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REPORT No. 3
OF 1944.

RAPPORT No.
VAN

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FUEL RESEARCH INSTITUTE

OF SOUTH AFRICA.

BRANDSTOF-NAVORSINGS-INSTITUUT

VAN SUID-AFRIKA.

SURVEY REPORT No. 66.

SUBJECT :
ONDERWERP: REPORT ON BOREHOLES PUT DOWN BY THE MIDDELBURG STEAM COAL AND COKE COMPANY ON THE FARMS HARTEBEESTFONTEIN 134 AND BLESBOKFONTEIN 130 IN THE BETHAL DISTRICT OF TRANSVAAL.

DIVISION :
AFDELING: CHEMISTRY.

NAME OF OFFICER :
NAAM VAN AMPTENAAR: DR. B. GAIGHER.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT No. 3 OF 1944.

SURVEY REPORT No.66.

REPORT ON BOREHOLES PUT DOWN BY THE MIDDELBURG STEAM COAL AND COKE COMPANY ON THE FARMS HARTEBEESTFONTEIN 134 and BLESBOKFONTEIN 130 IN THE BETHAL DISTRICT OF TRANSVAAL.

During the period December 1941 to January 1942, three boreholes were put down by the Middelburg Steam Coal and Coke Company on the farms Hartebeestfontein 134 and Blesbokfontein 130 in the Bethal District of Transvaal. The locations of the boreholes are given on the accompanying sketch map. (See back of report) ~~page~~ .

The prospected area lies approximately fifteen miles south of Witbank and seven miles south east of Minnaar Station. The details of the borehole cores indicating the coal seams and the strata encountered and the depths below the surface are given in Table I. (See back of report page 6).

The strata encountered consist of sandstones and shales. All the boreholes were stopped in Dwyka. The elevation of the Dwyka varies from 5056 feet a.m.s.l., in borehole C to 5128 feet a.m.s.l., in borehole A, i.e. 72 feet over a distance of about 1¼ miles.

All the coal seams Nos. 1 to 5 of the Witbank Area were encountered in all the boreholes, excepting in borehole C where the No. 5 seam has been denuded.

The No. 1 seam either rests on the Dwyka (borehole A) or is separated from it by 1 to 10 feet (boreholes B and C respectively) of sandstones and shales. The seam is unusually thin for the No. 1 seam in the Witbank Area, the width of the coal in the seam varying from 3 feet in borehole A to 5 inches in borehole B.

The No. 2 seam was encountered 5 to 27 feet above the Dwyka and is separated from the No. 1 seam by 1 to 16 feet of grits and sandstones. The seam width varies from 15 feet in borehole C to 25 feet in borehole A.

An interesting feature of the area is the presence of a coal band 5 inches to 14 inches thick, 1½ to 3 feet above the No. 2 seam. This is probably a split of the No. 2 seam.

The No. 3 seam is present in all the boreholes, and is separated from the No. 2 seam by 40 to 52 feet of shale. The seam width varies from 8 inches to 27 inches.

The No. 4 seam lies 8 to 18 feet above the No. 3 seam and is split up into an Upper and a Lower No. 4 seam by 7 to 16 inches of shale parting. The total seam width of the No. 4 seam including the shale parting, is 15 to 16 feet.

The No. 5 seam, where it is present, is separated from the No. 4 seam by 76 to 78 feet of sandstones and shales. The seam has a width of 4 feet.

ANALYTICAL METHODS AND THEIR SIGNIFICANCE.

Descriptions of the analytical methods employed for coal survey work and the significance to be attached to the determinations are given in the appendix. (See back of report page 22).

SECTION A : PROXIMATE ANALYSES.

The cores from all the boreholes were examined and sampled by Officers of the Fuel Research Institute. The details of the samples taken are given in Table 2 (see back of report page 8). The core of each seam in each borehole is given a distinctive sample number and each sub-division of such a core a distinctive letter, starting from the bottom of the seam with the letter A.

Table 3 (see back of report page 12) gives the proximate analyses on an air-dried basis of the samples listed in Table 2, together with (a) The percentage float at a S.G. of 1.45
(b) The percentage ash on the float at 1.45
(c) The swelling number on the float at 1.45
(d) The percentage float at a S.G. of 1.6
(e) The percentage ash on the float at 1.6
(f) The swelling number on the float at 1.6

From the individual analytical data given in Table 3, certain average proximate analyses of various sections of the seams have been drawn up and are tabulated in Table 4. (See back of report page 15).

The average analyses are intended to represent in the majority of cases, the maximum mining width of coal, and inferior bands which are capable of removal by picking during production, have been excluded from both the widths and the analyses. Certain widths which are considered too narrow to be minable are given in the table for correlative purposes only.

SECTION B : ULTIMATE ANALYSES.

For the purpose of further and more detailed investigation, Composite seam samples based on the characteristics of the coals revealed by the proximate analyses in Section A were made up. These are made by mixing - in proportion to the amount of coal they represent - samples of the same type of coal from different boreholes, provided that the proximate analyses have confirmed their general similarity. A series of samples was thus obtained representing the various types of coal found in each seam and on these more advanced work has been carried out.

Composite samples have been made up of:-

(1) The No. 1 seam in boreholes A and C.
(2) The bright-banded coal at the bottom of the No. 2 seam in boreholes A, B and C.
(3) The mixed coal above the bottom bright coal of the No. 2 seam in boreholes A, B and C.
(4) The mixed mainly bright coal above the mixed coal of the No. 2 seam in boreholes A, B and C,
(5) The dull coal towards the top of the No. 2 seam in boreholes A, B and C.

(6) The bottom/.....

(6) The bottom portion of the No. 4 seam below the shaly sandstone parting, in boreholes A, B and C.

The composition and type of coal represented by these samples is given in Table 5 (see back of report page 16). The proximate analyses of the samples are given in Table 6 (see back of report page 17) and the Ultimate analyses in Table 7 (see back of report page 17). The ultimate analyses have been carried out in all cases on the float at a S.G. of 1.6. This procedure is adopted in order to eliminate as far as possible, errors due to the presence of adventitious mineral matter. The results are expressed on a dry-ash-free basis so as to represent the composition of the coal substance proper.

The usual increase in hydrogen content and decrease in carbon content as the coal changes from dull to bright is apparent.

The nitrogen contents are normal for South African coals. There is a slight increase in the percentage of nitrogen in the coal seams from the bottom to the top.

The sulphur contents are medium to low.

The somewhat high oxygen content of the coal is normal for the Southern Witbank Coalfield and may be responsible for the lack of swelling properties in the coal of this area.

Table 8 (see back of report page 18) gives data on distribution of sulphur in the composite samples. These analyses have been carried out on the whole coal including adventitious mineral matter. The total sulphur content of the floats at S.G. 1.6 are included in the table for comparative purposes.

The total sulphur contents of the whole coals are medium to very high. In the bright coals, where the sulphur is highest, most of it is mineral, probably in the form of pyrites present in the bright coals. Where the sulphur contents are high these are considerably reduced by floating the coal at 1.6 S.G. The organic sulphur contents are normal for the Witbank Coalfield and are slightly higher in the brighter coals.

SECTION C : CARBONIZATION ASSAYS.

Low temperature carbonization assay figures on the composite samples listed in Table 5, are given in Table 9 (see back of report page 18). The assays were carried out on the floats at 1.6 S.G.

As is usually the case the brighter coals with their higher volatile and hydrogen contents yield more tar and gas than the low volatile, hydrogen poor, duller coals.

The yields of tar and gas are poor to medium and the coke residues are all pulverulent so that the coals will be of no value as raw materials for the carbonization industries.

SECTION D/.......

SECTION D : FLOAT AND SINK ANALYSES.

Float and sink analyses together with their attendant ash and swelling number determinations have been carried out on the samples listed in Table 5. The results are given in Table 10 (see back of report page 19). From these figures an idea can be formed of the washability of the coals. Generally speaking the coals have good washability curves, excepting for the No. 4 seam (sample M 183) and the top dull coal in the No. 2 seam (sample M 187) in which the coal is spread over a wide S.G. range.

SECTION E : ASH FUSION TEMPERATURES.

In Table 11 (see back of report page 21) the ash fusion temperatures are given of the whole coals and the floats at 1.6 S.G. of the samples listed in Table 5.

As is usually the case low ash fusion temperatures are associated with high mineral sulphur contents. By floating the coals at a S.G. of 1.6 the ash fusion temperatures are in most cases materially improved.

SECTION F : GENERAL SUMMARY.

The boreholes cover an area of about 100 morgan but owing to their limited number no definite conclusions as to the nature of the coal over the whole area can be made. The discussion will therefore be limited to the coal actually encountered in the individual boreholes.

The Nature of the Coal.

(a) Seam No. 1.

This seam was encountered in all the boreholes, but was only sampled in boreholes A and C. The coal in the seam is of medium quality in both boreholes, but the narrow widths (23 ins. and 10 ins) renders the coal of no economic importance.

(b) Seam No. 2.

The seam widths in the three boreholes vary from 25 feet in borehole A to 15 feet in borehole C. A generalised vertical section of the seam in the three holes is as follows:-

		% Ash.	% Vol.Mat.
	ROOF: Shale		
50" - 194"	Dull roof coal	17	21
16" - 42"	Mixed mainly bright coal	11	30
25" - 42"	Mixed coal	13	26
7" - 18"	Bottom bright coal	12	31
	FLOOR: Sandstone		

The coal in the seam is non-swelling and could only be utilized as a general purpose steam coal. The seam contains 7½ feet (in borehole B) to 14 feet (borehole A and C) medium quality coal with the following analysis:-

Cal. Val/.......

Cal. Val. 12 to 12½ lbs/lb.
Ash 12½ to 15%.
Vol. Matter 22 to 26½ %.

This section of the seam includes a large proportion of the top dull coal, and if the coal is to be cleaned by washing a good type of washer operated under strict control would be necessa ry.

By reducing the minable width in borehole C to 7½ feet, coal could be extracted which on washing, should yield a product of over 12.8 lbs/lb calorific value.

(c) The No. 3 seam.

The No. 3 seam was intersected in all the boreholes, but was sampled in borehole C only. Here the seam is 17 inches wide and consists of slightly swelling bright coal of high ash content (21%).

(d) The No. 4 seam.

Although the No. 4 seam has a width of 15 to 16 feet, only the bottom 6½ to 8 feet is of sufficiently good quality to be considered as a mining proposition. Even in this section of the seam the coal is split up by numerous shale partings and careful hand-picking would be necessary to obtain a reasonable quality household coal. The average analysis of the coal is as follows:-

Cal. Val. 11.1 to 11.7 lbs/lb.
Ash 15½ to 18½ %.
Vol. Matter 23 to 25%.

As already stated improving the quality of the coal by washing would be a difficult process.

(e) The No. 5 seam.

The No. 5 seam was sampled in boreholes A and B, and the analyses suggest that the coal has been weathered. It is devoid of swelling properties, which is unusual for this seam in the Witbank Coalfield. The coal is generally bright with an average volatile matter content of 26 to 27% and an ash content of 15 to 18%.

B. Gaigher.
B. GAIGHER.

2nd. May 1944.

ASSISTANT.

TABLE I.

BOREHOLE RECORDS.

Thickness of Strata Ft.	Ins.	Description of Strata.	Depth below Surface Ft.	Ins.
Borehole No. A.		**Collar level : 5378' a.m.s.l.**		
32	0	Surface soil laterite	32	0
8	4	Sandstone	40	4
16	10	Sandstone with shale bands	56	4
4	0	COAL - No. 5 seam (4' recovered)	60	4
10	8	Sandy shale	71	0
	6	Grits	71	6
38	6	Sandy shale	110	0
24	10	Sandy stone	134	10
1	4	Sandy shale	136	2
4	6	COAL - Upper No. 4 Seam - (4' 5" recovered)	140	8
1	4	Shale	142	0
9	2	COAL - Lower No. 4 Seam - (9' 2" recovered)	151	2
18	10	Sandy shale	170	0
	8	COAL - No. 3 Seam (8" recovered)	170	8
46	11	Shale	217	7
	5	COAL	218	0
1	6	Grits	219	6
25	1	COAL - No. 2 Seam (25' recovered)	244	7
	11	Gritty sandstone	245	6
2	8	COAL)	248	2
1	4	Grits) - No. 1 Seam (4'5" rec.)	249	6
	6	COAL)	250	0
10	0	Dwyka	260	0
Borehole No. B.		**Collar level : 5353' a.m.s.l.**		
14	0	Surface soil laterite	14	0
26	8	Sandstone	40	8
7	4	Sandy shale	48	0
4	0	COAL - Seam No. 5 (4' recovered)	52	0
7	6	Sandstone with shale bands	59	6
22	9	Sandstone	82	3
14	11	Sandstone with shale bands	97	2
32	5	Shale	129	7
5	3	COAL - Upper No. 4 Seam - (5' 3" recovered)	134	10
	9	Shale	135	7
9	4	COAL - Lower No. 4 Seam - (9' 4" recovered)	144	11
9	6	Shale with sandstone bands	154	5
2	5	COAL - No. 3 Seam (2' 3"recovered)	156	10
1	11	Grits	158	9
45	7	Shale	204	4
1	2	COAL	205	6

3'4" Shale/.......

Thickness of strata Ft.	Ins.	Description of Strata.	Depth below Surface Ft.	Ins.
Borehole B (continued)				
3	4	Shale	208	10
15	2	COAL - No. 2. Seam (15' 2" rec.)	224	0
1	0	Grits	225	0
13	9	Gritty sandstone	238	9
	5	COAL - No. 1 seam (5" recovered)	239	2
1	1	Shale	240	3
3	9	Dwyka	244	0
Borehole No. C.		Collar level : 5265' a.m.s.l.		
27	0	Surface soal laterite clays	27	0
22	5	Sandstone	49	5
14	1	Sandstone with shale bands	63	6
12	3	Shale with sand bands	75	9
4	5	Shale	79	2
7	6	Gritty sandstone	86	8
	9	Shale	87	5
2	11	Sandstone	90	5
2	11	Shale with sand bands	93	4
6	1	COAL - Upper No. 4 Seam - (5' 8" recovered)	99	5
	7	Shale	100	0
9	3	COAL - Lower No. 4 Seam - (9' 3" recovered)	109	3
7	6	Shale	116	9
	7	Sandstone	117	4
1	5	COAL - No. 3 Seam (1' 5" recovered)	118	9
37	10	Shale	156	7
	8	COAL	157	3
2	0	Shale	159	3
2	3	COAL)	161	6
	5	Shale) - No. 2 Seam (22'10" rec)	161	11
20	4	COAL)	182	3
5	2	Gritty sandstone	187	5
3	4	Sandstone	190	9
2	6	Shale	193	3
	9	Grits	194	0
1	1	Shale	195	1
1	4	Sandstone	196	5
1	2	Shale	197	7
1	4	COAL - No. 1 Seam (1'4" recovered)	198	11
4	1	Sandstone	203	0
2	7	Shale	205	7
3	8	Sandstone	209	3
	9	Dwyka	210	0

TABLE II/.......

TABLE 2.

DESCRIPTION OF SAMPLES TAKEN.

F.R.I. SAMPLE NUMBER	BOREHOLE NUMBER.	WIDTH Ins.	DESCRIPTION OF SAMPLE.
Seam I.			
	A.		245' 6" ROOF: Gritty sandstone
L 153		23	Mixed coal.
		6	Shale - Not Sampled.
		16	Sandstone - Not Sampled.
		6	Shale with coal stringers - Not Sampled.
		13	Sandstone - Not Sampled.
			250'10" FLOOR: Dwyka.
	C.		197' 7" ROOF: Shale.
		6	Shale - Not Sampled.
L 157		10	Dull coal with a few bright stringers.
			198'11" FLOOR: Sandstone.
Seam No. 2.			
	A.		219' 6" ROOF: Grits.
L 152		23	Shale - Not Sampled.
J.		42½	Dull coal.
H.		90	Dull coal.
G.		61½	Dull coal.
F.		16½	Mainly bright coal.
E.		16½	Dull coal.
D.		25	Mainly dull coal (3" carbonaceous shale at top of sample excluded)
C.		6	Dull granular coal.
B.		25	Alternating dull and bright coal.
A.		7	Very bright-banded coal.
			244' 7" FLOOR: Gritty sandstone.
L 154	B.		208'10" ROOF: Shale.
		17	Dull shaly coal - Not Sampled.
G.		34	Dull coal, bottom 5" dull granular coal.
F.		16	Mixed mainly dull coal.
E.		31	Mixed coal.
D.		11	Very bright-banded coal.
C.		28	Dull shaly coal.
B.		27	Mixed coal.
A.		18	Very bright-banded coal, pyritic.
			224' 0" FLOOR: Sandstone.

L 158/......

Table No. 2 (continued)

F.R.I. SAMPLE NUMBER	BOREHOLE NUMBER	WIDTH Ins.	DESCRIPTION OF SAMPLES.
L 158	C.		159' 3" ROOF: Shale.
M.		26	Dull coal merging into shale.
		5	Gritty shale - Not Sampled.
L.		7	Bright-banded coal.
		12	Dirty coal - Not Sampled.
K.		30	Dull coal.
J.		58	Uniformly dull coal.
H.		21	Mainly dull coal.
G.		14	Dull coal with fine bright stringers.
		0½	Shale - Not Sampled.
F.		21	Mainly dull coal.
E.		42	Alternating dull and bright coal.
D.		7	Bright-banded pyritic coal.
C.		7	Gas-like coal (dull)
		0½	Shale - Not Sampled.
B.		8	Mainly dull coal.
A.		8	Mixed coal (broken core)
		2	Carbonaceous shale - Not Sampled.
		7	Shaly grit - Not Sampled.
			182' 3" FLOOR: Gritty sandstone.
Seam No. 3. L 159	C.	17	117' 4" ROOF: Sandstone. Bright coal, with ½" shale 2" from top and 1" shale 8" from bottom excluded. 118' 9" FLOOR: Shale.
Seam No. 4.			
L 151	A.		136' 2" ROOF: Sandy shale.
		10	Carbonaceous shale and bright coal bands - Not Sampled.
		7	Dull inferior coal - Not Sampled.
		1	Shale - Not Sampled.
F.		12	Very bright finely-banded coal.
		2	Grit - Not Sampled.
E.		16	Mixed coal.
		42½	Carbonaceous shale - Not Sampled.
D.		8	Very bright coal, 1" shale in middle excluded.
C.		36	Dull splinty coal with a few bright bands.
B.		40	Dull coal with an irregular fracture.
		3	Shale - Not Sampled.
A.		2½	Very bright coal.
			151' 2" FLOOR: Sandy shale.

L 155/......

Table No. 2 (continued)

F.R.I. SAMPLE NUMBER	BOREHOLE NUMBER	WIDTH Ins.	DESCRIPTION OF SAMPLES.
L 155	B.		129' 7" ROOF: Shale.
		2	Shale with bright stringers - Not Sampled.
L.		6	Bright, pyritic coal.
		6	Shaly coal - Not Sampled.
		4	Shale - Not Sampled.
K.		12	Mixed coal (dirty).
		5	Shale with coal stringers - Not Sampled.
J.		7	Dull coal with bright stringers.
H.		17	Mainly bright coal.
		9	Shaly sandstone - Not Sampled.
		1	Bright coal - Not Sampled.
		6	Dull shaly coal - Not Sampled.
G.		12	Bright coal.
		5	Carbonaceous shale - Not Sampled.
F.		7	Bright coal with mud intrusion excluded.
		1	Shale - Not Sampled.
		(5	Mainly dull coal.
E.		(1	Shale - Not Sampled.
		(22	Mainly dull coal.
D.		6	Bright coal.
		3	Carbonaceous shale - Not Sampled.
C.		22	Dull dirty coal.
B.		20	Alternating coal (bright at bottom)
A.		5	Bright coal.
			144'11" FLOOR: Shale with sandstone bands.
L 160	C.		93' 4" ROOF: Shale with sandstone bands.
		16	Shale - Not Sampled.
K.		3	Bright coal.
		12	Shale - Not Sampled.
J.		16	Dull shaly coal with bright bands.
H.		11	Mixed coal.
G.		11	Bright coal.
		11	Shaly sandstone - Not Sampled.
		1	Bright coal - Not Sampled.
		5	Dull granular coal, dirty.- Not Sampled.
F.		10	Mainly bright coal.
		4	Shale with bright coal stringers - Not Sampled.
E.		13	Mainly bright coal, bottom 3" dull coal.
		1	Shale - Not Sampled.
D.		24	Alternating bright and dull coal.
		4	Shale - Not Sampled.
C.		15	Mainly dull coal.
B.		21	Mainly bright coal.
A.		13	Bright-banded coal.
			109' 3" FLOOR: Shale.

L 150/.....

Table No. 2 (continued)

F.R.I. SAMPLE NUMBER	BOREHOLE NUMBER	WIDTH Ins.	DESCRIPTION OF SAMPLES.
L 150	A.		56' 4" ROOF: Sandstone with shale bands.
C.		30	Mixed coal.
B.		8	Dull coal.
A.		9	Bright, pyritic coal.
		1	Shale - Not Sampled.
			60' 4" FLOOR: Sandy shale.
L 156	B.		48' 0" ROOF: Sandy shale.
C.		10	Weathered coal and shale (broken core)
B.		12	Bright, finely-banded coal, weathered.
A.		16	Shale and coal mixed - very broken core.
			52' 0" FLOOR: Sandstone with shale bands.
			NOTE: (1) Coal probably weathered (2) 10 of core missing.

TABLE 3.

PROXIMATE ANALYSES OF SAMPLES.

SAMPLE NUMBER	B.H. No.	WIDTH Ins.	CAL.VAL. lbs/lb.	% H_2O.	% ASH.	% VOL. MATTER	% FIXED CARBON	% F. 1.45	% ASH F1.1.45	% F 1.6	% ASH F1.1.6	SW.NO F1.45	SW.NO. F1.6
Seam No. 1.													
L 153	A	23	11.9	2.4	16.4	28.2	53.0	56.3	7.5	85.4	11.1	1	1
L 157	C	10	12.0	2.3	15.0	28.3	54.4	57.7	8.3	92.2	12.5	1	1
Seam No. 2.													
L 152	J. A	42½	-	3.0	22.6	21.5	52.9	18.6	6.1	62.1	11.6	1	1 p
	H) G)	151½	11.9	3.0	15.2	21.8	60.0	44.2	6.6	82.8	10.7	1 p	-
	F.	16½	12.6	2.7	11.0	29.9	56.4	78.8	4.0	86.1	5.7	1	1 f
	E.	16½	-	2.7	27.1	17.4	52.8	15.2	6.0	46.3	13.6	1 p	-
	D.	22	-	2.8	22.3	20.2	54.7	35.2	5.1	56.7	9.6	1 f	-
	C.	6	-	2.6	20.3	23.6	53.5	23.5	7.5	67.5	13.4	1 f	-
	B.	25	12.2	2.8	13.1	26.2	57.9	61.6	5.9	86.7	9.1	1	1 f
	A.	7	12.4	2.6	12.6	27.6	57.2	69.4	5.8	86.7	7.4	1	1
L 154	G. B.	34	11.6	2.9	18.0	22.0	57.1	42.0	7.8	76.3	11.5	1 p	-
	F.	16	12.4	2.9	12.5	23.9	61.5	72.4	7.2	90.0	9.3	1 p	-
	E.	31	13.2	2.6	8.0	29.7	59.7	86.0	5.0	93.7	6.[illegible]	1	-
	D.	11	13.2	2.4	8.2	35.0	54.4	88.0	4.5	91.6	4.9	1½	1½
	C.	28	-	-	34.8	-	-	-	-	-	-	-	-
	B.	27	12.0	2.6	15.2	25.7	56.5	51.9	6.3	83.2	10.0	1 f	-
	A.	18	12.4	2.55	12.7	31.1	53.7	72.1	5.5	87.6	7.5	1 f	-

L 158/....

Table 3 (continued)

SAMPLE NUMBER	B.H. No.	WIDTH Ins.	CAL.VAL. lbs/lb.	% H_2O.	% ASH.	% VOL. MATTER	% FIXED CARBON	% F. 1.45	% ASH F1.1.45	% F 1.6	% ASH F1.1.6	SW. NO. F1.1.45	SW.NO F1.6
Seam No. 2.													
L 158	M. C	26	-	2.6	26.7	17.2	53.5	10.7	6.1	50.8	11.6	1 p	-
	L.	7	-	1.7	25.6	27.2	45.5	21.5	8.2	59.3	13.1	1 f	-
	K.	30	11.0	2.6	20.4	19.1	57.9	10.0	7.2	62.0	12.9	1 p	-
	J.	58	11.2	2.6	18.9	19.9	58.6	14.9	6.6	72.4	12.6	1 p	-
	H.	21	11.6	2.4	16.8	20.2	60.6	45.9	6.5	74.6	10.2	1 p	-
	G.	14	12.4	2.6	11.3	21.7	64.4	69.4	6.7	89.6	9.2	1 p	-
	F.	21	12.0	2.5	13.4	22.6	61.5	62.6	5.9	82.7	8.5	1 p	-
	E.	42	12.7	2.5	9.6	24.7	63.2	80.4	5.9	91.7	7.1	1 p	-
	D.	7	12.5	1.9	13.0	33.4	51.7	74.0	4.9	80.1	6.0	2	1½
	C.	7.	13.1	2.3	7.0	27.7	63.0	88.9	4.5	94.0	5.3	1 f	-
	B.	8	-	1.8	30.8	20.2	39.2	16.5	6.0	33.1	13.1	1 f	-
	A.	8	11.4	1.9	18.1	20.5	59.5	31.8	6.2	80.1	12.8	1 p	-
Seam No. 3.													
L 159	C.	15½	-	2.4	21.0	28.1	48.5	49.4	7.5	72.2	12.3	1	1
Seam No. 4.													
L 151	F. A.	12	11.8	2.5	14.6	34.7	48.2	79.0	8.2	89.8	10.8	1 p	-
	E.	16	11.0	2.7	20.6	25.4	51.3	40.6	7.7	75.3	14.1	1	1 f
	D.	8	-	2.7	21.2	27.3	48.8	46.3	6.2	71.5	9.3	1	1 f
	C.	36	10.9	3.0	20.0	23.3	53.7	31.6	7.7	74.4	13.4	1 f	-
	B.	40	11.3	3.1	17.0	22.1	57.8	46.8	6.6	77.6	10.3	1 f	-
	A.	22½	12.8	3.2	8.0	26.5	62.3	85.4	5.3	91.7	5.7	1 f	-
L 155	L. B.	6	-	2.0	24.3	30.6	43.1	44.0	7.3	60.1	9.2	2	2
	K.	12	-	2.3	26.6	24.7	46.4	20.9	9.2	55.0	15.1	1	1 f
	J.	7	-	2.3	26.2	21.4	50.1	15.0	9.0	57.7	18.8	1 p	-
	H.	17	11.2	2.3	19.2	27.8	50.7	47.6	8.0	77.3	12.4	1	1 f
	G.	12	12.2	2.3	12.7	28.2	56.8	70.4	7.3	88.2	8.9	1 f	-
	F.	7	11.7	2.2	16.2	30.7	50.9	47.2	7.7	80.2	9.9	1	1
	E.	27	10.7	2.7	20.7	22.4	54.2	13.7	8.3	72.0	13.8	1 f	-
	D.	6	12.3	2.6	11.7	30.7	55.0	69.3	4.8	83.9	6.1	1	1
	C.	22	11.2	2.7	19.1	21.4	56.8	35.3	7.1	70.7	12.1	1 p	-
	B.	20	11.7	2.7	15.1	25.5	56.7	60.1	6.5	82.6	9.2	1 f	-
	A.	5	13.0	2.6	7.4	31.3	58.7	89.0	6.3	96.2	15.3	1	1

L 160/.....

Table 3 (continued)

SAMPLE NUMBER	B.H. No.	WIDTH Ins.	CAL.VAL. lbs/lb.	% H_2O.	% ASH.	% VOL. MATTER	% FIXED CARBON	% F. 1.45	% ASH F1.1.45	% F 1.6	% ASH F1.1.6	SW. NO. F1.1.45	SW.NO. F1.6
Seam No. 4.													
L 160	K. C.	3	11.2	2.2	19.9	31.2	46.7	50.0	8.0	72.1	10.7	1½	1
	J.	16	-	2.3	34.4	20.7	42.6	-	-	-	-	-	-
	H.	11	10.8	2.4	22.0	24.0	51.6	20.0	8.5	64.9	13.8	1 f	-
	G.	11	11.5	2.4	18.3	31.5	47.8	61.6	8.3	82.5	11.9	1 f	-
	F.	10	11.8	2.6	12.4	28.4	53.6	66.9	6.4	79.7	8.8	1 f	-
	E.	13	11.5	2.6	17.3	28.0	52.1	50.9	6.7	74.7	11.0	1 f	-
	D.	24	11.3	2.6	18.0	24.2	55.2	43.9	6.5	73.6	10.7	1 f	-
	C.	15	10.8	2.8	20.6	19.8	56.8	18.6	6.4	65.2	11.6	1 p	-
	B.	21	12.1	2.8	13.0	23.7	60.5	62.2	6.6	88.9	9.5	1 f	-
	A.	13	12.9	2.8	7.6	28.5	61.1	83.7	5.2	92.8	6.6	1 f	-
Seam No. 5.													
L 150	C. A.	30	11.9	3.6	15.2	26.6	54.6	60.5	5.3	82.8	10.4	1	1 p
	B.	8	11.6	3.4	16.8	25.6	54.2	54.3	8.2	82.3	12.6	1 f	-
	A.	9	12.3	3.8	10.5	32.1	53.6	85.6	6.0	89.9	7.6	1 f	-
L 156	C. B.	10	11.0	3.7	19.5	22.3	54.5	26.7	7.6	81.1	14.9	1 f	-
	B.	12	12.6	2.6	10.7	29.5	57.2	74.0	6.5	92.5	9.3	1 f	-
	A.	16	-	3.2	22.1	25.3	49.4	41.6	7.1	84.9	18.0	1 f	-

TABLE 4.

AVERAGE PROXIMATE ANALYSIS OF SEAM SECTIONS.

SAMPLE NUMBER SECTIONS INCLUDED	B.H. No.	TOTAL WIDTH SECTION Ins.	TOTAL WIDTH EXCLUSIONS Ins.	CAL.VAL. lbs/lb.	% H_2O.	% ASH.	% V.M.	% F.C.	% Fl 1.45	% ASH Fl.1.45	% F 1.6	% ASH Fl.1.6
Seam No. 2.	A.											
L 152 A + B.		32	0	12.2	2.8	13.0	26.5	57.7	63.3	5.9	86.7	8.7
F,G,H	...	168	0	12.0	3.0	14.8	22.6	59.6	47.6	6.2	83.1	10.2
	B.											
L 154 A + B		45	0	12.2	2.6	14.2	27.9	55.4	60.0	5.9	85.0	9.0
D,E,F,G.		92	0	12.5	2.7	12.5	26.5	58.4	67.6	6.0	86.4	8.3
	C.											
L 158 C - G		91	½	12.5	2.5	10.8	24.7	62.0	74.8	5.8	88.6	7.5
C - J		170	½	11.9	2.5	14.3	22.3	60.8	50.8	6.0	81.3	9.4
Seam No. 4.												
L 151 B + C	A.	76	0	11.1	3.1	18.4	22.7	55.9	39.6	7.0	76.1	11.7
L 151 A - G	B.	99	10	11.5	2.6	16.7	25.3	55.6	45.2	6.7	78.3	11.1
	C.											
L 160 A + B		34	0	12.4	2.8	10.9	25.5	60.7	70.4	6.0	90.4	8.4
A - F		96	9	11.7	2.7	15.5	24.9	56.8	52.7	6.3	79.7	9.7
Seam No. 5.												
L 150 A, B, C	A.	47	0	11.9	3.6	14.6	27.5	54.3	64.3	5.9	84.1	10.2
L 156 A, B, C	B.	38	0	-	3.1	17.8	25.8	53.2	47.9	6.7	86.3	14.3

TABLE 5.

COMPOSITION AND DESCRIPTION OF COMPOSITE SAMPLES.

SAMPLE NUMBER	COMPOSITION	TYPE OF COAL AND AREA REPRESENTED.
Seam No. 1.		
M 182	L 153 - 23 parts L 157 - 10 "	Composite seam sample. Boreholes A and B.
Seam No. 2.		
M 184	L 152 A - 7 parts L 154 A - 18 " L 158 C - 7 " L 158 D - 7 "	Bright-banded coal at bottom of seam. Boreholes A, B and C.
M 185	L 152 B - 25 parts L 154 B - 27 " L 158 E - 42 "	Mixed coal above bottom bright. Boreholes A, B and C.
M 186	L 152 F - 16½ parts L 154 D - 11 " E - 31 " L 158 F - 21 "	Mixed mainly bright coal above M 185. Boreholes A, B and C.
M 187	L 152 G) H) - 51½ parts J - 42½ " L 154 F - 16 " G - 34 " L 158 G - 14 " H - 21 " J - 58 " K - 30 "	Dull coal towards top of seam and above M 186. Boreholes A, B and C.
Seam No. 4.		
M 183	L 151 A - 2½ parts B - 40 " C - 36 " D - 8 " L 155 A - 5 " B - 20 " C - 22 " D - 6 " E - 27 " F - 7 " G - 12 " L 160 A - 13 " B - 21 " C - 15 " D - 24 " E - 13 " F - 10 "	Composite bottom portion of seam below shaly sandstone parting. Boreholes A, B and C.

Table 6.....

TABLE 6.

PROXIMATE ANALYSES OF COMPOSITE SAMPLES.

SAMPLE NUMBER	WHOLE COAL			FLOAT AT S.G. 1.6			
	H_2O. %	ASH. %	V.M. %	WEIGHT %	H_2O. %	ASH. %	V.M. %
Seam No. 1.							
M 182	2.6	15.9	28.8	86.5	2.7	11.4	29.6
Seam No. 2.							
M 184	2.8	11.8	30.7	86.4	2.6	6.6	32.1
M 185	3.0	12.5	26.2	87.6	2.7	8.3	26.8
M 186	2.1	10.5	29.8	88.6	2.8	6.3	30.1
M 187	3.3	17.1	21.5	76.0	3.4	10.8	22.1
Seam No. 4.							
M 183	3.3	16.7	25.1	78.0	3.3	10.9	25.9

TABLE 7.

ULTIMATE ANALYSIS.

On a Dry-Ash-Free basis - Floats at S.G. 1.6

SAMPLE NUMBER	% CARBON	% HYDROGEN	% NITROGEN	% SULPHUR	% OXYGEN + ERRORS
No. 1 Seam.					
M 182	82.2	5.1	1.8	0.6	10.3
No. 2 Seam.					
M 184	81.8	5.1	1.9	0.8	10.4
M 185	82.7	4.7	2.0	0.5	10.1
M 186	82.2	5.1	2.1	0.6	10.0
M 187	83.2	4.4	2.0	0.4	10.0
No. 4 Seam.					
M 183	82.5	4.7	2.1	0.7	10.0

Table 8/......

TABLE 8.

SULPHUR DISTRIBUTION.

SAMPLE NUMBER	ON WHOLE COAL			ON FLOATS AT S.G.1.6
	% MINERAL SULPHUR	% ORGANIC SULPHUR	% TOTAL SULPHUR	% TOTAL SULPHUR
Seam No. 1.				
M 182	0.37	0.41	0.78	0.47
Seam No. 2.				
M 184	3.18	0.47	3.65	0.74
M 185	0.74	0.39	1.13	0.46
M 186	0.97	0.40	1.37	0.55
M 187	0.52	0.27	0.79	0.33
Seam No. 4.				
M 183	0.77	0.42	1.19	0.65

TABLE 9.

CARBONIZATION ASSAYS.

Low Temperature - 600°C on Float S.G. 1.6

SAMPLE NUMBER	% COKE	% TAR	% LIQUOR	GAS %	GAS DENSITY Air = 1	% V.M. in COKE	NATURE OF COKE
Seam No. 1.							
M 182	74.1	10.0	8.3	8.3	0.65	4.6	Pulverulent
Seam No. 2.							
M 184	71.8	11.0	8.0	9.7	0.65	6.0	Pulverulent
M 185	76.0	8.8	8.0	7.9	0.63	5.5	Pulverulent
M 186	73.6	10.2	8.4	8.5	0.65	4.0	Pulverulent
M 187	79.9	5.2	8.3	5.6	0.64	6.2	Pulverulent
Seam No. 4.							
M 183	76.8	5.7	9.5	8.3	0.71	3.7	Pulverulent

Table 10/......

TABLE 10.

FLOAT AND SINK ANALYSIS.

SAMPLE NUMBER	FLOAT 1.3	FLOAT 1.30-1.35	FLOAT 1.35-1.40	FLOAT 1.40-1.45	FLOAT 1.45-1.50	FLOAT 1.50-1.55	FLOAT 1.55-1.60
Seam No. 1.							
M 182							
Weight %	5.2	11.1	24.9	16.0	16.1	9.9	3.3
Ash %	-	-	7.4	10.9	16.8	21.2	
Cumulative Wt. %	5.2	16.3	41.2	57.2	73.3	83.2	86.5
Cumulative Ash %	-	4.7	6.3	7.6	9.6	11.0	11.4
Cumulative Sw. No	-	1	1 f	-	-	-	-
Seam No. 2.							
M 184							
Weight %	1.1	36.8	30.0	14.9	7.6	2.2	0.8
Ash %	-	-	4.4	7.6	16.9	26.7	
Cumulative Wt. %	1.1	37.9	60.9	75.8	83.4	85.6	86.4
Cumulative Ash %	-	3.1	4.1	4.8	5.9	6.2	6.6
Cumulative Sw.No.	-	1	1	1 f	-	-	-
M 185							
Weight %	2.6	17.4	23.6	23.5	12.4	6.6	1.5
Ash %	-	-	5.6	8.4	11.6	25.2	
Cumulative Wt. %	2.6	20.0	43.6	67.1	79.5	86.1	87.6
Cumulative Ash %	-	3.0	4.4	5.8	6.7	7.7	8.4
Cumulative Sw.No.	-	1 f	-	-	-	-	-
M 186							
Weight %	10.3	23.3	32.6	17.6	7.5	3.0	0.3
Ash %	-	-	4.3	7.4	13.8	24.2	
Cumulative Wt. %	10.3	33.6	60.2	77.8	85.3	88.3	88.6
Cumulative Ash %	-	2.8	3.9	4.7	5.5	5.8	6.2
Cumulative Sw.No.	1	1	1 f	-	-	-	-

Table 10 (continued)

SAMPLE NUMBER	FLOAT 1.3	FLOAT 1.30-1.35	FLOAT 1.35-1.40	FLOAT 1.40-1.45	FLOAT 1.45-1.50	FLOAT 1.50-1.55	FLOAT 1.55-1.60
M 187							
Weight %	0.6	3.1	8.9	20.1	21.5	13.0	8.8
Ash %	-	-	-	7.7	11.1	14.7	20.9
Cumulative Wt. %	0.6	3.7	12.6	32.7	54.2	67.2	76.0
Cumulative Ash %	-	-	5.3	6.8	8.5	9.7	11.0
Cumulative Sw.No.	-	1f	-	-	-	-	-
M 183							
Weight %	0.5	12.2	18.1	15.0	14.0	10.8	7.4
Ash %	-	-	5.7	9.2	14.3	17.1	29.1
Cumulative Wt. %	0.5	12.7	30.8	45.8	59.8	70.6	78.0
Cumulative Ash %	-	3.7	4.9	6.3	7.5	9.0	10.9
Cumulative Sw.No.	-	1 f	-	-	-	-	-

TABLE 11.

ASH FUSION TEMPERATURES.

SAMPLE NUMBER	ASH FUSION TEMPERATURE °C.	
	WHOLE COAL	FLOAT AT S.G. 1.6
Seam No. 1.		
M 182	+ 1400	+ 1400
Seam No. 2.		
M 184	1300	+ 1400
M 185	1400	+ 1400
M 186	1400	+ 1400
M 187	+ 1400	+ 1400
Seam No. 4.		
M 183	1400	1400

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

APPENDIX.

ANALYTICAL METHODS AND THEIR SIGNIFICANCE.

1. SAMPLING:

Sampling is carried out according to South African Standard Specification, S.A. No. 13 of 1937, "Standard Methods for the Sampling of Coal in South Africa".

11. PREPARATION OF SAMPLES:

The samples are prepared in the manner specified in "Sampling of Coal in South Africa", S.A. No. 13 of 1937, issued by the South African Standards Institution. The laboratory samples are ground to pass a 60 mesh sieve (square aperture : 0.3 mm) except in the case of specific gravity analysis (float and sink tests) and hydrogenation tests, for which minus 20 mesh (square aperture : 1 mm) material is used.

111. PROXIMATE ANALYSES:

(1) Moisture Content: This is the loss of weight obtained by heating 1 gram of coal at 101 - 105°C for one hour.

(2) Ash Content: This is the residual ash obtained by combusting 1 gram of coal in a muffle furnace. The coal is slowly heated to 800°C and kept at this temperature for one hour.

(3) Volatile Matter Content: This is the loss of weight obtained by heating 1 gram of coal at 920°C for 7 minutes minus the weight of water present in the coal.

(4) Fixed Carbon percentage: This is obtained by subtracting the sum of moisture, ash and volatile matter contents, expressed as percentages, from 100.

1V. CALORIFIC VALUE:

This value, reported in Evaporative Units (lbs/lb), is calculated from the rise in temperature obtained by combusting 1 gram of coal in oxygen at 30 atmospheres pressure in a Berthelot-Mahler-Kroeker bomb calorimeter.

The determination is carried out according to South African Standard Specification, S.A. No. 5 of 1940, "The Determination of the Comparative Calorific Values of Coals in South Africa".

V. PRELIMINARY FLOAT AND SINK ANALYSES:

Twenty gram portions of the coal are separated into different specific gravity fractions in a centrifuge using petrol and carbon tetrachloride mixtures of varying specific gravity. The apparatus and method used is described in the Journal of the Chemical, Metallurgical and Mining Society of South Africa, Vol. 34, No. 8 : "A Specific Gravity Investigation of Coal Samples" by P.E. Hall.

(a) The percentage float at a S.G. of 1.45 is the percentage by weight of the coal which has a S.G. less than 1.45. This float contains the majority of the swelling constituents of the coal when these are present in a sample.

(b)/.......

(b) The percentage of float at a S.G. of 1.6 is the percentage by weight of the coal which has a S.G. less than 1.6. It represents approximately the amount of coal substance present and also gives a rough figure for the performance of an ordinary washer on the coal. This figure subtracted from 100 gives the amount of adventitious mineral matter in a coal sample.

(c) The percentage ash on the float at 1.45 gives some indication of the minimum ash content likely to be obtained by washing at this specific gravity.

(d) The percentage ash on the float at 1.6 represents the amount of mineral matter intimately associated with the coal substance and as such furnishes an approximate figure for the minimum ash content for a normal washed product from the particular sample.

(e) The Swelling Number is the ratio of the final to the initial volume of 1 gram of coal heated strongly under standard conditions and is a measure of the swelling propensities of the coal.

This test is carried out according to B.S.S. Specification, No. 804 of 1938. "The Crucible Swelling Test for Coal".

1 Denotes a residue of definite coke structure but no swelling. 1 f denotes a residue easily friable and possessed of no coke structure. 1 p denotes a residue in powder form. A value of 3 or more indicates definite coking possibilities.

(f) If the float 1.45 material exhibits swelling propensities, further swelling number determinations are carried out on the S.G. 1.6 fraction. These figures give an indication of the swelling propensity with this S.G. cut.

VI. DETAILED FLOAT AND SINK ANALYSIS:

Float and sink analyses together with their attendant ash and swelling number determinations, are made on composite coal samples.

This work is usually carried out from three different aspects viz:-

(i) the characterisation of types of coal and the subsequent use of this data in correlation.

(ii) the investigation, in a more detailed manner, of the possibilities and results of washing.

(iii) the investigation of the effects of washing on the swelling properties of the coal.

Where the two latter aspects - which are, of course, closely related - command the most attention, floats corresponding to possible washery products are preferred, since from them the yields and charateristics of the cleaned products can be readily obtained. This involves making cuts at various specific gravities and analysing the resulting floats. Such a method is known as "cumulative" float and sink analysis.

On the other/.......

On the other hand, where the characterisation and correlation of coal seams are involved, the separation into a series of fractions of narrow specific gravity range is adopted. In this way, any change in the nature or behaviour of the coal fractions with change in specific gravity is more easily appreciated and more strongly emphasised than would be the case in the cumulative method. This type is known as "fractional" float and sink analysis.

For those properties which are additive e.g. ash content, the cumulative figures can be built up from the fractional and vice versa. This cannot be done in the case of non-additive properties. Nevertheless, swelling numbers - strictly speaking a non-additive property - can be calculated with fair accuracy from fractional to cumulative figures if the number for any fraction is not greater than 8 or less than 1½.

Where desirable, complete float and sink analyses of both types are determined.

When using float and sink analysis figures as guides to possible commercial results, it must always be remembered that the laboratory separations are made on fine coal and depend entirely on specific gravity differences. The products are, therefore, cleaner and more uniform than could ever be obtained from a commercial washer whether operating on run-of-mine or sized coal. The analytical figures represent optimum conditions and due allowance must be made for this when interpreting them into commercial practice.

Experience of many laboratory float and sink analyses carried out on coal actually being commercially washed has suggested a rough interpretation which can be given to the figures. In general, if the coal is not poor in quality the large scale percentage of float will not be less than the figure obtained in the laboratory on fine coal.

The percentage ash on the float obtained from a commercial washer is, however, usually from 2 - 4% higher than the value obtained from a laboratory separation. Furthermore, it has been found that the smaller the size of the coal being washed on a large scale, the more closely does the percentage yield and the percentage of ash in the product approach the fine coal float and sink analysis. That is to say, for example, that the allowance made in estimating the washability of pea coal need not be so great as that for, say round coal.

If the coal is poor (more than 18 - 20% ash) it is advisable to make a liberal allowance, since with this material only washers of the best type operated under strict control function at all satisfactorily.

VII. ULTIMATE ANALYSIS:

The ultimate analysis is generally carried out on the float at a S.G. of 1.6. This procedure is adopted in order to eliminate as far as possible the effects due to the presence of adventitious mineral matter.

Carbon, hydrogen, nitrogen and sulphur contents are all determined by standard methods for coal analysis:- viz:

(a) Carbon/.......

(a) Carbon and Hydrogen: The method used is described in B.S.S. No. 1016 of 1942, "Analysis and Testing of Coal and Coke", page 31.

(b) Nitrogen: The method followed is that described by Beet (Fuel in Science and Practice, volume X1 of 1932, page 196; volume X111 of 1934, page 343) and Hall (Journ. Chem. Met. and Min. Soc. of South Africa, volume XXXV1 of 1935, No. 2, page 28).

(c) Total Sulphur: This is determined by the Eschka method, described in B.S.S. No. 1016 of 1942, "Analysis and Testing of Coal and Coke", page 43.

The oxygen content is obtained by subtracting the sum of the carbon, hydrogen, nitrogen and sulphur percentages from 100. The value obtained therefore includes all analytical errors.

The results are expressed on a dry-ash-free basis, so as to present the composition of the organic substance itself, unmixed with mineral matter.

V111. SULPHUR DISTRIBUTION:

The figures showing the distribution of sulphur in a sample are on an "as received" basis i.e. including adventitious mineral matter.

The total sulphur content on the whole coal is determined by the Eschka method and the mineral sulphur content by extraction with dilute nitric acid, according to the method described in B.S.S. No. 1016 of 1942, page 45.

1X. CARBONIZATION ASSAYS:

There are two forms of carbonization assays, viz: the low temperature (600°C) and the high temperature (900°C) and both are carried out in the Gray-King Apparatus.

Low Temperature Gray-King Assay:

This is carried out at a temperature of 600°C on the floats at a S.G. of 1.6 and is used, primarily for correlative purposes either as a means of characterising a new coal or for establishing the variation in a given type of coal. The results can also be used, however, for determining the type and quantity of the products which the coal under test would furnish in a large scale low temperature carbonization retort. The apparatus and method used is that described in the "Methods of Analysis of Coal" issued by the Fuel Research Station, Greenwich (Physical and Chemical Survey of the National Coal Resources, No. 7.)

No direct relationship between the retort and assay yields obtained from South African coals has been deduced but the following interpretation has been found to be applicable overseas. Depending on the type of plant, the large scale tar yield varies from 70 - 80% of that given by the assay. The gas yield is also slightly higher than can be obtained in practice. The yield of coke will be very close to that given by the assay. "Standard" to "very swollen" coke residues indicate coals which will probably produce satisfactory smokeless fuels, while those which are appreciably more

friable/.......

friable than "standard" indicate coals which will not yield suitable large scale coke products.

The assay is carried out on the float at 1.6 S.G. for the same reasons as are outlined in Section 7 (ultimate analysis) and also since that fraction would most nearly represent the ordinary washed product from the seam or section of the seam under consideration.

<u>High Temperature Gray-King Assay:</u>

This test is only made on such seams or sections of seams as appear to be possible sources of coking or gas coals. Usually the float at a S.G. of 1.45 is used as representing the optimum quality of coal which could be commercially produced by the best possible washing.

A temperature of 900°C is employed and a cracking unit kept at a constant temperature of 800°C is installed. The method and apparatus used is that described in "The Assay of Coal for Carbonization Purposes (Part III)" issued by the Fuel Research Station, Greenwich, (Technical Paper No. 24). The calorific value of the gas is determined by combustion of a measured volume in excess air in a Löffler Gas Calorimeter.

The High Temperature Grey-King Carbonization Assay has been designed specifically to simulate large scale gas making conditions both in horizontal and continuous vertical retorts. Here again no direct relationship between the retort and assay yields with South African coals has been deduced and it is necessary to rely entirely on overseas results. The assay conditions are such that the factors of comparison with horizontal retort practice approach unity. It is considered that the factors for coke oven practice should not diverge unduly from unity in spite of a number of variables such as type of plant, type of coal and size of coal. The factors retort/assay for gas yield, gas calorific value and coke yield are very close to unity. The assay yield of tar is low and the factor varies from 1.2 to 1.5 as the coal varies from strongly to weakly-swelling. The coke residues "friable" and "pulverulent" obtained from the assays indicate coals unsuitable for large scale coke production. Coke residues from "standard" to "very swollen" indicate that the coals will probably yield cokes under large scale conditions.

The best gas coals so far tested in South Africa give about 18 - 20% gas, and they yield 65 - 70 therms of gas per long ton of coal. The highest calorific values of the gas so far found vary from 5400 to 5700 Calories per cubic metre at N.T.P.

X. <u>ASH FUSION TEMPERATURES:</u>

A knowledge of the composition and behaviour of the ash from any coal is of importance from both a fundamental and technical aspect. The use of coal in many industrial appliances e.g. producers and forced draught boilers is seriously limited by the behaviour of the ash.

The mineral matter from which the ash is derived occurs in two forms:-

(a) <u>Inherent mineral matter</u> which occurs as an integral part of the coal and is not separable therefrom by ordinary means e.g. picking or washing.

(b) Adventitious/.......

(b) Adventitious mineral matter which may be again subdivided into:-

(i) more or less isolated pockets and more continuous bands included in the coal seams.

(ii) mineral matter derived from accompanying strata.

Run-of-mine coal would contain all the forms of mineral matter described above; effective picking should remove the greater portion of (b) (ii) and washed coals would contain (a), and (b) (i) to a limited extent only. In order to determine the ash fusion temperatures of ordinary picked but unwashed coal, these tests are carried out on the whole coal samples, including adventitious mineral matter. If a figure for washed coal is required, the determination is made on the floats at 1.6 S.G.

A direct correlation between the laboratory determinations of the ash fusion temperature and behaviour of the ash in practice has not so far been possible. Although the determinations are carried out under conditions designed to resemble as closely as possible those actually obtaining in a furnace, the differences between small and large scale conditions are appreciable. The results indicate, however, the probable behaviour of the ash in practice and the following scheme may be used for interpreting the laboratory determination of the ash fusion temperature.

(a) less than 1250°C - likely to cause clinkering trouble under all furnace conditions.

(b) 1250°C to 1400°C - unlikely to produce clinker under general conditions, although trouble may be experienced with industrial appliances like producers and forced draught boilers.

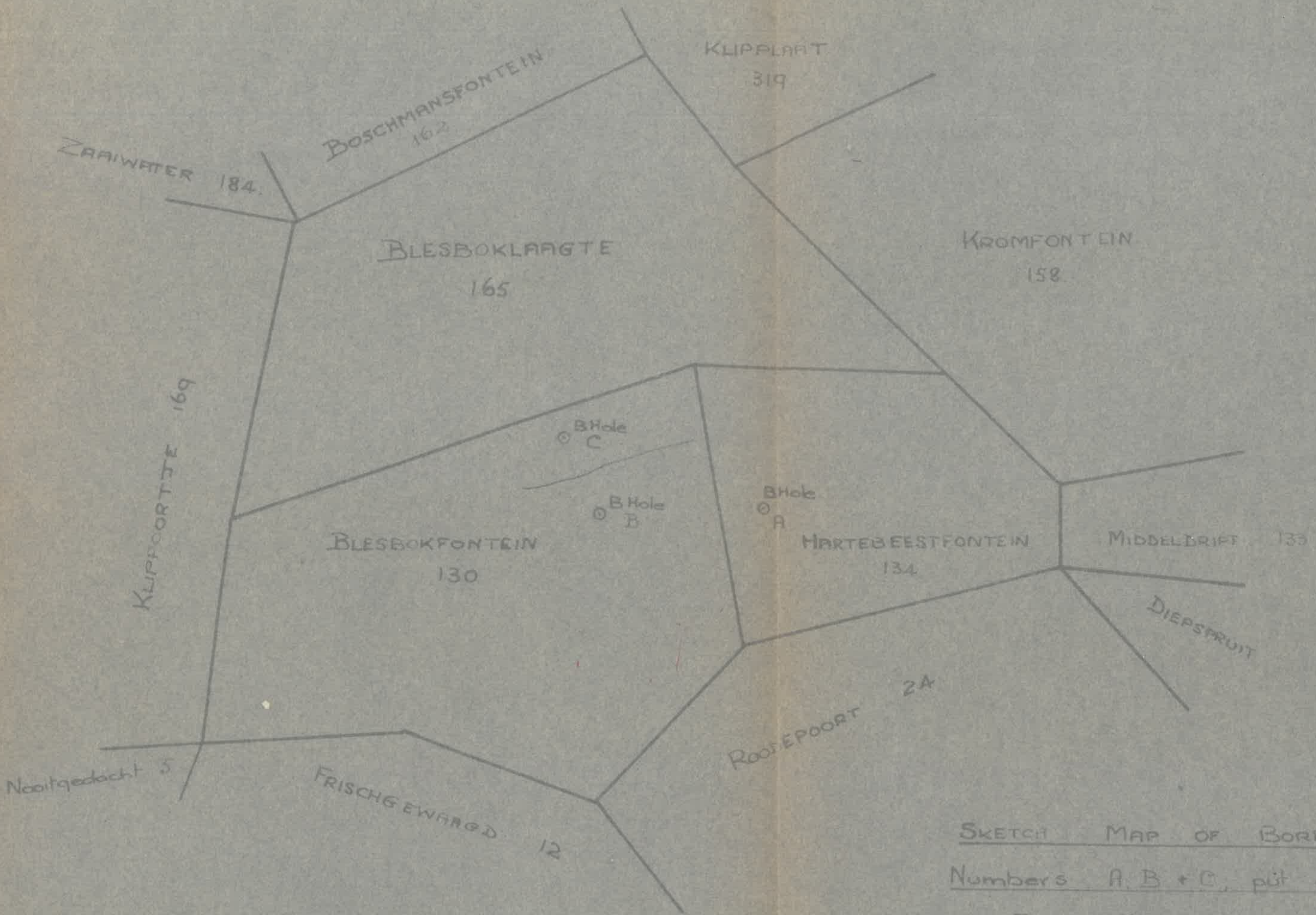
(c) greater than 1400°C - highly refractory ash which will probably not clinker under any conditions.

XI. HYDROGENATION:

The work done in this sphere constitutes a comparative hydrogenation survey. Consequently, a discontinuous rotary converter, though it affords no quantitative data as to the behaviour of the coal in a large scale continuous plant, can nevertheless be used. Under rigidly standard conditions, results obtained with this apparatus are qualitatively comparable.

The coals are heated in the form of a paste containing 57% of coal, 38% of oil and 5% of molybdenum sulphide as catalyst. After filling the converter with 440 grams of the paste and hydrogen to a pressure of 100 atmospheres, the converter is heated to 450°C and kept at this temperature for one hour.

The evaluation of the results is based on the percentage of residual organic benzene-insoluble material reckoned on a dry-ash-free basis. Where this figure is low, the coal may be expected to give better large scale results than where it is high. The best coals so far tested in South Africa have yielded 8 - 11% of this insoluble residue. The average is about 31% and the maximum 60%.



Sketch Map of Borehole Numbers A, B + C, put down on Farms Hartebeestfontein 134 and Blesbokfontein 130, in the Middelburg District of Transvaal.

Scale 1 : 60,000