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FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA

THE MACERAL COMPOSITION OF THE PRODUCTS PREPARED

ONDERWERP:
SUBJECT: BY THE COLLIERIES IN THE ORANGE FREE STATE AND AT NEW SPRINGFIELD IN THE TRANSVAAL

AFDELING:
DIVISION:

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INTRODUCTION

A survey of the maceral composition of the products prepared by the collieries in the Republic was initiated a number of years ago.

The first report (Report No. 10 of 1974) dealt with the maceral composition of the products prepared by the collieries in the Transvaal. One major colliery (New Springfield, south of Heidelberg) was not included in this report by virtue of the fact that it is situated near the border of the Orange Free State and mines the same seams as the collieries in that province.

PRESENTATION OF RESULTS

The basic data on which this report is based, consisting of the maceral analyses of the commercially available products prepared by each colliery, are recorded in Table 4, where they appear in alphabetical order. Table 5 contains the calculated mean value for each product under the names of the respective collieries.

In Diagram 1, the calculated mean value for the coal produced by each colliery and the calculated mean value for the whole coalfield, as well as the calculated values for the Transvaal coal seams, are graphically represented on a visible mineral matter free basis for purposes of comparison. Diagram 2 contains the same data, but on a basis of reactives : inerts : visible mineral matter.

GENERAL CONSIDERATIONS

There are three thick seams present in the coalfield, but the Top and Bottom (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 relatively low grade.

Five major collieries produce just over 25% of the Republic's total annual production from seven shafts, i.e. more than the combined production of all the collieries in Natal. About 95% of the coal produced from this 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 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. 1 and No. 2 for Coalbrook Colliery. About 25% of the coal produced by Cornelia Colliery is sold on the general market.

THE SIGNIFICANCE OF A MACERAL ANALYSIS

Macerals are the elementary coal components and can be observed only under a microscope. They can be divided into two main groups. One group is chemically reactive and the other group is chemically inert. The former has a lower carbon to hydrogen ratio than the latter.

Bright coals contain high percentages of vitrinite, and dull coals high percentages of inertinite. Exinite is a very reactive maceral and occurs in both bright and dull coals in fairly small quantities, particularly in South African coals. The general tendency for exinite is to occur in slightly greater quantities in bright than in dull coals.

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 in 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.

VARIATIONS IN PETROGRAPHIC VALUES

In the report on the maceral composition of the products derived from the

coals mined in the Transvaal, it was pointed out that owing to a number of 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 a variation can occur in the products prepared by a specific colliery. It was therefore decided that if the vitrinite contents of three analyses of any given product, carried out at intervals, differ from each other within reasonable limits, the analysis must be regarded as being typical of that product. A variation of not more than 5% was aimed at. This criterion was also applied in the case of the Orange Free State coals. With two exceptions, the mean variation amounted to less than 3%. Where only two analyses per product were reported, the variation was so small that it was not deemed necessary to obtain further samples.

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

TABLE 1

COMPARISON OF MEAN PETROGRAPHIC COMPOSITION OF THE WASHED AND RAW COALS PRODUCED

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/...

higher than that of the unwashed coal, but the amount of mineral matter in both coals remains virtually the same. Inspection of the mean values obtained for the products prepared by each colliery, as recorded in Table 5, shows that, with the exception of the coal produced by Sigma, which gave a relatively high value, the values obtained for the other collieries are very similar, the variation being less than 4%. This confirms the microscopical observation that the mineral matter is finely dispersed throughout 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 is 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 washers, particularly the mixed smalls.

THE PETROGRAPHIC PROPERTIES OF THE COAL SEAMS

It was impossible to obtain samples of the individual coal seams. The only comparison that can be made is between the No. 2 Seam (mined by Sigma, Coalbrook No. 2, Vierfontein and New Springfield) and a combination of the three seams (mined by Coalbrook No. 3, Bertha I and Bertha II).

The results, calculated on a visible mineral matter free basis, are recorded in Table 2.

TABLE 2

COMPARISON BETWEEN THE MEAN VALUES OBTAINED ON NO. 2 SEAM AND THOSE OF THE OTHER THREE SEAMS ON A VISIBLE MINERAL MATTER FREE BASIS

Seam	% Vitrinite	% Exinite	% Inertinite	Ratio $\frac{\text{Reactives}}{\text{Inerts}}$
No. 2	30,6	3,6	65,8	0,5:1
Nos. 1, 2 & 3	31,8	4,5	63,7	0,6:1

The values obtained on No. 2 Seam are only slightly inferior to those pertaining to Nos. 1, 2 and 3 Seams, and the differences must be regarded as negligible.

The similarity in petrographic composition of the products prepared by the collieries becomes even more apparent when the collieries producing them are arranged in a descending order of vitrinite contents on a visible mineral

matter/

matter free basis, as recorded in Table 3.

TABLE 3

COLLIERIES ARRANGED IN 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

The greatest variation in petrographic composition is between the products prepared by Vierfontein, situated in the western extremity, and New Springfield in the eastern extremity of the coalfield. This variation amounts to only 7,8% in vitrinite, which is relatively small but creates the impression that the coal declines in vitrinite content towards the east. However, the collieries in the Vereeniging-Sasolburg area produce coal of a very similar petrographic composition. With the exception of Bertha I, the products of which are only slightly inferior to those produced by Vierfontein, four collieries, viz. Bertha II, Coalbrook Nos. 2 and 3, and Sigma, produce coal that varies with only 3% in vitrinite content.

COMPARISON OF THE PETROGRAPHIC PROPERTIES BETWEEN THE O.F.S. COALS AND OTHER COAL SEAMS

The mean maceral composition (on a visible mineral matter free basis) of the products prepared by each colliery in the O.F.S. coalfield is represented in Diagram 1 by dots, and the mean value for the coal over the whole field by a small circle.

For purposes of comparison, the mean values obtained on four Transvaal coal

seams/...

seams*, as well as the coals from Nos. 2, 2A and 4 Seams currently supplied for the generation of electricity in that province, are also shown in small circles. It can be noticed that the Transvaal power station coals** do not differ appreciably from those of the O.F.S. and are, in fact, very similar in petrographic composition to the coal produced by Vierfontein.

The O.F.S. coals are particularly notable for their low vitrinite and abnormally high visible mineral matter contents, and for further purposes of comparison the mean petrographic values are plotted in Diagram 2 on the basis of reactives : inerts : visible mineral matter. The power station coals from the Witbank-Middelburg-Hendrina area (referred to as Transvaal power station coals in the diagram) fall largely in the same category as those of the O.F.S., notwithstanding the fact that the former contain a slightly higher amount of vitrinite and therefore also have a slightly higher ratio of reactive to inert material.

SUMMARY AND CONCLUSIONS

Products prepared by five collieries from seven shafts were petrographically analysed. About 95% of the total tonnage mined, which amounts to about a quarter of the Republic's total annual coal production, is used for the generation of electricity and for gasification.

There are three relatively thick coal seams present in the field, but all are not mined everywhere. The seams are similar in petrographic composition, as are the products produced by the collieries. They are characterized by their low vitrinite, high inertinite and abnormally high mineral matter content. The exinite content is very similar to that found in the Witbank No. 2 Seam coal.

A comparison of the petrographic characteristics of the washed and unwashed products shows that washing improved the amount of vitrinite slightly, but the visible mineral matter content remained virtually the same for both products, indicating that the mineral matter is more or less finely dispersed throughout the coal. There also is some evidence that the vitrinite content declines in the coalfield from the west towards the east.

Although/...

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* Data extracted from Report No. 10 of 1974.

** Power station coal from Ermelo field not included.

Although the coal is of a lower grade than any of the coals mined in the Transvaal, it does not compare very unfavourably in petrographic constitution with the power station coals derived from seams Nos. 2, 2A and 4 in the Witbank-Middelburg-Hendrina area, as the following mean values indicate:-

Coal	% Vitrinite	% Exinite	% Inertinite	% Visible mineral matter	Ratio Reactives / Inerts
O.F.S. coals	26,3	3,4	55,6	14,7	0,4:1
V.m.m.f.*	30,8	4,0	65,2	-	0,5:1
Transvaal power station coals	32,5	4,3	51,8	11,4	0,6:1
V.m.m.f.*	36,7	4,8	58,5	-	0,7:1

* Visible mineral matter free.

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PRINCIPAL RESEARCH OFFICER

PRETORIA
7th January, 1975.

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TABLE 4

PETROGRAPHIC ANALYSIS OF PRODUCT SAMPLES

Colliery & Product	% Vitrinite	% Exinite	% Inertinite	% Visible minerals	Ratio Reactives / Inerts	Reference
Coalbrook No. 2						
	27,5	4,4	57,6	10,5	0,5:1	72/647A
Mixed smalls	20,2	0,0	61,5	18,3	0,3:1	73/13A
	26,0	3,2	58,0	12,8	0,4:1	73/841A
Coalbrook No. 3						
	24,1	5,3	61,8	8,8	0,4:1	72/648A
Mixed smalls	26,3	1,2	57,5	15,0	0,4:1	73/14A
	26,0	2,5	55,9	15,6	0,4:1	73/842A
Cornelia-Bertha I						
	30,0	4,8	53,8	11,4	0,5:1	69/436A
Cobble "A"	31,8	2,9	46,5	18,8	0,5:1	74/750A
	27,5	6,0	56,0	10,5	0,5:1	69/436B
Nuts	31,3	4,5	46,0	17,9	0,6:1	72/645A
	30,8	1,7	53,5	14,0	0,5:1	73/12A
	26,7	1,0	58,2	14,1	0,4:1	73/12B
Peas	28,3	2,0	50,1	19,6	0,4:1	74/750B
	27,0	4,6	54,0	14,4	0,5:1	72/645C
Mixed smalls	29,2	1,2	48,8	20,8	0,4:1	73/12C
Cornelia-Bertha II						
	28,0	8,9	50,1	13,0	0,6:1	72/646A
Large nuts	26,4	3,8	52,7	17,1	0,4:1	74/751A
	26,2	5,7	43,3	24,8	0,5:1	72/646B
Peas	22,1	3,0	59,4	15,5	0,3:1	74/751B
	29,8	6,7	54,9	8,6	0,6:1	69/437B
Mixed smalls	29,7	4,9	58,3	7,1	0,5:1	72/646C
Sigma						
	23,3	3,3	50,1	23,3	0,4:1	72/649A
Mixed smalls	22,9	1,8	56,5	18,8	0,3:1	73/15A
	20,6	1,7	64,8	12,9	0,3:1	73/843A
	22,5	4,5	53,3	19,7	0,4:1	72/650A
	23,6	1,0	49,2	26,2	0,3:1	73/16A
	28,3	2,0	55,9	13,8	0,4:1	73/843B
Springfield						
	24,8	1,2	58,5	15,5	0,4:1	72/651A
Mixed smalls	22,5	2,4	62,2	12,9	0,3:1	74/752A
Vierfontein						
	34,9	5,2	49,7	10,2	0,7:1	71/645A
Crushed coal	29,6	6,7	57,0	6,7	0,6:1	69/426A
	28,9	4,2	47,2	19,7	0,5:1	72/652A

Table 5/...

TABLE 5

THE MEAN PETROGRAPHIC ANALYSIS OF EACH PRODUCT

Colliery & 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	
Cornelia-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	
Cornelia-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	
Sigma						
Crushed coal	23,5	2,4	55,0	19,1	0,4:1	6
V.m.m.f.*	31,0	3,1	65,9	-	0,5:1	
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	
Vierfontein						
Crushed coal	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	

* Visible mineral matter free.

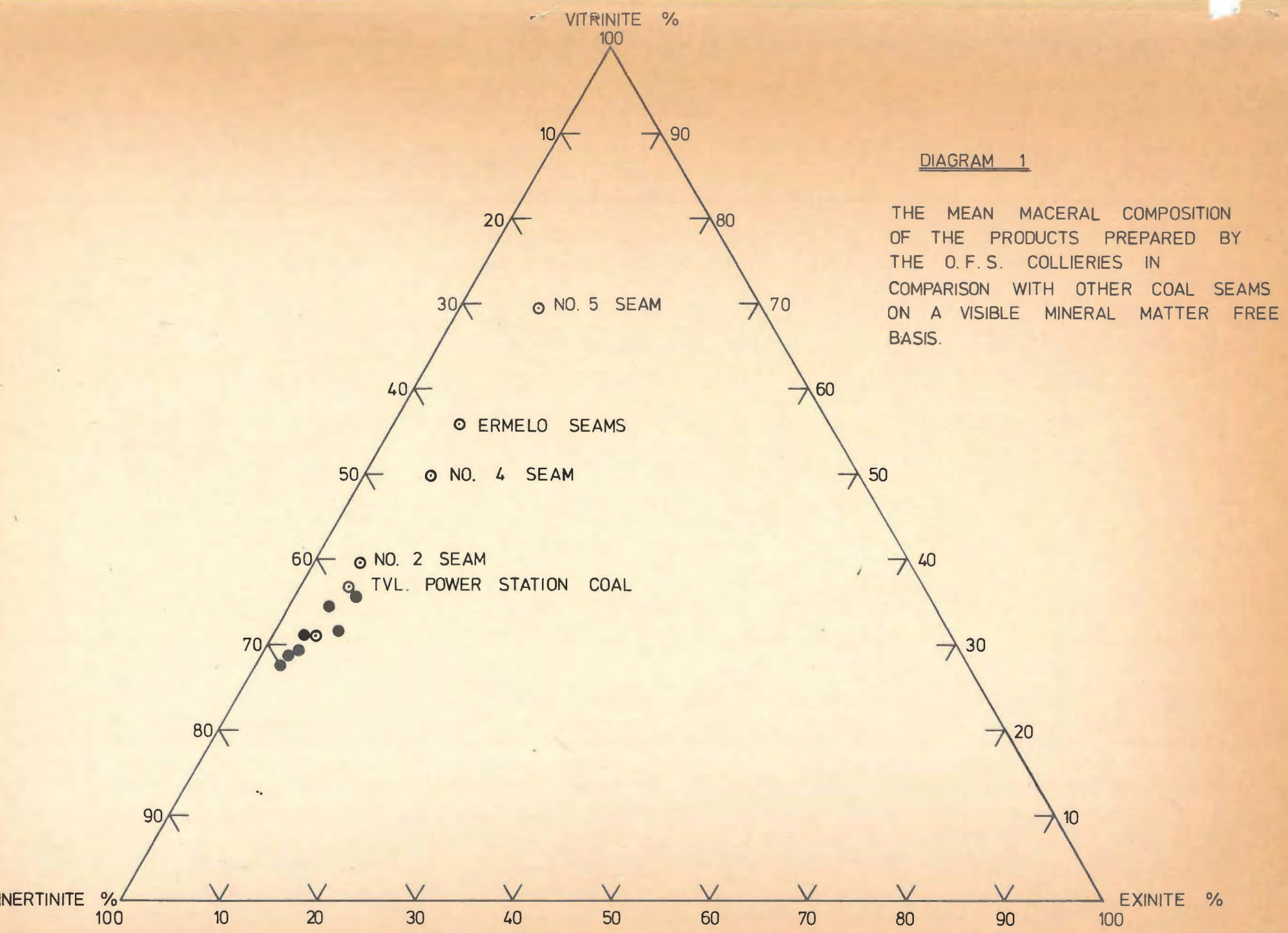

DIAGRAM 1

THE MEAN MACERAL COMPOSITION OF THE PRODUCTS PREPARED BY THE O. F. S. COLLIERIES IN COMPARISON WITH OTHER COAL SEAMS ON A VISIBLE MINERAL MATTER FREE BASIS.

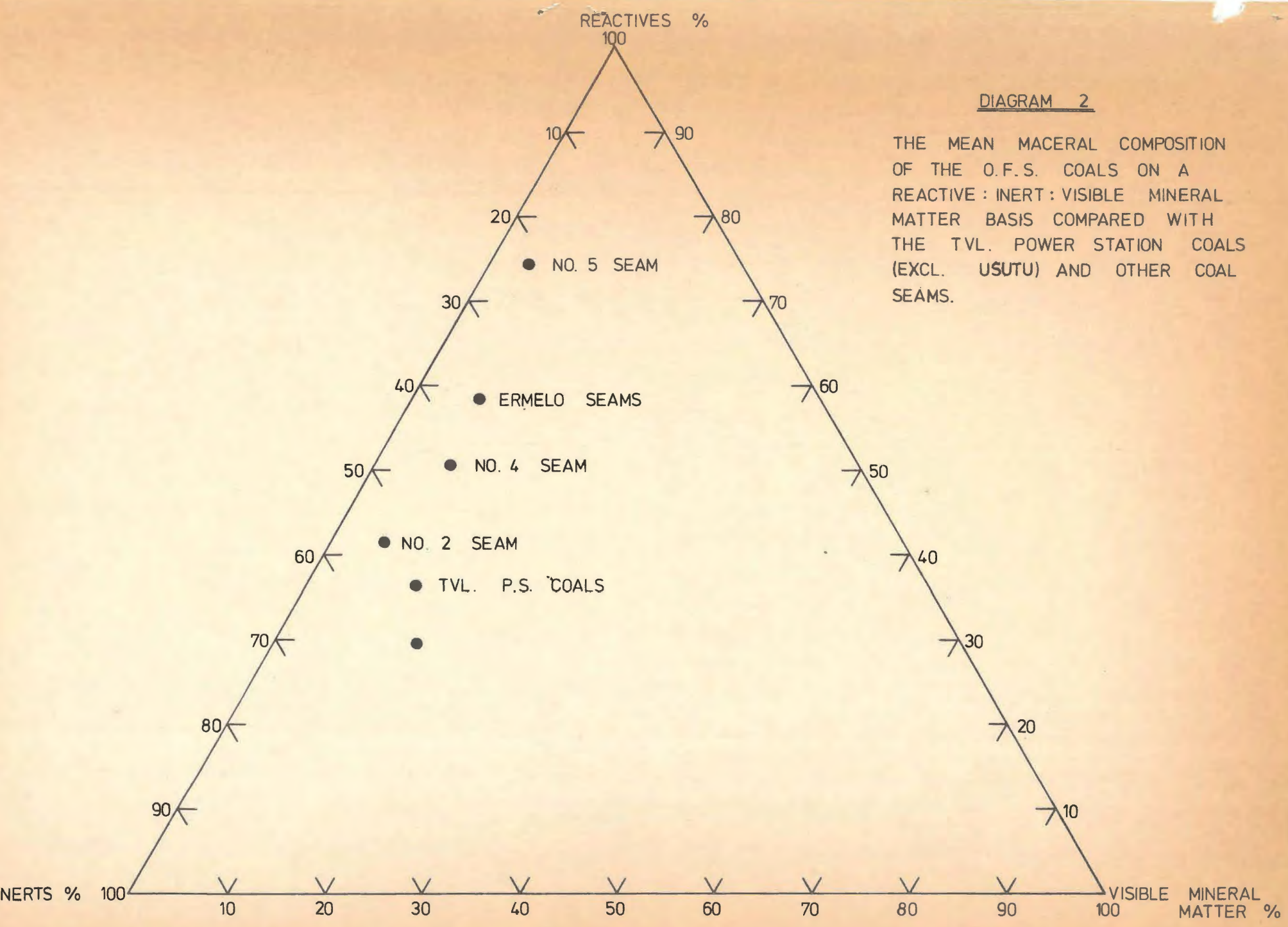

DIAGRAM 2

THE MEAN MACERAL COMPOSITION OF THE O.F.S. COALS ON A REACTIVE : INERT : VISIBLE MINERAL MATTER BASIS COMPARED WITH THE TVL. POWER STATION COALS (EXCL. USUTU) AND OTHER COAL SEAMS.