituents on a visible mineral matter free basis are 1,1 and 0,7 for the northern and southern areas, respectively.

4.5 THE COALS OF THE UTRECHT AREA

The coalfield is situated some 40 km east of Newcastle, and the coal seams can be identified with those of the Paulpietersburg and Vryheid areas. There are three operating collieries namely Umgala, Zimbutu and Utrecht. The first two collieries adjoin, while the latter is situated some 7 km towards the north.

The mean petrographic values obtained on the products are recorded in Table 18.

TABLE 18

MEAN MACERAL COMPOSITION OF THE COALS PRODUCED IN THE UTRECHT AREA

Colliery	Seams Mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Umgala	Alfred	33,7	4,1	57,7	4,5	0,6:1
Utrecht	Main	51,4	1,0	42,3	5,3	1,1:1
Zimbutu	Alfred	39,7	4,4	50,9	5,0	0,8:1
Mean+		36,7	4,1	54,4	4,8	0,7:1
Mean V.m.m.f.		38,6	4,3	57,1	-	0,8:1

+Excluding Utrecht. See text.

The mean values recorded for the products prepared by Utrecht colliery leave the impression that the coal is substantially superior, from a petrographical point of view, to that mined by Umgala and Zimbutu. Furthermore, the Main or Upper Gus Seam is known to be of better quality than the Alfred Seam. When the survey was carried out, Utrecht colliery was producing lean coal with a volatile matter content in the order of 12% but is at present producing anthracite. In lean coals, as in anthracites, the increased rank imparts a higher reflectance to the petrographic components which makes it difficult to distinguish between vitrinite and semi-fusinite under the microscope and the two macerals can therefore be confused. Since there appears to be some reason to doubt the accuracy of the Utrecht analysis and taking into account that the colliery's production at the time of writing is roughly only 7½ per cent of the total production from the area, it was decided to exclude the analysis from the calculation of the mean values in Table 18.

4.6 THE COALS OF THE VRYHEID AREA

There are two major collieries producing coal from this area, which is situated some 30 km east of Vryheid. Vryheid Coronation colliery produces coking coal exclusively, while some 80% of the coal produced by Hlobane is for coking purposes and the rest is sold on the general market.

The mean petrographic values of the products prepared by the collieries are recorded in Table 19.

TABLE 19

MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE COLLIERIES IN THE VRYHEID AREA

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Hlobane	Alfred Gus Dundas Coking	59,1	2,3	35,7	2,9	1,6:1
Vryheid Coronation	Gus, Upper Lower Dundas	57,5	3,1	35,1	4,3	1,5:1
Mean		58,3	2,7	35,4	-	1,6:1
Mean V.m.m.f.		60,5	2,8	36,7	-	1,7:1

The two collieries adjoin and the petrographic composition of the products is very similar notwithstanding the fact that the coal is produced from a diversity of seams.

4.7 THE COALS OF THE PAULPIETERSBURG AREA

This area is situated some 60 to 70 km east of Utrecht. There are two collieries producing coal from the Coking Seam namely Tendega and Dumbe.

The mean petrographic values of the products prepared from the Coking Seam are recorded in Table 20.

TABLE 20

MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED IN THE PAULPIETERSBURG AREA

Colliery	Seams mined	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Dumbe	Coking	59,0	6,6	30,1	4,3	1,9:1
Tendega	Coking	59,7	4,8	31,7	3,8	1,8:1
Mean		59,3	5,7	30,9	4,1	1,9:1
Mean V.m.m.f.		61.9	5,9	32,2	-	2,1:1

The petrographic composition of the Coking Seam, where mined by the two collieries, is similar. With the exception of Indumeni, the coking coals produced by Dumbe and Tendega have the highest ratio of reactives to inerts.

4.8 COMPARISON OF THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED IN THE DIFFERENT AREAS

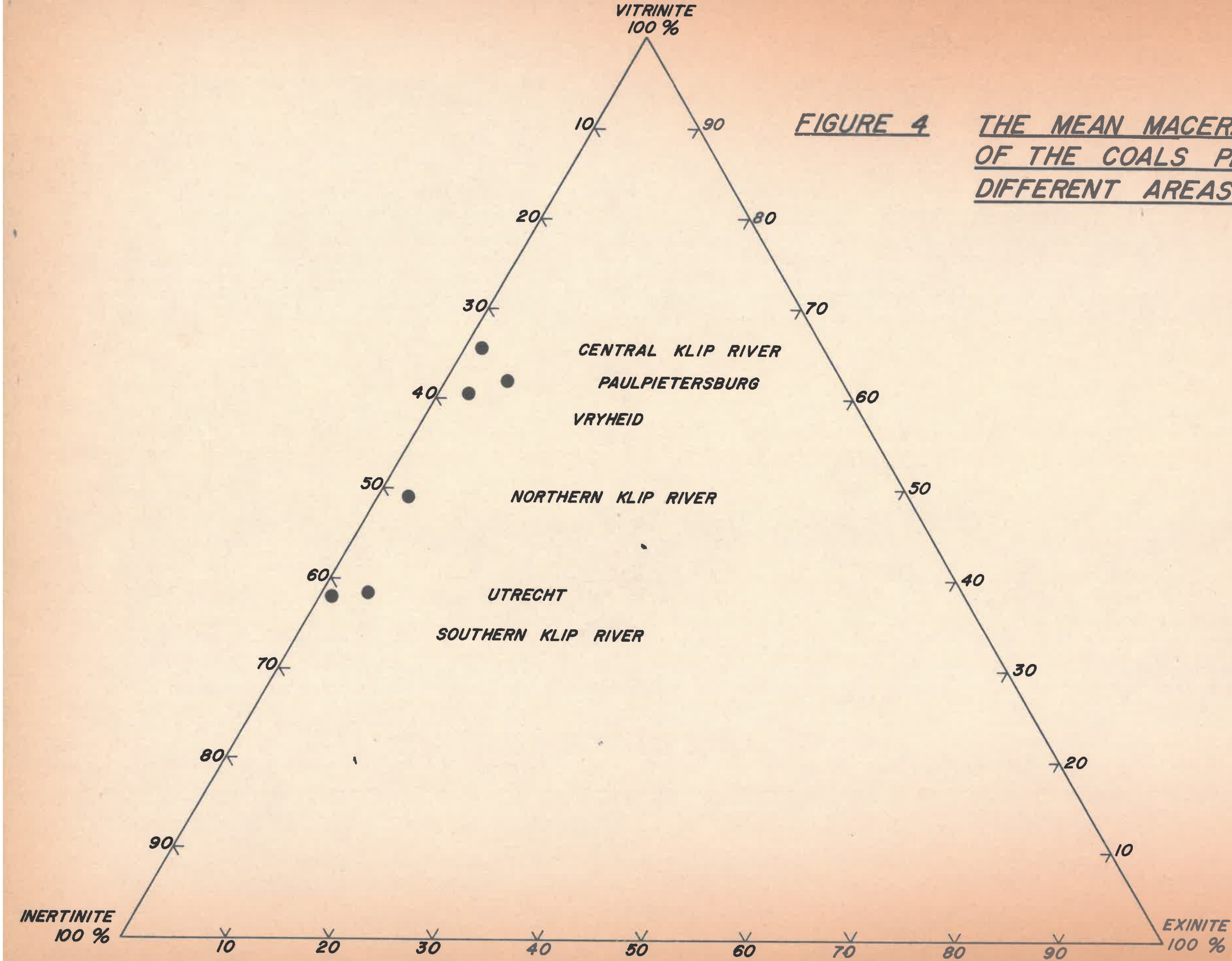
The mean maceral composition of the products prepared by the collieries in the different areas and calculated on a visible mineral matter free basis is arranged in a descending order of the vitrinite content in Table 21.

TABLE 21

THE MEAN MACERAL COMPOSITION OF THE PRODUCTS REPARED IN THE DIFFERENT AREAS ARRANGED IN A DESCENDING ORDER OF VITRINITE CONTENT

Area	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Central Klip River	65,6	1,8	32,6	2,1:1
Paulpietersburg	61,9	5,9	32,2	2,1:1
Vryheid	60,5	2,8	36,7	1,7:1
Northern Klip River	48,9	3,0	48,1	1,1:1
Utrecht	38,6	4,3	57,1	0,8:1
Southern Klip River	38,1	1,1	60,6	0,7:1

FIGURE 4 THE MEAN MACERAL COMPOSITION OF THE COALS PREPARED IN THE DIFFERENT AREAS OF NATAL.



The areas occupying the three top positions in the Table produce coking coal and the other three bituminous coal. Kilbarchan colliery, situated in the Northern Klip River area is now also producing coking coal by washing at 1,40 relative density. The petrography of this coking coal fraction will be dealt with in a separate report. The high vitrinite contents and the resultant high ratios of reactive to inert components of the coking coals in contrast to the other bituminous coals are very apparent.

The maceral composition of the coals from the various areas are graphically represented in Figure 4.

4.9 THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY EACH COLLIERY IN NATAL ON A VISIBLE MINERAL MATTER FREE BASIS

A synopsis of the mean maceral composition of the products prepared by each colliery in Natal appears in a descending order of the vitrinite content.

TABLE 22

THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY EACH COLLIERY IN NATAL ON A VISIBLE MINERAL MATTER FREE BASIS ARRANGED IN A DESCENDING ORDER OF THE VITRINITE CONTENTS

Colliery	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Indumeni	75,4	1,0	23,6	3,2:1
Natal Navigation	63,4	1,3	35,3	1,8:1
Tendega	62,0	5,0	33,3	2,0:1
Dumbe	61,7	6,9	31,4	2,2:1
Hlobane	60,9	2,4	36,7	1,7:1
Vryheid Coronation	60,1	3,2	36,7	1,7:1
Durban Navigation	57,8	3,2	39,0	1,6:1
Ingagane	50,9	3,2	45,9	1,2:1
Kilbarchan	48,3	2,3	49,4	1,0:1
Ballengeich	47,5	3,6	48,9	1,0:1
Zimbutu	41,7	4,6	53,7	0,9:1
Newcastle-Platberg	38,3	1,1	60,2	0,7:1
Umgala	35,2	4,3	60,5	0,7:1
Mean (Weighted)	52,7	2,9	44,4	1,3:1

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The collieries producing coking coal occupy the seven top positions in the Table. It can also be noted that only three collieries produce coals having ratios of reactive to inert components lower than 1:1.

5.0 SECTION 5 - GENERAL SURVEY OF RESULTS AND DISCUSSION

5.1 VARIATION IN COMPOSITION OF THE PRODUCTS

5.1.1 Transvaal products

The variation in maceral composition of the products prepared by each colliery, of at least 80% of the collieries, was less than 8% for the vitrinites and inertinites. For the exinites and visible mineral matter the variation was 4% and even less. The calculated mean variation for all the products investigated was 5,8% for the vitrinites, 2,4% for the exinites, 6,1% for the inertinites and 3,2% for the visible mineral matter. The only notable exception is Van Dyks Drift colliery, where the variation in vitrinite content amounted to 17,5% and in the inertinite content, to 16,0%.

It does not appear as if the vitrinites follow any consistent pattern from the larger to the smaller coal sizes. The number of cases where the larger sized products contain more vitrinite than the smaller sizes, and vice versa, are more or less equal. However, for the Witbank No. 4 and No. 2 Seams, the reactive components tend to be slightly higher in the large coal on the visible mineral matter free basis. This is also valid for the nuts and peas. In two instances where the No. 5 Seam coal was not washed, the vitrinite was concentrated in the duff coal. Higher vitrinite concentration in the coking coal as compared with the larger gas coal from the two Springbok mines confirms this tendency.

The maceral composition of the products prepared by the collieries in the Transvaal, calculated on a visible mineral matter free basis, is graphically represented in Figure 5.

It can be noted that the majority of the products contain less vitrinite than inertinite and that the exinite content is, with one exception, less than 10%.

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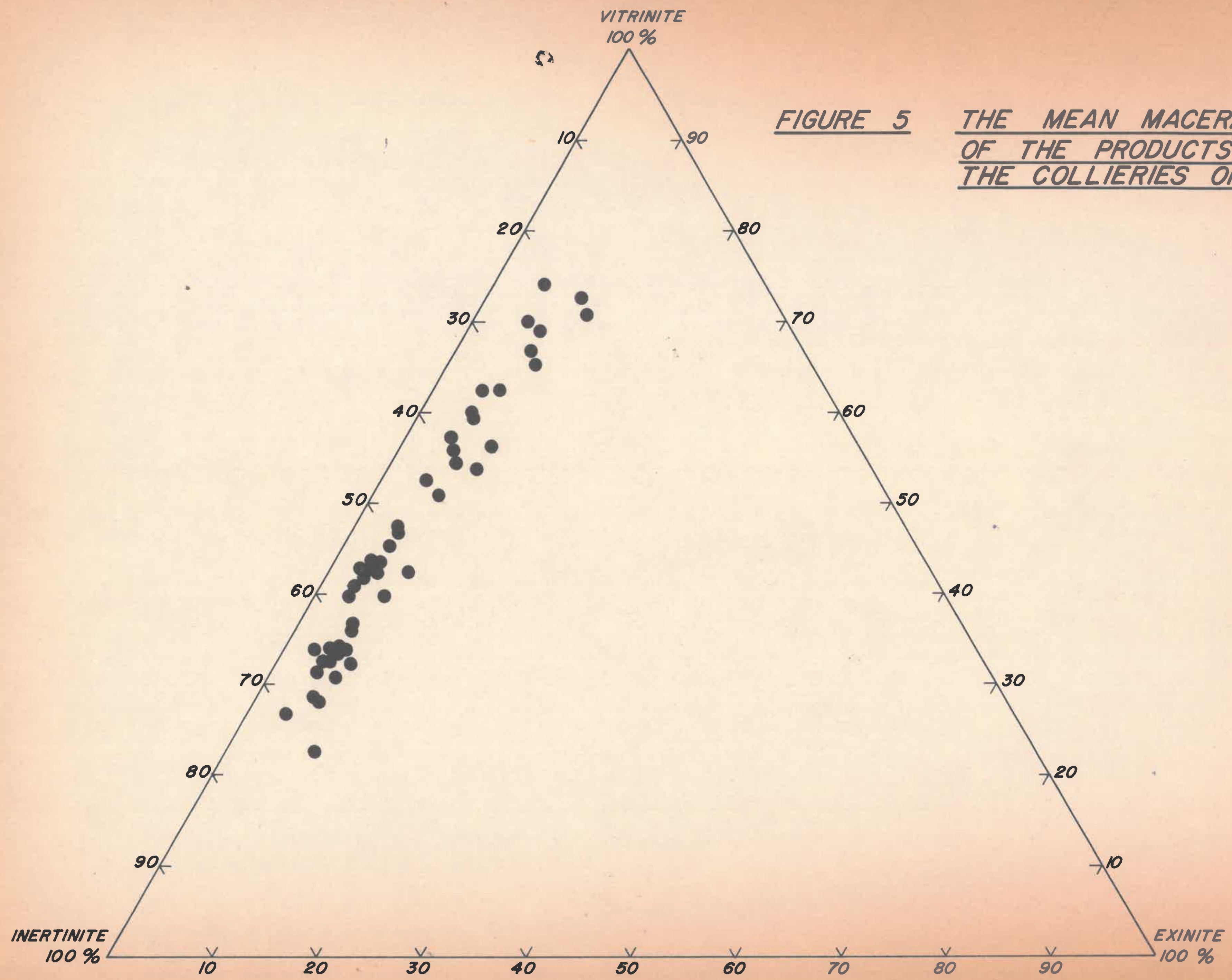


FIGURE 5 THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE COLLIERIES OF THE TRANSVAAL.

The most striking feature is the great variation occurring in the vitrinite which amounts to roughly 50% between the products with the highest and lowest values.

5.1.2 Orange Free State products

Of the collieries mining in the Orange Free State coalfield, only two, namely Cornelia-Bertha I and -Bertha II prepare more than one product. In addition to mixed small coal which represents about 75% of their output, Bertha I prepares cobble "A", nuts and peas. Bertha II prepares large nuts and peas.

The vitrinite contents of the products vary very little in the case of Bertha I, the greatest variation was recorded between cobble "A" and peas which amounted to only 3,4%. For Bertha II the greatest variation was between the mixed smalls and peas which amounted to 5,6%. In both instances, the pea coal tends to give lower vitrinite values than the rest of the products.

5.1.3 Natal products

The coking coals contain considerably more vitrinite than the non-coking bituminous coals and they are all characterised by their relatively low exinite content. In fact the exinite content is even lower than that recorded for the Orange Free State coals which gave an average of 4,1%. Of the products prepared in the Transvaal, 50% contained 5% or more (with a maximum of 9%) exinite in comparison with only 15% of the Natal products. This is largely due to the high exinite content of the No. 5 Seam blend coking coals and the Ermelo coals.

The variation in vitrinite and inertinite contents between the different products prepared by the same colliery proved to be considerable in most cases. On the other hand, the variation in exinite content is very small. The calculated mean variation for the products investigated was 13,8% for the vitrinites, 1,8% for the exinites, 13,7% for the inertinites and 4,6% for the visible minerals. The differences recorded for the products prepared by Hlobane colliery were rather high and amounted to 26,8% and 28,3% for the vitrinites and inertinites respectively. (The values obtained on the middlings were not taken into account as the product constituted less than 1% of the colliery's total output).

37/.......

Variations of less than 10% in the vitrinites and inertinites in the different products prepared by the same colliery, were recorded for only three collieries.

Of the nine collieries preparing more than one product, the vitrinites follow a consistent pattern from the larger to the smaller coal sizes in the case of four collieries, viz. Hlobane, Ingagane, Utrecht and Natal Navigation, where they increase steadily with a decrease in size. In the products prepared by Zimbutu, the vitrinites remain fairly constant the difference between the highest and lowest values being only 5,4%. No consistent pattern could be observed in the products prepared by Umgala, Star, and Newcastle-Platberg. However, with the exception of the latter two collieries, the vitrinite is more highly concentrated in the fines (i.e. mixed smalls and duff) prepared by all the other collieries.

5.2 THE PETROGRAPHIC COMPOSITION OF THE SEAMS MINED BY THE VARIOUS COLLIERIES IN THE THREE PROVINCES

Table 23 contains a summary of the mean maceral composition of the seams mined in the different coalfields of the Republic. The seams are arranged in a descending order of the vitrinite content, but where coals from two areas contain equal amounts of vitrinite as in the case of the Witbank No. 4 Seam and the Top and Bottom Seams of the Northern Klip River area, the total amounts of reactive constituents were taken into consideration.

38/......

TABLE 23

THE MEAN MACERAL COMPOSITION OF THE SEAMS MINED BY THE VARIOUS COLLIERIES ON A VISIBLE MINERAL MATTER FREE BASIS

Seams and/or Areas	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Witbank No. 5	69,7	7,6	22,7	3,4:1
Central Klip River	65,6	1,8	32,6	2,1:1
Paulpietersburg	61,9	5,9	32,2	2,1:1
Vryheid	60,5	2,8	36,7	1,7:1
Ermelo	55,8	6,8	37,4	1,7:1
Witbank No. 4	48,9	5,7	45,4	1,2:1
Northern Klip River	48,9	3,0	48,1	1,1:1
Witbank No. 2 Seam	39,5	4,5	56,0	0,8:1
Utrecht	38,6	4,3	57,1	0,8:1
Southern Klip River	38,1	1,1	60,6	0,7:1
Orange Free State	31,1	4,1	64,8	0,5:1

The Witbank No. 5 Seam occupies the top position in the Table and taking its high exinite content into consideration it is appreciably more reactive than any of the other coals at present being mined. The coals from the Central Klip River, Paulpietersburg and Vryheid which have strong coking properties occupy prominent positions in the Table. A high ratio of reactive to inert components is not neccessarily the only prerequisite for a good coking coal as the rank also plays a very important part. High rank coking coals can still have fair coking properties at ratios as low as 1:1, but in medium rank coking coals and blend coking coals the coking potential improves with an increasing ratio of reactive to inert components. The maceral composition of the seams, on a visible mineral matter free basis, is illustrated in Figure 6.

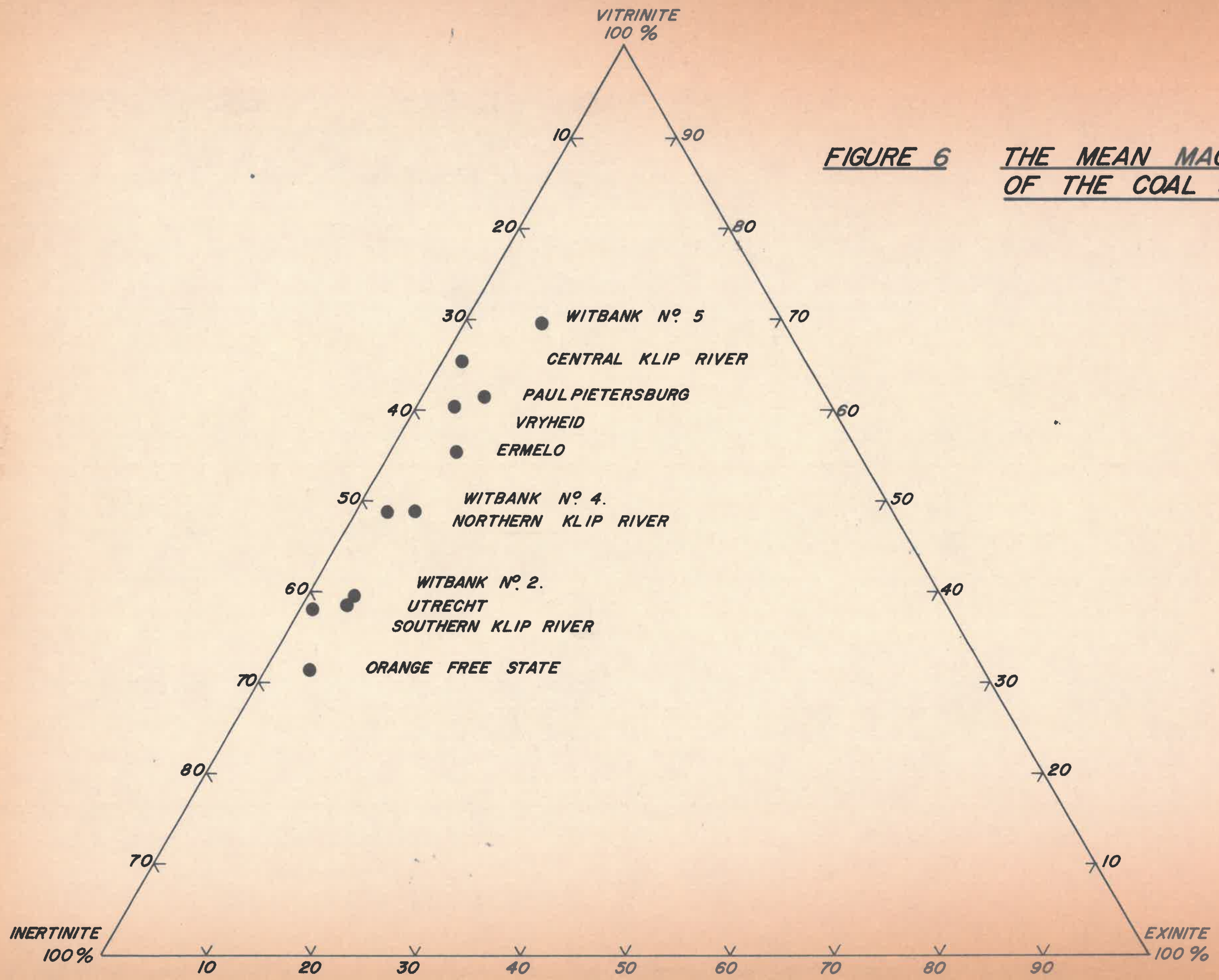
5.3 COMPARISON OF THE MACERAL COMPOSITION OF COALS SUPPLIED TO POWER STATIONS FOR THE GENERATION OF ELECTRICITY

Thirteen major collieries, six of which are situated in the Transvaal, six in the Orange Free State+ and one in Natal, supply coal to power stations

+New Springfield colliery near the OFS border on the Transvaal side is considered as a Free State colliery on account of the type of coal that is produced.

39/......

FIGURE 6 THE MEAN MACERAL COMPOSITION OF THE COAL SEAMS MINED IN S.A.



for the generation of electricity. These collieries are responsible for over 60% of the country's annual coal production. The collieries situated in the Middelburg-Witbank area do not apply mechanical cleaning procedures except that at Blinkpan a McNally drum is used.

Four of the collieries in the Orange Free State coalfield are in possession of coal cleaning plants. These are Bertha I, Bertha II, Vierfontein and Springfield. The latter two collieries wash their coal only intermittently.

The coals used for the generation of electricity are characterized by their relatively low vitrinite and very high visible mineral matter content. Only four of the thirteen collieries produce coal having a visible mineral matter content of less than 10%. These are Usutu near Ermelo, Blinkpan in the Middelburg-Witbank area, Bertha II in the Orange Free State and Kilbarchan in Natal. Usutu gave a value of 5,6% while the others gave values ranging from just under 8% to just under 10%. Considering the visible mineral matter content of the coals produced by the collieries in the OFS coalfield, the value obtained for the Bertha II is rather surprising since the other values vary from about 12 to nearly 18%.

The maceral composition of the coals supplied to power stations, are recorded in Table 24 on a visible mineral matter free basis. The collieries are arranged in a descending order of vitrinite content.

TABLE 24

THE MEAN MACERAL COMPOSITION OF COALS SUPPLIED TO POWER STATIONS

Colliery	Vitrinite %	Exinite %	Inertinite %	Ratio Reactives / Inerts
Usutu	53,5	8,7	37,8	1,7:1
Kilbarchan	48,3	2,3	49,4	1:1
Blinkpan	43,8	3,3	52,9	0,9:1
Optimum	42,6	7,6	49,8	0,9:1
Vierfontein	35,3	6,2	58,4	0,7:1
Bertha I	34,6	3,7	61,7	0,6:1
New Largo	32,6	4,5	62,9	0,6:1
Bertha II	31,6	6,4	62,0	0,6:1
Anglo Power Kriel	31,2	4,5	64,3	0,5:1
Coalbrook No. 3	29,3	3,5	67,2	0,5:1
Coalbrook No. 2	28,6	2,9	68,5	0,5:1
New Springfield	27,6	2,1	70,3	0,4:1
Arnot	26,7	3,9	69,4	0,4:1

It can be noted that Usutu (and to some extent Kilbarchan) produce coal superior in maceral composition to any of the other coals used for the generation of electricity.

The mean maceral composition of the power station coals, including those used for gasification are graphically illustrated in Figure 7.

5.4 COALS USED BY SASOL FOR GASIFICATION

Products from two collieries are being used for gasification purposes viz. Sigma in the Orange Free State and Bosjesspruit in the Transvaal coalfield. At present Bosjesspruit is producing from the No. 4 Seam only.

The following Table gives a comparison of the maceral composition of the products prepared by the collieries.

TABLE 25

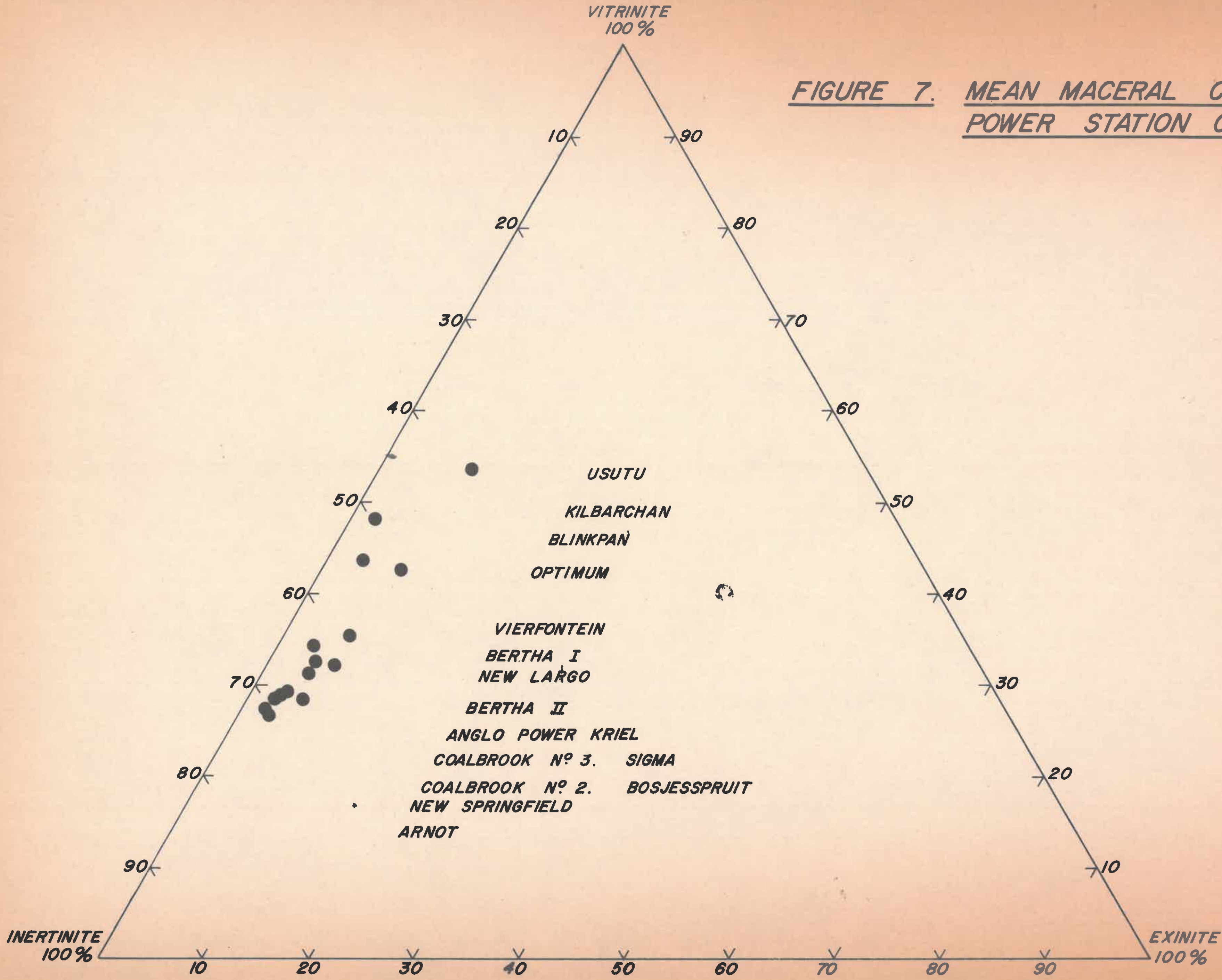
THE MACERAL COMPOSITION OF THE COALS USED FOR GASIFICATION

Colliery	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts
Sigma	23,5	2,4	55,0	19,1	0,4:1
(V.m.m.f.)	29,0	3,0	68,0	-	0,5:1
Bosjesspruit	26,2	4,9	60,4	8,5	0,5:1
(V.m.m.f.)	28,6	5,4	66,0	-	0,5:1

The vitrinite contents of the products mined by the two collieires are very similar but the main difference lies in the visible mineral matter content where Sigma coal contains 10½% more visible minerals. On a visible mineral matter free basis the coals are practically identical, the only difference being in the exinite and inertinite contents making the Bosjesspruit product very slightly more reactive than that from Sigma.

The maceral composition of the products from both collieries are very similar to that of the coals used for power station fuel. For this reason they have been included in Figure 7.

FIGURE 7. MEAN MACERAL COMPOSITION OF POWER STATION COALS.



5.5 SUMMARY AND CONCLUSIONS

One hundred-and-eighty-eight products prepared by 34 collieries in the Transvaal, 6 in the Orange Free State and 15 in Natal were investigated. Only 25% of the products contained over 50% vitrinite and 62% of them contained vitrinite varying between 30% and 50%.

Examination of the ratios of reactive to inert constituents i.e. the bright and dull components of the coal show that 39% of the samples had ratios of 1:1 and over. Fifty two per cent of the samples had ratios varying between 0,9 and 0,6. The highest ratio recorded was 4,0:1 for the No. 5 Seam duff coal produced by Kriel colliery and the lowest ratio recorded was 0,3:1 for New Springfield mixed smalls and Hlobane middlings.

This leaves the impression that South African coals are by nature predominantly dull in appearance. The impression is mainly created by the fact that the majority of collieries discussed in the report are mining the dull coal seams and they are doing so by virtue of their great economic importance. About 60% of the products analysed were derived from the dull coal seams.

Considering the seams that are being mined in the different coal districts, the Witbank No. 5 contains the brightest coal followed in a descending order of brightness according to the ratios of bright to dull components by the coking coals from the Central Klip River Area, Paulpietersburg and Vryheid. They have ratios varying between 3,4 - 1,7:1. Of the non-coking coals, those from the Ermelo field also have a ratio of 1,7:1.

The Northern Klip River and Witbank No. 4 Seam coals are very similar in maceral composition with nearly equal amounts of bright to inert constituents but with the bright components slightly dominating. The Witbank No. 2 Seam, the Utrecht and Southern Klip River seams are very similar and rather on the dull side having ratios of 0,8 - 0,7:1. The Orange Free State coal seams consist of really dull coal with a ratio of 0,5:1.

It follows that the coal seams in South Africa are not as inert as they are sometimes made out to be but it is quite correct to state that the bulk of the coal produced in the country consists of the dull variety. However, by European standards the coals are, with the exception of the bright coal seams of Waterberg and Soutpansberg (which have to date not been mined), considered to be rather on the dull side.

42/......

The exinites showed very little variation in the products. In fact, 82% of the products contained 6% and less exinite. The highest value recorded was 12% for the No. 5 Seam round coal produced by New Wakefield colliery and the lowest value recorded was 0,8% for Newcastle-Platberg peas but values of less than 1% are not uncommon for Natal coals. In general the Natal coals contain considerably less exinite than the Transvaal and Orange Free State coals. The No. 5 Seam coals are the richest in exinite followed by the Ermelo coals. The exinite content of the OFS coals is very similar to that of the No. 2 Seam.

The mean maceral composition of the products prepared by the collieries in the Republic of South Africa is graphically illustrated in Figure 8 on a visible mineral matter free basis.

The diversity in petrographic composition is conspicuous and it is doubtful whether any other country produces coals showing such great variations in vitrinite and inertinite contents in the products prepared therefrom.

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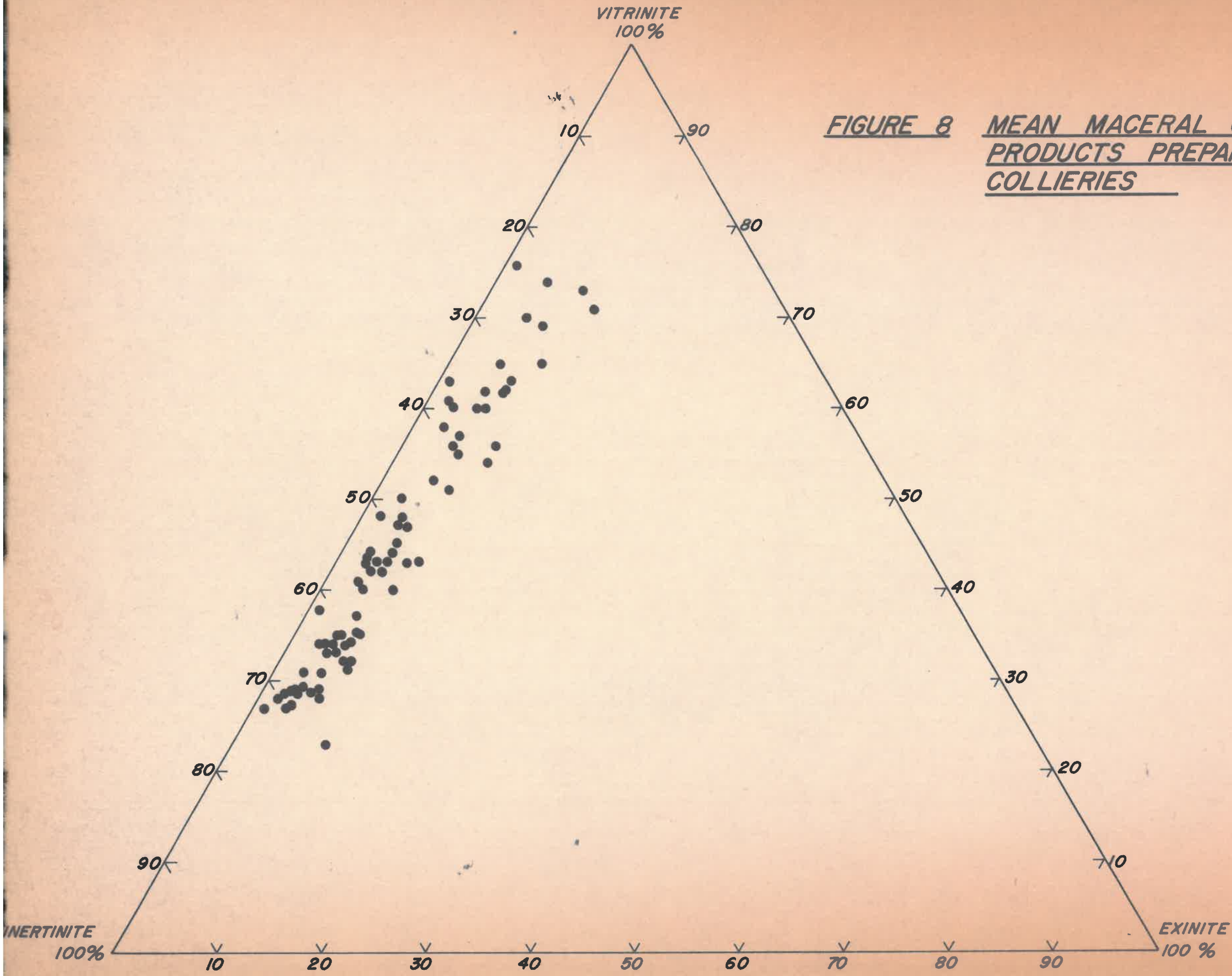

FIGURE 8 MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE COLLIERIES

6.0 SECTION 6 - THE MEAN MACERAL COMPOSITION OF THE COAL PRODUCTS

6.1 TABLE OF TRANSVAAL PRODUCTS

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
ALBION						
Cobbles	31,7	5,9	58,0	4,4	0,6:1	2
Nuts	32,1	4,6	58,7	4,6	0,6:1	3
Peas	30,8	4,6	59,4	5,2	0,6:1	2
Duff	34,4	4,8	53,5	7,3	0,6:1	3
Mean	32,3	5,0	57,3	5,4	0,6:1	
V.m.m.f.	34,1	5,3	60,6	-	0,7:1	
ANGLO POWER KRIEL						
Crushed coal	28,4	4,1	58,5	9,0	0,5:1	2
V.m.m.f.	31,2	4,5	64,3	-	0,6:1	
ARNOT						
Crushed coal	23,3	3,4	60,1	13,2	0,4:1	3
V.m.m.f.	26,8	3,9	69,3	-	0,4:1	
BANK						
Cobbles	33,5	4,9	57,2	4,4	0,6:1	2
Nuts	36,4	4,6	56,2	2,8	0,7:1	2
Peas	36,6	5,0	54,8	3,6	0,7:1	2
Mixed Smalls	36,6	6,8	53,2	3,4	0,8:1	2
Duff	34,5	3,4	57,2	4,9	0,6:1	2
Low-ash	42,6	4,9	51,6	0,9	0,9:1	2
Middlings	29,5	6,4	60,3	3,8	0,6:1	2
Mean	35,7	5,1	55,8	3,4	0,7:1	
V.m.m.f.	37,0	5,3	57,7	-	0,7:1	

6.1 TABLE OF TRANSVAAL PRODUCTS (Continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
BELFAST						
Cobbles	24,3	1,6	64,4	9,7	0,3:1	2
Nuts	33,3	2,6	50,9	13,2	0,6:1	2
Peas	30,5	4,3	58,6	6,6	0,5:1	2
Duff	32,2	2,8	50,8	13,2	0,6:1	2
Mean	30,3	2,8	56,2	10,7	0,5:1	
V.m.m.f.	33,9	3,1	63,0	-	0,6:1	
BLESBOK						
Blend coking coal	63,5	8,3	25,8	2,4	2,5:1	3
V.m.m.f.	65,1	8,5	26,4	-	2,8:1	
BLINKPAN						
Crushed coal	40,5	3,0	48,8	7,7	0,8:1	2
V.m.m.f.	43,9	3,3	52,8	-	0,9:1	
BOSJESSPRUIT						
Crushed coal	26.2	4,9	60,4	8,5	0,5:1	2
V.m.m.f.	28,6	5,4	66,0	-	0,5:1	
DELMAS						
Rounds	46,1	2,4	44,9	6,6	0,9:1	2
Cobbles	40,5	4,4	51,1	4,0	0,8:1	2
Large Nuts	41,4	4,6	49,1	4,9	0,9:1	2
Small Nuts	41,2	5,6	48,2	5,0	0,9:1	2
Peas	40,6	4,4	48,8	6,2	0,8:1	2
Mixed Smalls	36,6	5,5	49,0	8,9	0,7:1	2
Mean	41,1	4,5	48,5	5,9	0,8:1	
V.m.m.f.	43,7	4,8	51,5	-	0,9:1	

6.1 TABLE OF TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
DOUGLAS						
Cobbles	42,3	3,6	50,6	3,5	0,9:1	4
Nuts	39,2	2,4	51,5	6,9	0,7:1	2
Peas	36,7	3,1	54,3	5,9	0,7:1	2
Duff	37,5	3,3	55,4	3,8	0,7:1	2
Mean	38,9	3,1	53,0	5,0	0,7:1	
V.m.m.f.	40,9	3,2	55,9	-	0,8:1	
EIKEBOOM						
Rounds	31,8	6,5	53,9	7,8	0,6:1	2
Cobbles	29,6	5,8	57,9	6,7	0,5:1	2
Large Nuts	35,7	6,2	54,5	3,6	0,7:1	3
Small Nuts	34,9	4,8	56,9	3,4	0,7:1	2
Peas	29,9	5,1	61,3	3,7	0,6:1	2
Duff	29,6	5,8	56,5	8,1	0,6:1	2
Mean	31,9	5,7	56,8	5,6	0,6:1	
V.m.m.f.	33,8	6,0	60,2	-	0,7:1	
GREENSIDE						
Cobbles	42,7	5,9	46,4	5,0	0,9:1	2
Nuts	44,3	3,0	47,6	5,1	0,9:1	2
Peas	37,3	4,2	54,1	4,4	0,7:1	2
Duff	37,9	3,1	50,8	8,2	0,7:1	2
Low-ash	60,9	6,6	30,0	2,5	2,1:1	2
Middlings	30,7	5,2	59,5	4,6	0,6:1	2
Mean	42,3	4,7	48,1	4,9	0,9:1	
V.m.m.f.	44,0	5,0	51,0	5,0	1,0:1	
No. 5 Seam Blend coal	65,0	6,9	25,2	2,9	2,6:1	
V.m.m.f.	66,9	7,1	26,0	-	2,8:1	

6.1 TABLE OF TRANSVAAL PRODUCTS (Continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
HAASFONTEIN						
Low-ash	59,3	5,0	34,6	1,1	1,8:1	1
Middlings	35,9	6,2	48,2	9,7	0,7:1	1
Mean	47,6	5,6	41,4	5,4	1,1:1	
V.m.m.f.	50,0	6,0	44,0	-	1,3:1	
KOORNFONTEIN						
Cobbles	51,5	5,6	37,3	5,6	1,3:1	2
Nuts	49,1	4,4	42,9	3,6	1,2:1	2
Peas	49,2	3,6	42,4	4,8	1,1:1	3
Mixed Smalls	49,3	4,1	41,1	5,5	1,2:1	2
Mean	49,9	4,4	40,9	4,8	1,2:1	
V.m.m.f.	52,4	4,6	43,0	-	1,3:1	
KRIEL						
Rounds	65,8	9,1	20,3	4,8	3,0:1	5
Cobbles	66,5	8,4	17,8	7,3	3,0:1	5
Large Nuts	64,3	9,2	20,2	6,3	2,8:1	2
Mixed Smalls	67,5	9,0	12,6	10,9	3,2:1	2
Duff	73,4	6,7	13,3	6,6	4,0:1	3
Mean	67,5	8,5	16,8	7,2	3,2:1	
V.m.m.f.	72,7	9,2	18,1	-	4,5:1	
LANDAU						
Rounds	43,5	3,5	48,6	4,4	0,9:1	2
Nuts	37,4	1,9	55,4	5,3	0,6:1	2
Peas	41,2	3,1	51,7	4,0	0,8:1	2
Duff	40,5	3,1	51,5	4,9	0,8:1	2
Low-ash	54,9	5,3	38,2	1,6	1,5:1	3
Middlings	26,6	6,1	62,5	4,8	0,5:1	2
Mean	40,6	3,8	51,3	4,3	0,8:1	
V.m.m.f.	42,0	4,0	54,0	-	0,9:1	

47/.....

6.1 TABLE OF TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
NAVIGATION (SACE)						
Blend coking coal	66,5	5,1	23,7	4,7	2,5:1	3
V.m.m.f.	69,8	5,4	24,8	-	3,0:1	
Middlings	20,9	8,1	63,5	7,5	0,4:1	2
V.m.m.f.	22,6	8,7	68,7	-	0,5:1	
NEW CLYDESDALE						
Rounds	30,6	2,8	63,8	2,8	0,5:1	2
Nuts	31,0	5,1	58,8	5,1	0,6:1	3
Mixed Smalls	36,7	3,7	55,5	4,1	0,7:1	2
Mean	32,8	3,9	59,3	4,0	0,6:1	
V.m.m.f.	34,2	4,1	61,7	-	0,6:1	
NEW LARGO						
Cobbles	29,7	3,6	54,5	12,2	0,5:1	2
Mixed Smalls	27,4	4,3	55,7	12,6	0,5:1	2
Mean	28,6	3,9	55,1	12,4	0,5:1	
V.m.m.f.	32,6	4,5	62,9	-	0,6:1	
NEW WAKEFIELD						
Rounds	66,5	12,0	17,5	4,0	3,7:1	3
Cobbles	65,3	11,1	19,3	4,3	3,2:1	3
Nuts	64,8	10,3	19,2	5,7	3,0:1	3
Duff	71,5	7,5	14,9	6,1	3,8:1	3
Mean	67,1	10,2	17,7	5,0	3,4:1	
V.m.m.f.	70,7	10,7	18,6	-	4,4:1	
OPTIMUM						
Crushed coal	37,4	6,7	43,5	12,4	0,8:1	3
V.m.m.f.	42,7	7,6	49,7	-	1,0:1	

48/......

6.1 TABLE ON TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
PHOENIX						
Cobbles	45,2	4,9	44,6	5,3	1,0:1	2
Nuts	42,0	4,5	50,1	3,4	0,9:1	4
Peas	47,0	4,0	44,8	4,2	1,0:1	4
Duff	46,6	3,5	44,8	5,1	1,0:1	3
Mean	45,2	4,2	46,1	4,5	1,0:1	
V.m.m.f.	47,3	4,4	48,3	-	1,1:1	
SOUTH WITBANK						
Cobbles	47,8	4,4	40,9	6,9	1,1:1	2
Nuts	42,5	4,0	46,6	6,9	0,9:1	3
Peas	42,4	5,6	46,2	5,8	0,9:1	2
Mixed Smalls	40,0	4,3	45,8	9,9	0,8:1	2
Duff	42,8	3,5	44,4	9,3	0,9:1	3
Mean	43,1	4,4	44,7	7,8	0,9:1	
V.m.m.f.	46,7	4,8	48,5	-	1,1:1	
SPITZKOP						
Cobbles	50,7	4,1	38,4	6,8	1,2:1	2
Nuts	49,9	3,9	37,8	8,4	1,2:1	2
Peas	54,1	7,9	33,5	4,5	1,6:1	2
Mixed Smalls	52,1	6,4	37,9	3,6	1,4:1	2
Duff	49,6	7,1	37,7	5,6	1,3:1	2
Mean	51,3	5,9	37,0	5,8	1,3:1	
V.m.m.f.	54,5	6,2	39,3	-	1,5:1	
SPRINGBOK NO. 2 SEAM						
Cobbles	42,3	3,0	49,9	4,8	0,8:1	2
Nuts	38,3	3,0	51,7	7,0	0,7:1	2
Mixed Smalls	39,1	5,2	52,7	3,0	0,8:1	2
Mean	39,9	3,7	51,5	4,9	0,8:1	
V.m.m.f.	42,0	3,9	54,1	-	0,9:1	

49/.......

6.1 TABLE OF TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
SPRINGBOK NO. 5 SEAM						
Blend coking coal	72,4	4,9	20,0	2,7	3,4:1	2
V.m.m.f.	74,4	5,0	20,6	-	3,9:1	
Gas coal	54,0	8,5	33,3	4,2	1,7:1	2
V.m.m.f.	56,4	8,9	34,7	-	1,9:1	
SPRINGBOK - HOPE SECTION						
Blend coking coal	67,3	7,1	23,2	2,4	2,9:1	2
V.m.m.f.	68,9	7,3	23,8	-	3,2:1	
Gas coal	62,3	5,0	28,4	4,3	2,1:1	2
V.m.m.f.	65,1	5,2	29,7	-	2,4:1	
USUTU						
Crushed coal	50,5	8,2	35,7	5,6	1,4:1	2
V.m.m.f.	53,5	8,7	37,8	-	1,6:1	
VAN DYKS DRIFT						
Rounds	48,4	3,7	43,6	4,3	1,1:1	3
Nuts	30,9	5,5	59,6	4,0	0,6:1	2
Mixed Smalls	44,0	3,3	47,7	5,0	0,9:1	2
Low-ash	56,3	4,7	37,4	1,6	1,6:1	2
Middlings	30,6	6,7	58,1	4,6	0,6:1	5
Mean	42,1	4,7	49,3	3,9	0,9:1	
V.m.m.f.	43,8	4,9	51,3	-	1,0:1	
WATERPAN						
Cobbles	27,1	9,2	58,3	5,4	0,6:1	2
Nuts	33,8	2,8	58,7	4,7	0,6:1	2
Mixed Smalls	31,3	5,9	55,7	7,1	0,6:1	2
Duff	34,2	3,5	55,0	7,3	0,6:1	3
Mean	31,6	5,4	56,9	6,1	0,6:1	
V.m.m.f.	33,7	5,8	60,5	-	0,7:1	

6.1 TABLE OF TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
WITBANK CONSOLIDATED						
Cobbles	49,4	8,2	36,0	6,4	1,4:1	2
Peas	45,7	5,0	43,2	6,1	1,0:1	2
Mixed Smalls	48,5	5,3	37,8	8,4	1,2:1	3
Duff	47,1	6,0	41,7	5,2	1,1:1	3
Mean	47,7	6,1	39,7	6,5	1,2:1	
V.m.m.f.	51,0	6,5	42,5	-	1,4:1	
TAVISTOCK						
Rounds	46,1	5,1	45,9	2,9	1,0:1	2
Nuts	35,7	4,1	56,1	4,1	0,7:1	2
Peas	43,7	2,7	49,0	4,6	0,9:1	2
Duff	35,9	3,0	49,6	11,5	0,6:1	2
Mean	40,4	3,7	50,1	5,8	0,8:1	
V.m.m.f.	42,9	3,9	53,2	-	0,9:1	
TRANSVAAL NAVIGATION						
Cobbles	34,9	4,8	57,6	2,7	0,7:1	3
Nuts	30,7	6,4	59,1	3,8	0,6:1	3
Peas	34,6	5,1	55,1	4,4	0,7:1	3
Duff	34,0	5,2	55,2	5,6	0,6:1	3
Mean	33,6	5,4	56,9	4,1	0,6:1	
V.m.m.f.	35,0	5,6	59,4	-	0,7:1	
TWEEFONTEIN						
Cobbles	43,7	5,8	47,5	3,0	1,0:1	2
Nuts	45,2	4,7	46,5	3,6	1,0:1	3
Peas	43,7	4,0	48,9	3,4	0,9:1	2
Duff	42,3	3,2	49,9	4,6	0,8:1	3
Mean	43,7	4,4	48,2	3,7	0,9:1	
V.m.m.f.	45,4	4,6	50,0	-	1,0:1	

6.1 TABLE OF TRANSVAAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
UNION						
Rounds	54,6	5,3	33,4	6,7	1,5:1	2
Nuts	52,0	5,5	35,4	7,1	1,4:1	2
Peas	55,9	4,7	34,1	5,3	1,5:1	2
Duff	58,8	5,0	27,6	8,6	1,8:1	2
Mean	55,4	5,1	32,6	6,9	1,5:1	
V.m.m.f.	59,5	5,5	35,0	-	1,9:1	
WOLVEKRANS						
Cobbles	36,8	3,4	54,0	5,8	0,7:1	2
Nuts	37,7	2,9	53,1	6,3	0,7:1	3
Peas	38,4	3,4	52,2	6,0	0,7:1	3
Duff	36,8	3,3	54,9	5,0	0,7:1	3
Mean	37,4	3,3	53,5	5,8	0,7:1	
V.m.m.f.	39,7	3,5	56,8	-	0,8:1	

6.2 TABLE OF ORANGE FREE STATE PRODUCTS

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
COALBROOK NO. 2						
Mixed Smalls	24,6	2,5	59,0	13,9	0,4:1	3
V.m.m.f.	28,6	2,9	68,5	-	0,5:1	
COALBROOK NO. 3						
Mixed Smalls	25,5	3,0	58,4	13,1	0,4:1	3
V.m.m.f.	29,3	3,5	67,2	-	0,5:1	
BERTHA I						
Cobble "A"	30,9	3,9	50,1	15,1	0,5:1	2
Nuts	29,9	4,1	51,9	14,1	0,5:1	3
Peas	27,5	1,5	54,2	16,8	0,4:1	2
Mixed Smalls	28,1	2,9	51,4	17,6	0,4:1	2
Mean	29,1	3,1	51,9	15,9	0,5:1	
V.m.m.f.	34,6	3,7	61,7	-	0,6:1	
BERTHA II						
Large nuts	27,2	6,4	51,3	15,1	0,5:1	2
Peas	24,2	4,3	51,3	20,2	0,4:1	2
Mixed Smalls	29,8	5,8	56,6	7,8	0,6:1	2
Mean	27,1	5,5	53,1	14,3	0,5:1	
V.m.m.f.	31,6	6,4	62,0	-	0,6:1	
NEW SPRINGFIELD						
Mixed Smalls	23,7	1,8	60,3	14,2	0,3:1	2
V.m.m.f.	27,6	2,1	70,3	-	0,4:1	
SIGMA						
Crushed coal	23,5	2,4	55,0	19,1	0,4:1	
V.m.m.f.	29,0	3,0	68,0	-	0,5:1	
VIERFONTEIN						
Mixed Smalls	31,1	5,4	51,3	12,2	0,6:1	3
V.m.m.f.	35,4	6,2	58,4	-	0,7:1	

53/.......

6.3 TABLE OF NATAL PRODUCTS

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
BALLENGEICH						
Rounds	43,5	3,6	47,6	4,3	0,9:1	2
Nuts	40,4	4,0	48,2	7,4	0,8:1	4
Peas	40,2	4,2	48,1	7,5	0,8:1	3
Mixed Smalls	50,3	2,9	42,3	4,5	1,1:1	4
Duff	41,2	2,6	50,7	5,5	0,8:1	3
Weighted mean	44,9	3,4	46,3	5,4		
V.m.m.f.	47,5	3,6	48,9	-	1,0:1	
DUMBE						
Coking coal	59,0	6,6	30,1	4,3	1,9:1	2
V.m.m.f.	61,7	6,9	31,4	-	2,2:1	
DURBAN NAVIGATION						
Coking coal	55,3	3,1	37,4	4,2	1,4:1	2
V.m.m.f.	57,8	3,2	39,0	-	1,6:1	
HLOBANE						
Rounds	37,8	1,3	58,9	2,0	0,6:1	2
Peas	41,7	1,6	53,9	2,8	0,8:1	3
Middlings	24,4	1,2	64,0	10,4	0,3:1	3
Mixed Smalls	45,9	2,6	48,3	3,2	0,9:1	2
Coking coal	63,8	2,5	30,8	2,9	2,0:1	3
Weighted mean	59,1	2,3	35,7	2,9	1,6:1	
V.m.m.f.	60,9	2,4	36,7	-	1,7:1	
INDUMENI						
Coking coal	72,1	0,9	22,6	4,4	2,7:1	2
V.m.m.f.	75,4	1,0	23,6	-	3,2:1	

54/......

6.3 TABLE OF NATAL PRODUCTS (continued)

Colliery and product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
INGAGANE						
Rounds/Cobbles	38,9	2,7	54,8	3,6	0,7:1	2
Nuts	43,7	3,0	48,8	4,5	0,9:1	3
Peas	48,4	2,7	43,8	5,1	1,0:1	3
Mixed Smalls	55,1	2,5	35,0	7,4	1,4:1	3
Duff	55,0	4,0	33,9	7,1	1,4:1	2
Weighted mean	48,1	2,9	43,4	5,6		
V.m.m.f.	50,9	3,2	45,9	-	1,2:1	
KILBARCHAN						
Mixed smalls	43,5	2,1	44,5	9,9	0,9:1	3
	48,3	2,3	49,4	-	1,0:1	
NATAL NAVIGATION						
Rounds/Cobbles	50,8	0,9	44,7	6,6	1,1:1	3
Nuts	54,1	2,0	39,7	4,2	1,3:1	2
Peas	62,7	1,1	30,0	6,2	1,8:1	2
Duff	66,1	1,2	28,9	3,8	2,1:1	4
Coking coal	63,8	1,2	29,9	5,1	1,9:1	2
Weighted mean	59,9	1,2	33,4	5,5	1,6:1	
V.m.m.f.	63,4	1,3	35,3	-	1,8:1	
NEWCASTLE-PLATBERG						
Rounds	40,8	0,9	55,1	3,2	0,7:1	2
Nuts	31,9	1,0	58,5	8,5	0,5:1	3
Peas	31,9	0,8	58,6	8,7	0,5:1	2
Mixed smalls	38,1	1,1	51,9	8,9	0,6:1	3
Duff	34,6	1,0	57,6	6,8	0,6:1	3
Mean	35,5	1,0	56,3	7,2	0,6:1	
V.m.m.f.	38,3	1,1	60,6	-	0,7:1	

55/......

6.3 TABLE OF NATAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
STAR						
Cobbles	56,6	2,3	34,2	6,9	1,4:1	2
Nuts	51,1	3,9	33,1	11,9	1,2:1	2
Peas	48,8	5,9	37,5	7,8	1,2:1	2
Duff	55,8	4,3	32,0	7,9	1,5:1	2
Mean	53,1	4,1	34,2	8,6	1,3:1	
V.m.m.f.	58,1	4,5	37,4	-	1,6:1	
TENDEGA						
Coking coal	59,2	4,8	31,7	3,8	1,8:1	2
V.m.m.f.	62,0	5,0	33,0	-	2,0:1	
UMGALA						
Rounds/Cobbles	32,1	4,5	60,8	2,6	0,6:1	2
Nuts	24,7	3,2	66,4	5,7	0,4:1	2
Peas	34,1	4,7	57,0	4,2	0,6:1	2
Mixed Smalls	41,6	4,3	50,0	4,1	0,8:1	3
Duff	35,9	3,8	54,4	5,9	0,7:1	3
Mean	33,7	4,1	57,7	4,5	0,6:1	
V.m.m.f.	35,2	4,3	60,5	-	0,7:1	
UTRECHT						
Nuts	42,7	0,9	49,3	7,1	0,8:1	3
Peas	48,5	1,1	44,9	5,5	1,1:1	3
Duff	61,6	1,0	33,7	3,7	1,7:1	2
Weighted mean	51,4	1,0	42,3	5,3	1,1:1	
V.m.m.f.	54,3	1,1	44,6	-	1,2:1	
VRYHEID CORONATION						
Coking coal	57,5	3,1	35,1	4,3	1,5:1	3
V.m.m.f.	60,1	3,2	36,7	-	1,7:1	

6.3 TABLE OF NATAL PRODUCTS (continued)

Colliery and Product	Vitrinite %	Exinite %	Inertinite %	Visible Minerals %	Ratio Reactives / Inerts	No. of samples
ZIMBUTU						
Rounds	38,0	6,3	52,3	3,4	0,8:1	3
Nuts	37,6	3,5	55,0	3,9	0,7:1	3
Peas	40,1	4,0	51,0	4,9	0,8:1	3
Mixed smalls	39,7	5,3	49,4	5,1	0,8:1	4
Duff	43,0	2,9	46,2	7,9	0,8:1	4
Mean	39,7	4,4	50,9	5,0	0,8:1	
V.m.m.f.	41,7	4,6	53,7	-	0,9:1	