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1952/76

OPEN CUT COAL INVESTIGATIONS
CESSNOCK MUSWELLBROOK REGION

PARNELL'S CREEK AREA
COMPLETION REPORT

Part I

Records 76/1952.

NORTHERN PROSPECT.

March 27th., 1953.

OPEN CUT COAL INVESTIGATIONS
CESSNOCK MUSWELLBROOK REGION.

PARNELL'S CREEK AREA
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SECTION 1

SUMMARY.

THE AREA HEREIN REPORTED ON IS OF 1.29 SQ. MILES, IN THE PARISH OF HOWICK, COUNTY OF DURHAM, N.S.W. BORING BEGAN IN MARCH AND FINISHED IN SEPTEMBER, 1952. TWENTYTWO BOREHOLES WERE SUNK ALL OF WHICH, TOTALLING 2,746 FT., WERE CORED THROUGHOUT.

A total of 10,182,000 long tons of band-free unweathered coal was defined in a total seam thickness of 32 ft. 6 ins. over a total seam area of 1,175 acres. Its estimated overall quality is :

H.M.	V.	F.C.	ASH	B.Th.U's.
2.8	34.4	48.5	14.2	12,040

This coal lies in five seams named Barrett's, Liddell Lower and Upper Splits, and Artie's Lower and Upper Splits, the band-free thicknesses of which are :

7'11"   4'6"   7'6"   7'1"   5'6"

respectively. Their respective total areas are :

460, 260, 190, 155, & 110 acres

and their estimated mean qualities are :

	H.M.	V.	F.C.	ASH	B.Th.U's.
B.	3.7	35.3	50.3	10.8	12,710
L.L.	2.7	33.7	48.6	14.9	11,850
L.U.	2.4	36.5	49.2	11.9	12,370
A.L.	2.7	30.4	43.8	23.0	10,630
A.U.	2.6	36.2	50.7	10.5	12,620

Their total band-free unweathered coal reserves are :

Barrett's	4,814,000	long tons
Liddell Lower	1,482,000	" "
Liddell Upper	1,745,000	" "
Artie's Lower	1,406,000	" "
Artie's Upper	735,000	" "

None of the seams fulfilled all the requirements of an open cut mining prospect of first class gas coal. Within the physical limits of open cut mining, at maximum overburden to coal ratio of 9:1, the seams would yield an estimated band-free unweathered tonnage of :

Barrett's	2,004,000	long tons
Liddell Lower	37,000	" "
Liddell Upper	265,000	" "
Artie's Lower	501,000	" "
Artie's Upper	356,000	" "

totalling 3,163,000 long tons at 9:1 ratio or less.

Barrett's Seam as a whole falls somewhat short of the requirements of quality sought. It has nevertheless a proportion of superior coal lying in one of four groups of plies. These plies are designated :

LM, JK, FGH, & ABCDE.

and their estimated mean qualities are :

	H.M.	V.	F.C.	ASH	B.Th.U's.	Approx. Thickness.
LM	3.35	37.72	50.14	8.8	13,090	2' 7"
JK	3.74	33.66	51.13	11.44	12,435	1' 4"
FGH	3.7	35.62	51.62	9.33	13,095	2' 5"
ABCDE	4.16	32.15	47.9	15.81	11,765	1' 7"
Rock Bands						1' 1"
						9' 0"

Within the physical limits of open cut mining Barrett's Seam contains the following reserves of band-free unweathered coal :

Overburden to coal Ratio	Long Tons
3:1	60,000
5:1	660,000
7:1	1,448,000
9:1	2,004,000

Overburden consists of about 70% arenaceous rock of which 47% is a type of greywacke. The remaining 30% consists of various argillaceous rocks. All the beds are lenticular.

The regional dip is 4° at 124° T. A uniform strike of 030° T was recorded. The coal seams are apparently undisturbed by igneous activity, faulting, minor folding or washouts and the like.

SECTION 2

INTRODUCTION.

As a working convenience the territory under the surveillance of the Joint Coal Board's District Mining Engineer at Cessnock was named the Cessnock Muswellbrook Region. It was so separated from the equivalent Newcastle Region.

Work for the Cessnock Muswellbrook Region was planned in 1951. Some surveying was then carried out in the Pyke's Gully Area, since taken over by the Joint Coal Board. At the beginning of 1952 boresites were pegged near Jerry's Plains but plants were not available until March. By then the District Engineer of the Joint Coal Board office at Cessnock thought that work should begin next to the Pyke's Gully Area. An area was selected, therefore, to the south and west of it, contained on the Military Map by the co-ordinates 91N/95E; 91N/97E; 82N/97E; 82N/94E; 89N/94E; 89N/95E occupying 8.0 sq. miles, and named Parnell's Creek Area. Parnell's Creek is a name occurring on Parish Maps for what appears on the Military Map as the upper reaches of Pond's Creek which enters the Hunter River north of Jerry's Plains. Parnell's Creek Area was then arbitrarily divided into three working sub-Areas namely Northern (originally designated North Western), Central and Southern Prospects of 1.29, 2.82, and 3.89 sq. miles respectively.

Officers of the State Geological Survey were consulted during the work. They communicated the results of their current structure survey in discussion and through their records. Officers of the Joint Coal Board at their Sydney headquarters and Cessnock District Office fully co-operated. The procedure of the Bureau and all results were continuously open to inspection by and discussion with members of the State Survey and the Joint Coal Board. Conferences took place between officers of the Bureau and the Joint Coal Board in Sydney and Cessnock because coal user-requirements of quantity and quality were changing as work proceeded and the type, intensity and disposition of boring needed to be modified accordingly.

When boring began in March 1952, nothing was accurately known of the subsurface geology in Parnell's Creek Area. The plan of boring was to locate boreholes, known as Scout Bores, at spacings of about 1,000 yds. with a lower limit of depth alternately in provable Upper Marine Beds and at the base of the lowest coal seam (Barrett's) of the Upper Coal Measures (See Section 6). When enough Scout Bores were drilled to predict the line of outcrop of a seam considered to be an open cut mining prospect a series of bores, known as Test and Define

Bores, were planned along the strike and located on a rectangular grid (See Section 3) of 900 ft. by 600 ft. intersections. Scout Bores were designated by the suffix S after the Serial Number (in order of drilling) and Test and Define Bores by T. A fully named borehole was to carry the distinguishing prefix BMR before the Serial Number. Test and Define Bores were planned to be no deeper than the practical limits of open cut mining. All bores were to be cored throughout. The plan presupposed the ability of the Bureau to survey ahead of Test and Define drilling and to obtain estimates of the quality of coal from Scout Bores before beginning Test and Define boring. The plan was mostly carried out: the spacing of Scout Bores had to be closer than planned.

Scout drilling in the Northern Prospect of Parnell's Creek Area had been preceeded, at the end of 1951 and early 1952, by a borehole known as the Bayswater No. 1 Bore located about 3¾ miles E of the NE corner, penetrating 1,500 ft. from a horizon high in the Tomago formation to beds in the Upper Marine Series (See Section 6) proved by the presence of a marine fauna. The experience gained from examining the lithology of the strata penetrated was useful to the work reported herein. Many thin rock sections were made from the cores recovered from this borehole; as a result some precision has been achieved in the description of overburden and the groundwork laid for a study of the sedimentation; the members of the Geological Department of the University of Sydney were invited to use any cores for such a study which is now in progress. No further bores are expected to be sunk in the Northern Prospect but a number of Scout Bores will be located on a line through the Ravensworth State Coal Mine Reserve towards the Bayswater Bore to give full value to it and the Northern Prospect Scout Bores.

The conclusions herein reported are the result of field teamwork by two groups of the Bureau of Mineral Resources; the Coal Field Parties of the Geological and the Petroleum Technology Sections. The Petroleum Technology Party, under M. Konecki, was responsible to the Chief Petroleum Technologist for all basic data obtained from boring. All interpretation of results rests, therefore, upon the descriptive borelogs written and coal samples selected by this party. All borelogs are signed by the compilers, M. Konecki, W. McKinnon, M. Reynolds, and J. Veevers. The Geological Party was responsible to the Chief Geologist for locating boreholes, topographic surveying and interpreting and recording results inferred from the basic data. Of the Geological Party, J. Veevers was in charge of the area, locating the boreholes, preparing maps and sections of the subsurface and directing the topographic survey. Draughting and map compilation was carried out by A. Stern who also contributed to surveying technique and methods of presenting and reproducing information on borelogs, maps and diagrams. Other members of the Geological Party including Mrs. I. Lovi, Miss L. Rogers and T. Rodger, carried out checking and compilation. Members of the State Survey who were constantly available for much appreciated information were F. Booker and P. McKenzie; similarly of the Joint Coal Board K. Mosher, W. Seward and W. Foskett, and of Sydney University Professor Marshall and Dr. Rutledge. Some petrological and palaeontological determinations were made by W. Dallwitz and Miss I. Crespin respectively, of the Bureau at Canberra. Such sections of these Records contributed individually are separately signed. The techniques of boring, coal core-recovery etc. (See Section 7) upon which basic data depend resulted from co-operation by the drilling authorities involved, namely Pacific Boring Company, and the Bureau Drilling Section which also laid down necessary specifications (within certain limits imposed by the Joint Coal Board) and incentives for good work. D. Rees and C. Bursill were responsible for implementing drilling contracts for the Commonwealth. K. Cairnes was in control of Bureau boring operations. Pacific Boring Company representatives were S. Stanley and T. Bielsky.

In the following report, which is the first of a series for contiguous areas in the Cessnock Muswellbrook Region, an attempt is made strictly to refer all terms, quantities and inferences to the source to prevent the carrying over of errors and fallacies. A glossary has been included because in coal-field work there is a looseness of terminology; many words have different values or wholly different meanings to different workers e.g. dant, smut, seam, split; therefore the meaning chosen for such words and terms as are used is given.

C. BURSILL.
Geologist in Charge,
Coal Field Party.

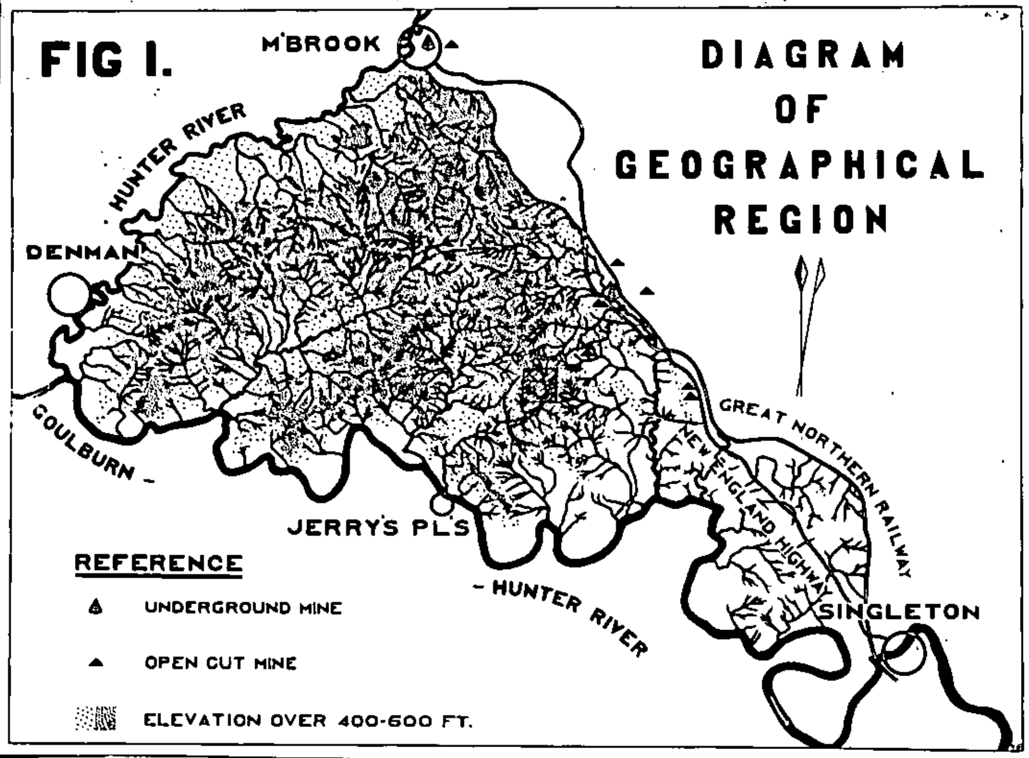
SECTION 3

TOPOGRAPHY AND SURFACE FEATURES.

3.1. REGIONAL.

The Hunter River flows from Singleton in a SE direction through a broad valley bounded on the N by heights of Carboniferous and on the S by cliffs of Triassic rocks. Above Singleton and between Singleton and Muswellbrook the river makes a sweeping bend with a westerly-pointing apex at Denman; this bend contains the region under discussion on two of its three sides. To the S of the sub-Area the Hunter River flows in a meander belt running roughly E from near Denman to Singleton. The Goulburn River enters it about 3 miles S of Denman making the reaches above Denman little more than a SW flowing tributary to a Goulburn-Hunter river system. A mass of land above 400 ft., and mainly above 600 ft., is contained by the great bend. These heights rise above 1,500 ft. at Mt. Arthur and Ogilvie and there are many ridges and peaks of 800 to 1,000 ft., the mass being drained by a radial dentritic system of creeks into the bend on the NW, W and S sides of the region. NW of Singleton there is a confluence of tributaries of which Bayswater Creek, flowing due S completes the radial drainage from the heights on the SE side. On their NE side the heights merge into the Carboniferous mass. The topography is rolling to moderately rugged, dissection is mature, but streams - all of which appear to be insequent - vary from youth to meandring maturity. There is no superficial evidence to suggest a drainage antecedent in respect of the Muswellbrook Dome uplift.

FIG I.



Singleton, Denman and Muswellbrook are about equidistant from the sub-Area which can be reached by tracks and gravelled roads from the New England Highway either from the N by turning off near Liddell Colliery or from the S by turning off near Ravensworth. The Great Northern Railway passes at Liddell Colliery within 4 miles of the centre of the sub-Area.

The region is mainly used for sheep grazing and dairy farming; cattle and horses are bred near the river stretches not far from the sub-Area and elsewhere; only small areas with river frontages are cultivated for crops. Underground coal mining is carried out at Muswellbrook and Balmoral in the Lower (Greta) Coal Measures and at Liddell in the Upper (Tomago) Coal Measures. Open cut mining is or was active at Muswellbrook, near Liddell (Newdell), Ravensworth, Durham, Foybrook and Pyke's Gully. The Pyke's Gully open cut mine, on the Liddell Seam, lies only about 2 miles from the centre of the sub-Area.

3.2 LOCAL.

3.2.1. Relief.

All of the sub-Area is above 400 ft. but Parnell's Creek has cut away a valley below this level to the S, in the Central Prospect. A ridge to the W divides it into a western hill which rises above 600 ft. in the NW corner and a less steep eastern half which nevertheless rises above 570 ft. in two rounded hills at the NE and SE corners. Slopes are gentle although the eastern side of the SE hill, near BMR 2T rises fairly steeply at the gradient 1 in 5. No cliffs or scarps occur. The valley of Parnell's Creek bisects the sub-Area into eastern and western halves. Thus the relief is moderately low and the form rolling.

3.2.2. Drainage.

Parnell's Creek is a small but fairly mature stream with its own small meander belt about 200 ft. wide in the upper reaches and associated swamps and minor alluvial deposits. It is about 10,000 ft. long and its confluence with the Hunter is about 275 ft. below the source creeks in the sub-Area, giving a mean gradient of about 1 in 36. It is not at grade down the whole length: the thalweg drawn from Military Map contours is humped suggesting a more mature lower half below a minor transitory depositional basin. Similarly the source region, which the sub-Area mostly contains, is drained by creeks of different ages from extreme youth to some maturity and as a consequence the thalweg is not a smooth curve. This is the result of an irregular rainfall and often prolonged dry weather during which the main creek dries into pools or completely. The swamps are short-lived even in wet weather. In places soil erosion has gone quite far and the minor drainage pattern is finely dendritic. The supply for Parnell's Creek mainly runs off the western ridge along rather ill-defined and usually dry channels, with a lesser supply from the NE and SE rises. Several creeks on both sides are dammed and 3 dams are well kept. The headwaters of Parnell's Creek are separated from Pyke's Gully on the north by an easterly extension of the western ridge. The catchment area for the part of Parnell's Creek contained by the sub-Area is about 1.78 sq. miles i.e. 138% of the sub-Area.

3.2.3. Ground Water.

In flood Parnell's Creek produces quite extensive swampy ground. From no bores, however, even BMR 15T and others within the meander belt, were recorded any water shows. In the deeper bore such as BMR 2S (500 ft.) this may possibly be due to the sealing-off by drilling fluid of any minor shows present. The drainage pattern and nature of outcrop (See Section 6) suggests that nearly all of the usually short, intense falls of rain would run off, little seeping in as ground water.

3.2.4. Vegetation.

The sub-Area is covered during most of the year with thin grass which thickens during prolonged wet weather even on the slopes. The grass is thicker throughout the year and includes reeds and marshy plants near the main creek and in its swamps. A belt of woodland stretches along the lower slopes of the western ridge; its trees are small to medium size and are fairly widely spaced, without undergrowth. A few small copses exist.

3.2.5. Soil, Drift etc.

The top soil is very thin on the heights and slopes but thickens substantially on the gently sloping outwash fans of tributary creeks at their confluence with the main creek. The top few feet of rotary boreholes do not give very reliable indications of the nature of soft rock and soil but BMR 13T probably passed through at least 10 ft. of clayey soil, including alluvium, and BMR 15T through 9 ft. 6 ins. Weathered rock, particularly shattered and limonitised clayironstone nodules, is scattered as drift. Many outcrops of resistant sandstone beds and lenses exist as almost vegetation-free platforms. During dry weather prolonged high winds, which have a fetch almost unimpeded by tall vegetation, cause a considerable ablation.

3.2.6. Land Divisions.

All of the sub-Area is in the Parish of Howick, County of Durham, Land Districts of both Muswellbrook and Singleton, Shire of Patrick Plains. The Shire is in the Eastern Division of N.S.W. The sub-Area also falls within the Upper Hunter Region of the N.S.W. Division of Development and Reconstruction. The Portions taken in are numbers 53, 54, 65, 70, 71, 80, 81, 83, 84, and part of 5.

3.2.7. Maps Used.

Basic surface information was taken from the Parish Map of Howick, Fourth Edition, 1st. October, 1935; Muswellbrook Sheet (Military Map) 1/63,360, 1941 and Air Photographs, Muswellbrook Sheet Run 4E, dated 1938, numbers 09487 to - 89 inclusive.

3.2.8. Land Owners, Entry, Rights etc.

All land is private, the Portions owned and personally worked by the brothers W. and H.J. Reynolds of Singleton. The owners do not possess mineral rights, the coal belonging to the Crown. Authority to Enter the Property under the Mining Act of 1906-1946 was not held by the Joint Coal Board for any Portion but 5. Consequently, in half the area boring took place with only the verbal permission of the landowners who continually raised difficulties over the use of tracks, gates, fences and the plugging of completed boreholes and filling of mud pits.

3.2.9. Land Utilisation.

The land is not very good; it is used for sparse grazing of sheep and cattle. Enclosures are few; a rabbit proof paddock and a small dwelling with home paddocks exist in the north not far from BMR 2T. Scattered ringbarked timber occurs especially in the S on the W of Parnell's Creek and also the woodland mentioned under 3.2.4. At least 3 dams are kept in good repair. No services exist but heavy electrical supply runs to the Pyke's Gully open cut about 2 miles away.

3.2.10. Surveying.

The initial Scout Bores were placed by locating them on the Military Map from which as a check they were transferred to the Parish Map and subsequently pegged in the ground by placing from some feature common to the field and map. When later the approximate position of Test and Define Bores was decided from all available evidence, a planimetric grid was drawn based on and oriented with the Military Map. The Test and define grid was then transferred to enlargements (at 6 ins. = 1 Mile and 2½ ins. = 1 Mile) of the Military Map and to the air photographs and conveniently numbered (BMR Plan N14/83)Ø. The grid co-ordinates of the Test and Define Bores were then estimated. The grid and the boresites in relation to it were then transferred to a plane table sheet on which was noted some feature common to the map (usually a fence on the Parish Map) and the field. From this feature the bores were located and pegged in the field by alidade. Thus the grid intersections were not themselves pegged on the ground except where they coincided with a boresite. The drillers did not always find it convenient to sink the bore exactly at the peg; therefore, a final survey was necessary to pick up the actual bore location during or after drilling and this often coincided with traverses of the topographical survey.

Surveying was carried out by plane table and telescopic alidade. All the usual precautions were taken, the methods being standardised against Bureau specifications modified in minor detail for the special case. The J.C.B. also provided standards and limits of accuracy. Estimates of accuracy may be considered in two groups (1) accuracy of stations: an examination of the telescopic alidades used, stadia rods, parrallel rule and the plane table itself indicated that for the whole sub-Area horizontal tolerance was plus or minus 20 ft. and vertical plus or minus 1 ft. (2) accuracy of compilation: in this another set of variables must be considered, for example the density of stations (in places as low as 1 per acre as against 1.5 considered ideal for the working scale 200 ft. = 1 in and the spacing of contours, nature and distance away of datum, spreading slight differences between contiguous plane table sheets and finally the change of shape resulting from various

Ø Not included in these Records.

reproductions; it is considered that a minimal error for any one point on the final compilation would be plus or minus 5 ft. vertical and plus or minus 40 ft. horizontal. Zones of the compilation will vary in horizontal accuracy, because of the accurate location of BMR 15T, mentioned hereunder, slight adjustments of the bores nearest to which could be more easily made during compilation than those further away.

The elevation datum first chosen was Railway Datum carried by the Joint Coal Board to some of their nearby boreholes and brought to BMR 1S by using an alidade as a level. Later a similar levelling traverse was carried to Howick Trig. Station and the correct * difference (97.1 ft.) between Railway and Military Datum observed (within + 0.9 ft.). After the Bureau survey was completed the Surveyor of Newcastle District, Department of Interior, ran a traverse from several Trig. stations accurately to locate BMR 15T in terms of Military Co-ordinates (See Appendix V). The Military Co-ordinates given in the compilation (Plate 1) can therefore be regarded as accurately surveyed and from these can be calculated the exact, or very nearly exact, bore locations in terms of latitude and longitude. Bore locations are also stated in terms of bearing and distance from a prominent Land Division feature, as measured on the compilation map. The feature chosen was the SW corner of Portion 53 and approximate SE corner of Portion 81 (See Appendix II Note (1)). This point is marked by a labelled post at the fence corners (See Plate 11).

The very large area required to be surveyed and bored necessitated standardisation of methods from the start. Parish and County (Land Division) Maps were found to be inaccurate in detail. The Military Map proved a very necessary reference. It was therefore decided that the small inconvenience likely to result from it would be outweighed by the value of relating all work to the Military Map; consistency then demanded the use of True North (Actually Grid North, See Glossary) orientation and bearings. A True (Grid) North azimuth # was surveyed in by theodolite by triangulation from 1st. class Trig. stations as given on the Military Map and a marked azimuth peg driven in at True (Grid) North from BMR 15T (See Appendix V) at 350 ft. distance.

All plane table sheets and stadia books are kept and for reference to them see Appendix II column 4 and Plate 1.

* Information from District Office, J.C.B. Cessnock.

\# The Department of Interior Plan Neg. No. 5211 N.S.W. gives magnetic declination as + $9\frac{1}{2}^{\circ}$ (See Appendix V) but Bureau of Mineral Resources, Declination Chart G96-3 gives + $10\frac{1}{2}^{\circ}$ (A.Stern)

Table 1. Summary of Mining Data.

A. ALL COAL PRESENT

Depth of Seam (Top) Min. Ft.	Depth of Seam (Top) Max. Ft.	Name of Seam	Average Strike °T	Mean Dip °	Mean Dip °T	Mean Total Thickness of Seam Ft.	Mean Total Thickness of Seam Ins.	Total Coal Reserves Including Bands (1) Long Tons	Total Coal Reserves Including Bands Acres (1)	Coal Reserves at 9:1 O.B. Ratio Max. Including Bands Long Tons	Coal Reserves at 9:1 O.B. Ratio Max. Including Bands Acres (1)	Mean Band Free Thickness of Coal (2) Ft	Mean Band Free Thickness of Coal (2) Ins.	Mineral Bands (2) %	Total Coal Reserves Band Free (2) Long Tons	Total Coal Reserves Band Free and Unweathered (2) % (6)	Total Coal Reserves Band Free and Unweathered (2) Long Tons	Band Free Coal Reserves at 9:1 O.B. Ratio Max (2) Long Tons	Band Free Unweathered Coal Reserves at 9:1 O.B. Ratio Max (2) Long Tons	Mean Quality H.M.	Mean Quality V.	Mean Quality F.C.	Mean Quality A	Mean Quality BTh.U's.
0	366	BARRETT'S	030	4	124	9	0	6,310,000	460	3,117,000	227·3	7	11	12	5,553,000	86·5	4,814,000	2,743,000	2,004,000	3·7	35·3	50·3	10·8	12,710 (5)
0	298	L. LIDDELL	030	4	124	6	0	2,340,000	260	413,000	45·9	4	6	25	1,755,000	83·5	1,482,000	310,000	37,000	2·7	33·7	48·6	14·9	11,850 (4)
0	234	U. LIDDELL	030	4	124	8	0	2,280,000	190	705,000	58·8	7	6	6	2,143,000	81·0	1,745,000	663,000	265,000	2·4	36·5	49·2	11·9	12,370 (4)
0	171	L. ARTIE'S	030	4	124	8	0	1,873,000	155	850,000	70·7	7	1	11·5	1,657,000	85·0	1,406,000	752,000	501,000	2·7	30·4	43·8	23·0	10,630 (4)
0	132	U. ARTIE'S	030	4	124	6	0	992,000	110	579,000	64·3	5	6	8	912,000	80·5	735,000	533,000	356,000	2·6	36·2	50·7	10·5	12,620 (4)
		TOTAL or MEAN				37	0	13,795,000	1,175	5,664,000	467·0	32	6	12·7	12,020,000	84·0	10,182,000	5,001,000	3,163,000	2·8	34·4	48·5	14·2	12,040 (5)

A. NOTES.

(1) AREAS BASED ON TOTAL AREA CONTOURED IN PLATE I.

(2) MINERAL BANDS ARE THOSE EXCLUDED FROM ANALYSES

(3) WEIGHTED MEAN OF 98 ANALYSES

(4) ARITHMETIC MEAN OF 2, 6, 7 AND 6 ANALYSES RESPECTIVELY.

(5) WEIGHTED MEAN (BY SEAM THICKNESS) OF MEAN SEAM QUALITY FIGURES.

(6) PROPORTION OF WEATHERED COAL TO TOTAL BANDFREE RESERVES (COLUMNS 11 ÷ 16)

B. BARRETT'S SEAM WITHIN OPEN CUT LIMITS

PLY. (7)	Band Free (2) Thickness FT	Band Free (2) Thickness INS	Mean Quality H.M.	Mean Quality V.	Mean Quality F.C.	Mean Quality A	Mean Quality BTh.U's.	O. to C. Ratio 3:1 (4), Area 66·3 (5), Mean Cover 13·5 ft. (4), % Weathered 92·5 (3): Reserve (1) Long Tons	O. to C. Ratio 3:1: Overburden Cu. Yds. (6)	O. to C. Ratio 5:1, Area 116·0, Mean Cover 22·6 ft, % Weathered 50: Reserve Long Tons	O. to C. Ratio 5:1: Overburden Cu. Yds.	O. to C. Ratio 7:1, Area 181·3, Mean Cover 31·5, % Weathered 34: Reserve Long Tons	O. to C. Ratio 7:1: Overburden Cu. Yds.	O. to C. Ratio 9:1, Area 247·0, Mean Cover 40·5 ft, % Weathered 24: Reserve Long Tons	O. to C. Ratio 9:1: Overburden Cu. Yds.
"AA" (7)	3	5	?	30 to 34·9	?	?	?	26,000		285,000		626,000		865,000	
"BB"	2	6	?	35 to 36·9	?	8·8	13,000	19,000		208,000		457,000		634,000	
"CC"	2	0	?	37 to 38·0	?	8·5	13,180	15,000		167,000		365,000		505,000	
LM (8)	2	7	3·4	37·7	50·1	8·8	13,090	20,000		218,000		478,000		660,000	
JK	1	4	3·7	33·7	51·1	11·4	12,435	10,000		111,000		243,000		336,000	
FGH	2	5	3·7	35·6	51·6	9·3	13,095	18,000		198,000		436,000		606,000	
ABCDE	1	7	4·2	32·2	47·9	15·8	11,765	12,000		133,000		291,000		402,000	
SEAM	7	11	3·7	35·3	50·3	10·8	12,710	60,000	319,000	660,000	2,061,000	1,448,000	4,413,000	2,004,000	5,865,000

B. NOTES

(1) BAND FREE UNWEATHERED COAL

(2) EXCLUDING "EXCLUDED" BANDS

(3) PROPORTION OF WEATHERED TO UNWEATHERED COAL

(4) BASED ON MEAN SEAM THICKNESS OF 9 ft., NOT BAND FREE THICKNESS.

(5) AREAS IN ACRES AS (1)A.

(6) OVERBURDEN IN 3:1 RATIO AREA IS ADJUSTED FOR ONLY 15 ACRES OF UNWEATHERED COAL

(7) "AA", "BB", "CC" ARE THEORETICAL PLIES

(8) FOR NOTATION OF PLIES SEE Plate 4.

C. OVERBURDEN

ROCK TYPES	APX % (1)	APPX AMOUNT CU. YDS
GREYWACKE	47	3,269,000
SANDSTONE	16	1,113,000
CLAY	16	1,113,000
CLAY SHALE	7	495,000
SILTSTONE	7	495,000
CLAYSTONE	5	398,000
SAND	1	69,000
SHALE	3/4	52,000
CLAY-IRONSTONE	1/4	17,000

C. NOTES

(1) %AGE IS VERY APPROXIMATE AND AMOUNT BASED ON TOTAL OVERBURDEN FROM OUTCROP TO 81 ft. ISOPACH OF BARRETT'S

SECTION 4

COAL.

4.1 SUMMARY

A summary statement of reserves is given in Section 1 and in more detail in the table opposite. The geology of the five seams encountered is given in Section 6 and Plates 1 and 2.

The Lower and Upper Splits of both Liddell and Artie's Seams were not tested and defined by close drilling and will not be considered in detail until the issue of a report on the sub-Area to the South where they are far more extensive. Barrett's Seam, the lowest stratigraphically is, however, considered in some detail since 22 bores encountered it and about 100 proximate analyses were made. Analyses are given in detail, as received from State Mines Department, in Appendix VIII and summarised in Appendix VII.

Barrett's Seam is considered first in bulk and some conclusions are drawn from a brief statistical treatment of the proximate analyses. Its bands and plies are given notations and the ply analyses then treated individually, mean analytical values being determined for four main groups of plies. Some of the characters of roof, floor, bands and plies are then considered. A Gray King carbonization test is discussed and finally weathering of coal is considered and the calculations of weathered coal given.

4.2. COAL RESERVES AND MINING LIMITS.

Table opposite states a number of calculations of reserves and overburden which have been summarised in Section 1. Weathered coal calculations are given in Section 4.8.

When work began in this area the definition of open cut minable coal, given in detail in earlier Records (e.g. 1952/7), was: minimum thickness of coal 5 ft., maximum operating depth 170 ft. maximum overburden to coal ratio 15:1, minimum calorific value of coal 10,000 B.Th.U's per lb. At a conference at J.C.B. Head Office, Sydney in March 1952, there was a suggestion that the maximum operating depth should be reduced to 100 ft. At a conference at J.C.B. District Office, Cessnock, in August 1952, it was considered that definite instructions existed to reduce the maximum operating depth to 100 ft. and the J.C.B. considered that the maximum overburden to coal ratio should be reduced to

10:1. By this time it became clear that the standards for open cut coal had been heightened and instructions were issued that high grade coking and gas coals were alone of importance. At a conference at J.C.B. Head Office in Sydney in November, 1952, the emphasis on gas coal was reiterated and a suggested definition of a gas coal prospect was: maximum overburden to coal ratio 10:1, maximum operating depth 100 ft., minimum seam thickness 5 to 7 ft. depending on quality, minimum volatile content 36%, minimum calorific value 12,500 B.Th.U's per lb., maximum ash content 10-16% depending on volatile content. There is no doubt that these changing views have left some vagueness as to the kind of coal sought and its physical limits for open cut mining; nevertheless in practice it has been possible to take an overall view and conform with common sense, changing conditions of coal supply and demands, and such facilities as the newly erected washing plant at Newdell, without either loss of important information or any considerable waste drilling.

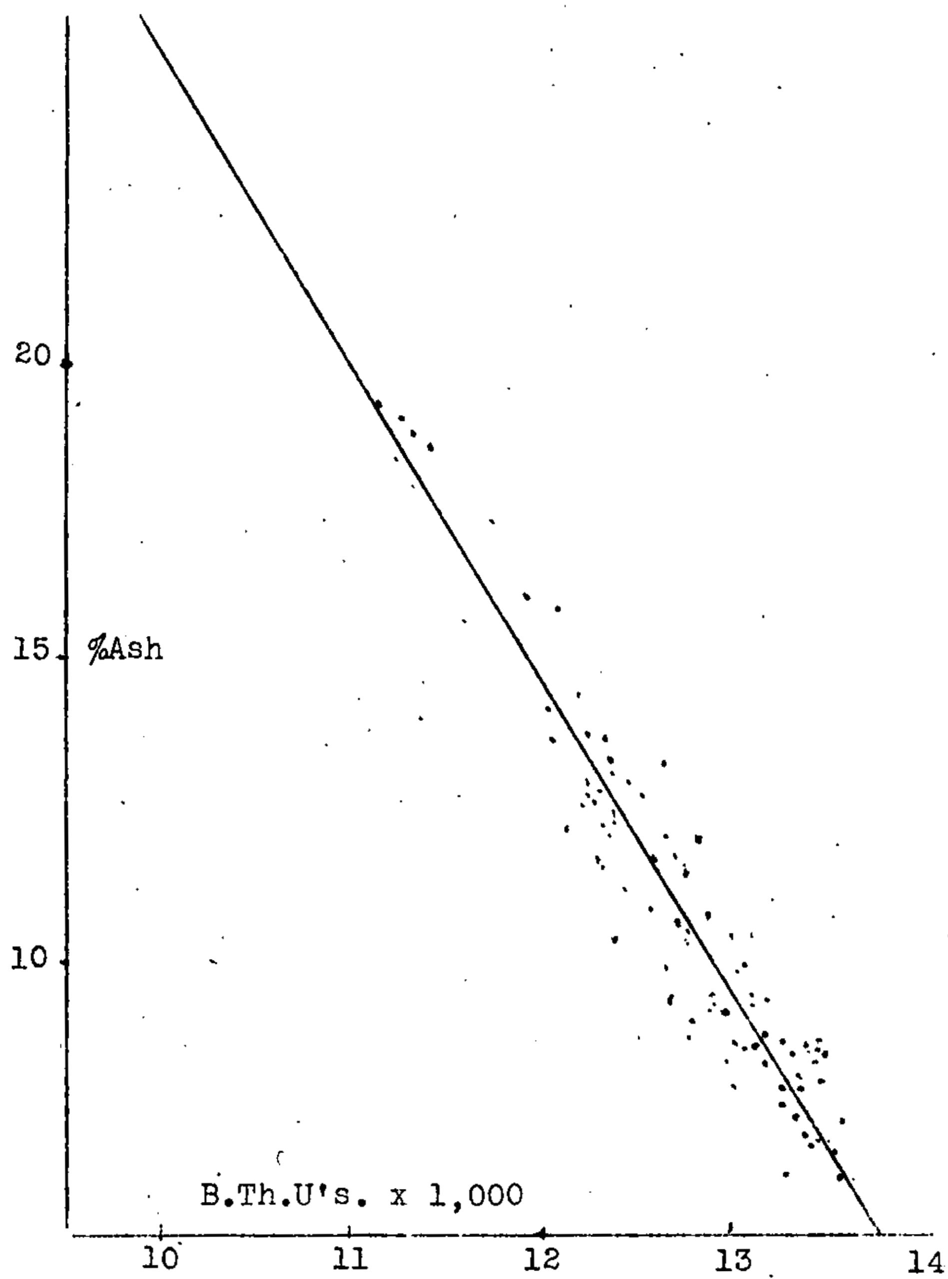
The value of the seams considered in this report are clearly in doubt and their working by any mining method would depend on immediate economic circumstances. It has been thought best, therefore, to examine the quality and physical disposition in some detail so that the ultimate decisions can be facilitated by all available data. At the same time calculations have been restricted to maximum overburden to coal ratios up to 9:1 as a compromise.

4.3. ANALYSES OF BARRETT'S SEAM IN BULK.

The number of proximate analyses made is statistically small (ca. 100, See Appendix III Summary of Analyses and Appendix VIII State Mines Department Analytical Reports): therefore only tentative conclusions can be drawn from them. As drilling in Barrett's Seam progresses the number of Analyses will rise to statistically more satisfactory dimensions. It may nevertheless be worth while to present some of the considerations made (and compilations of data drawn up) as a temporary measure of the chemical nature and value of the seam.

The curve (Figure 2) below is drawn through a plot of all observations of calorific value and ash content. The plot shows a considerable scatter and no particularly well defined aggregates attributable to individual plies of the seam.

Fig.2



All the analytical results have been plotted on a triaxial diagram, Figure 3, on which is also plotted for comparison the position of a number of proximate analyses of the Liddell Seam at Foybrook, a seam considered to be "a first class gas coal". The plot is essentially diagrammatic: a co-ordinate with dimensions for the sum of values of fixed carbon and hygroscopic moisture cannot be very satisfactory. Figure 4 locates Figure 3 within fully produced co-ordinates.

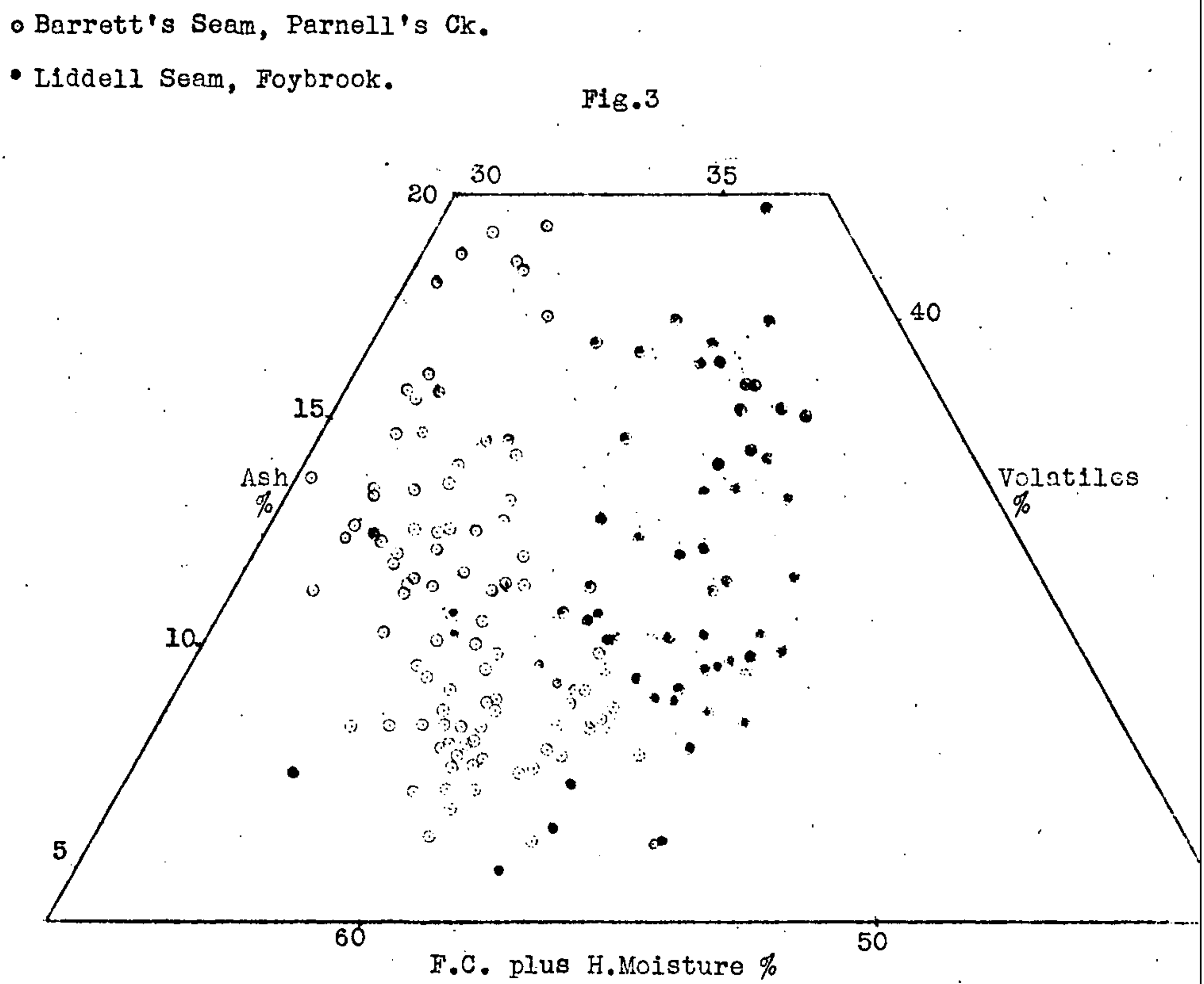

o Barrett's Seam, Parnell's Ck.
• Liddell Seam, Foybrook.
20
30
35
40
15
10
5
Ash %
Volatiles %
60
50
F.C. plus H.Moisture %

Fig.3

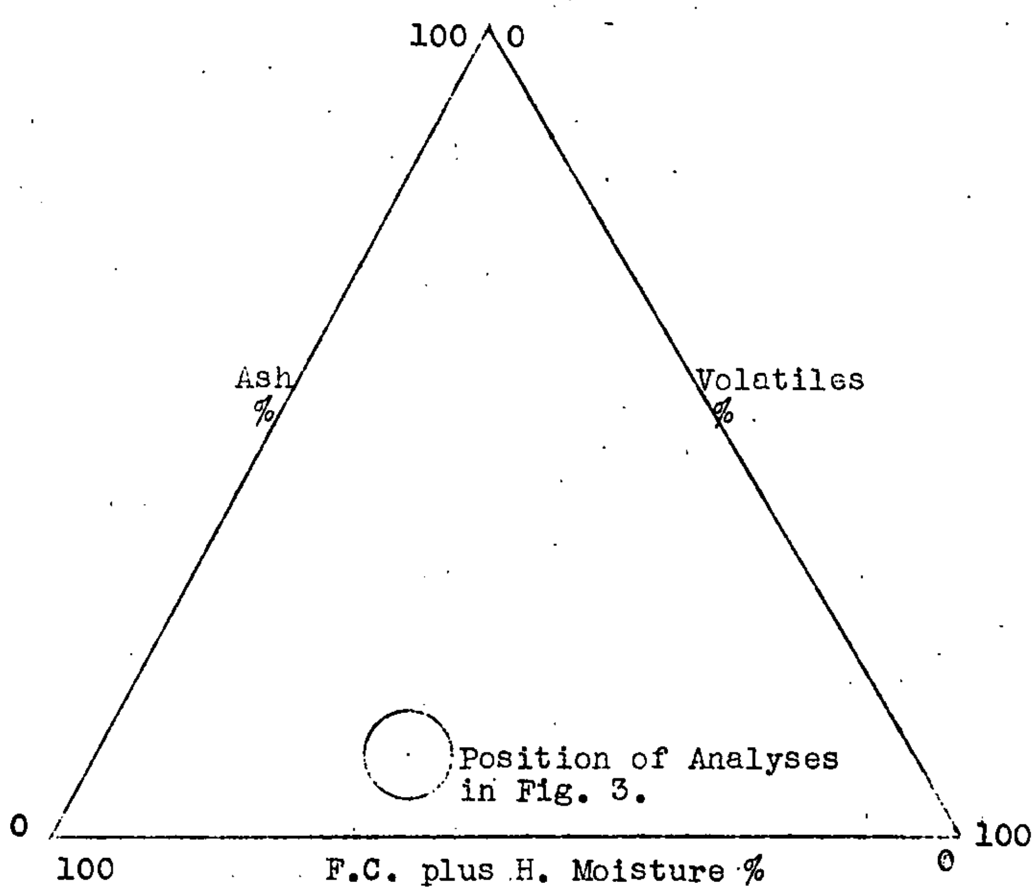

100
0
Ash %
Volatiles %
Position of Analyses in Fig. 3.
0
100
100
0
F.C. plus H. Moisture %

Fig.4

The following Table states the ranked calorific values for all analyses.

Ranked Calorific Values, Barrett's Seam, All Analyses.

9,790	11,020	12,010	13,000
	11,130	12,020	13,000
	11,240	12,050	13,020
	11,260	12,080	13,030
	11,320	12,120	13,060
	11,340	12,190	13,080
	11,350	12,200	13,080
	11,400	12,230	13,090
	11,580	12,230	13,100
	11,720	12,230	13,140
	11,900	12,230	13,150
	11,910	12,260	13,180
		12,280	13,210
		12,300	13,220
		12,310	13,230
		12,310	13,230
		12,340	13,240
		12,340	13,300
		12,340	13,300
		12,340	13,300
		12,350	13,310
		12,380	13,350
		12,400	13,360
		12,450	13,380
		12,500	13,380
		12,540	13,410
		12,570	13,410
		12,580	13,440
		12,610	13,440
		12,620	13,440
		12,670	13,510
		12,680	13,520
		12,700	13,530
		12,730	13,540
		12,730	
		12,740	
		12,750	
		12,760	
		12,760	
		12,780	
		12,850	
		12,860	
		12,860	
		12,870	
		12,880	
		12,930	
		12,940	
		12,990	
		12,990	

and Table below separates two class intervals, of 250 and 500 B.Th.U's respectively, from Table above, and states their frequencies.

Frequencies of Some Class Intervals from Table of Ranked Calorific Values.

Class Interval 500

11;000 to 11;500	f.	8
11;500 to 12;000		4
12;000 to 12;500		24
12;500 to 13;000		25
13;000 to 13;500		31
13,500 to 14,000		4

Class Interval 250

11,000 to 11,250	f.	3
11;250 to 11;500		5
11;500 to 11;750		2
11;750 to 12,000		2
12,000 to 12,350		11
12;250 to 12,500		13
12;500 to 12;750		13
12;750 to 13,000		0
13,000 to 13;250		17
13,250 to 13,500		14
13,500 to 13,750		4

Figures 5, 6 and 7 are histograms to demonstate the frequency distribution in this table for three class intervals of increasing size. The frequency distribution suggests a multimodal curve which may correlate with depositional plies of the seam. Such plies will be considered later. Figure 5 states graphically the data of Table above for intervals of 250, Figure 6 of Table above for intervals of 500 and Figure 7 states smaller intervals of 100.

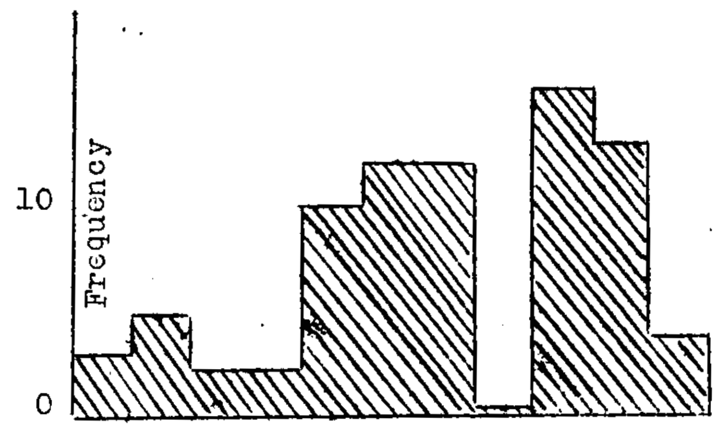


Fig.5 Class Interval 250 B.Th.U's.

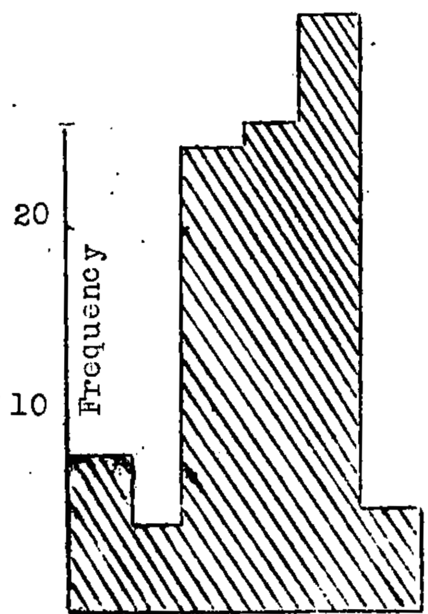


Fig.6 Class Interval 500 B.Th.U's.

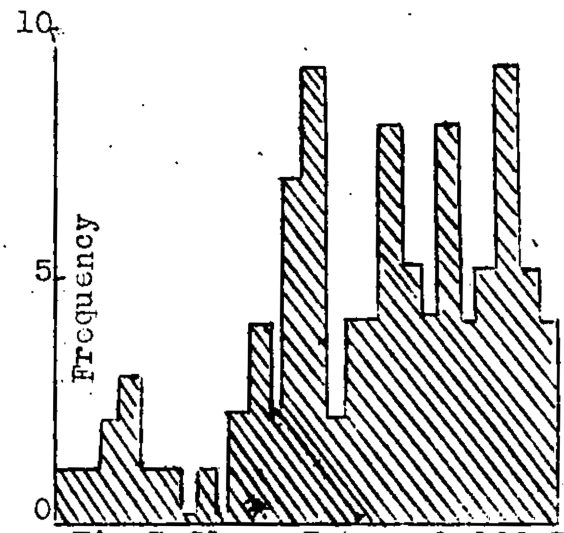


Fig.7 Class Interval 100 B.Th.U's

Table below (Page 18) states the ranked percentage volatiles of all analyses. Figures 8 and 9 are histograms demonstrating the frequency distribution of the values stated in this table for two widely separated class intervals. These histograms at least superficially suggest a more normal, though skew, frequency distribution curve and it should be interesting to see whether more data (analyses) will produce a correlation with the frequency distribution curve for calorific values. It will be seen later (Figure 10) that any direct relationship between calorific value and volatile content is not clearly apparent. The well defined normal curve in Figure 8 between 35.0% and 37.0% may suggest the possibility of several more or less normal nodes which will show better with a greater total frequency.

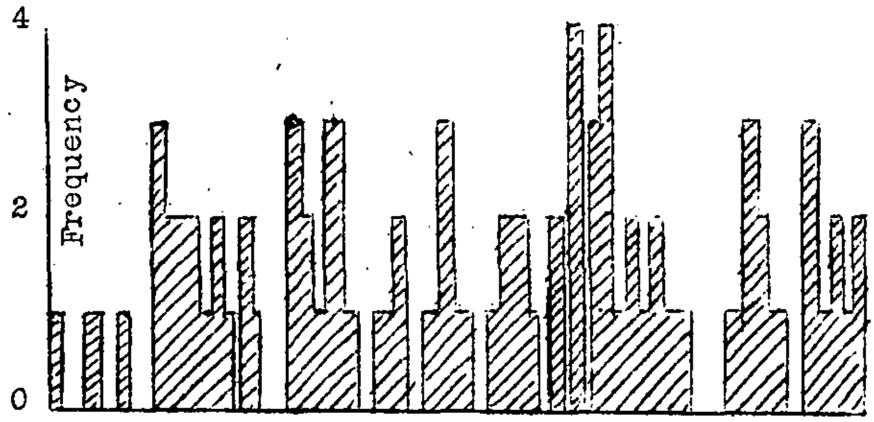


Fig.8 Class Interval 0.1% Volatiles.

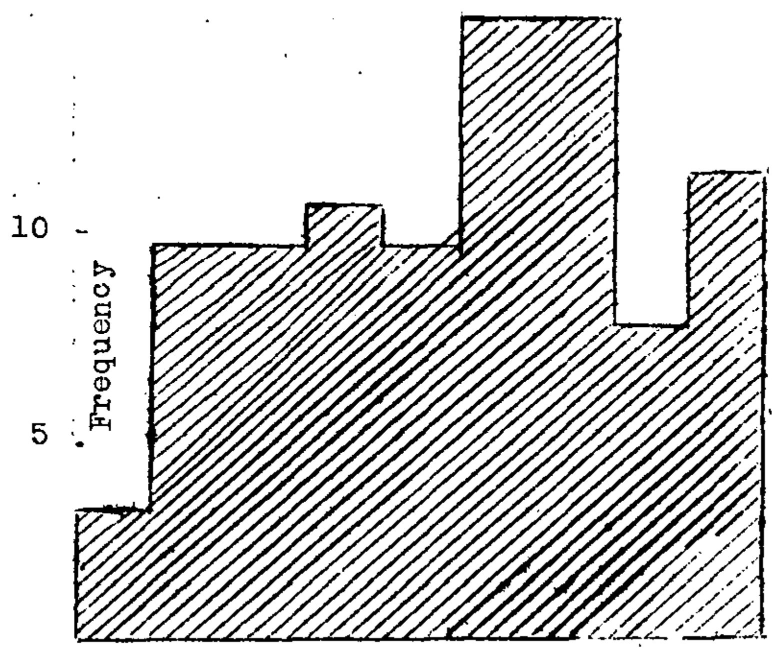


Fig.9 Class Interval 1.0% Volatiles

<u>Ranked Values of Volatile Content (%), All Analyses.</u>

28.7	30.3	31.1	33.0	34.0	35.0	36.1	37.0	38.0
28.8	30.7	31.5	33.0	34.0	35.1	36.1	37.5	38.1
	30.8	31.5	33.1	34,3	35.1	36.1	37.7	38.4
		31.5	33.2	34.4	35.2	36.2	37.7	38.4
		31.6	33.3	34.4	35.2	36.2	37.7	38.4
		31.7	33.3	34.5	35.3	36.2	37.8	38.5
		31.7	33.3	34.5	35.3	36.2	37.8	38.6
		31.8	33.4	34.6	35.4	36.3	37.9	38.6
		31.8	33.5	34.7	35.6	36.4		38.7
		31.9	33.8		35.6	36.5		38.8
		32.0	33.9		35.7	36.5		38.9
		32.1			35.7	36.6		38.9
		32.1			35.9	36.7		
		32.2			35.9	36.7		
		32.4			35.9	36.8		
		32.4			35.9	36.9		
		32.5						
		32.9						
		32.9						
		32.9						

Since the volatile content of the seam is important as an indicator of its value for gas making, it can be considered further. Table below states all values of volatile content for those analyses falling within the class interval 35.0% to 36.9%. Table on page 20 similarly states values for the class interval 37.0% to 38.9%. The class intervals selected for these tables are the two major upper groups in Figures 7 and 8. Both tables also state ash and calorific values, sample interval and ratio of each sample interval to total thickness of coal sampled. A full summary of quantitative analytical results is stated in Appendix VII and full proximate analytical reports for each bore are given in Appendix VIII.

Ranked values of Volatile Content Within Class Intervals 35.0% to 36.9%.

Volatile Content %	Ash Content %	Calorific Values B.Th.U's.	Sample Interval Ft. *	Ratio of Sample Interval to Sum of Intervals %
35.0	10.3	12,700	1.583	3.47
35.1	8.2	13,000	1.396	2.97
35.1	10.5	12,540	1.250	2.63
35.2	12.0	12,310	3.083	6.55
35.2	11.4	12,570	1.542	3.28
35.3	10.0	12,730	1.416	3.01
35.3	9.0	12,670	1.437	3.06
35.4	8.6	12,760	1.645	3.50
35.6	11.3	12,730	2.083	4.44
35.6	8.2	13,220	1.125	2.40
35.1	9.6	13,000	1.229	2.61
35.7	6.9	13,520	1.416	3.01
35.9	8.2	13,380	1.437	3.06
35.9	7.9	13,410	1.292	2.75
35.9	7.9	13,140	1.333	2.83
35.9	9.9	12,850	1.666	3.55
36.1	8.9	13,150	0.916	1.43
36.1	8.9	13,060	1.208	2.56
36.1	7.5	13,230	1.500	3.19
36.2	8.0	13,440	1.333	2.83
36.2	8.1	13,440	1.416	3.01
36.2	7.4	12,990	1.375	2.92
36.2	7.9	12,930	1.709	3.64
36.3	6.9	13,300	1.250	2.63
36.4	8.7	12,940	2.000	4.26
36.5	7.7	13,300	0.791	1.37
36.5	5.9	13,240	0.416	1.19
36.6	6.6	13,350	1.791	3.82
36.7	7.5	13,310	1.333	2.83
36.7	9.0	12,870	1.208	2.57
36.8	10.8	12,740	2.666	5.67
36.9	6.9	13,380	1.125	2.40

Ranked Values of Volatile Content within Class Interval 37.0% to 38.9%. (with other variables).

Volatile Content %	Ash Content %	Calorific Value B.Th.U's.	Sample Interval Ft. *	Ratio of Sample Interval to Sum of Intervals %
37.0	11.4	12,780	3.416	8.45
37.5	7.2	13,360	1.125	2.79
37.7	8.8	13,230	2.541	6.23
37.7	7.3	13,140	1.125	2.79
37.7	9.8	13,080	1.916	4.75
37.8	8.3	13,210	1.812	6.95
37.8	7.7	13,100	1.875	4.65
37.9	9.0	13,090	1.875	4.65
38.0	9.6	13,020	2.000	4.96
38.1	7.6	13,440	2.000	4.96
38.4	8.4	13,300	2.750	6.82
38.4	5.8	13,180	1.625	4.03
38.4	8.1	13,540	2.645	6.55
38.5	8.3	13,410	2.958	7.32
38.6	10.1	12,990	1.500	3.72
38.6	10.2	13,080	1.083	2.68
38.7	8.7	12,860	3.291	8.15
38.8	6.0	13,530	1.208	2.99
38.9	8.2	13,380	1.916	4.75
38.9	6.8	13,510	0.750	1.86
			40.433	100.05

The total thickness of coal profiles drilled and cored in all bores (See Appendix II Summary Sheet of Drilling), neglecting the part seam in BMR 18T, is approximately 174 ft. With so few observations (19 bores in all) it is difficult to select a suitable average; the arithmetic mean will serve however, and its value is taken as 9 ft.

The following Table states the total number of bands of other rock than geological coal occurring in each bore section of the seam. Full details of bands are given in Appendix VI, from which it can be seen that the sample intervals, as stated in Tables above will include physically the "included" bands which are taken into account in the analysis, but also include within the value of the interval the "excluded" bands which are not taken into account in the analysis. However, in the following considerations, no adjustment has been made for "excluded" bands because (1) they represent a relatively small proportion (3.0%) of the total sampled thickness (i.e. sum of sample intervals) and (2) the overall accuracy is not high.

Rock Bands etc. in Barrett's Seam.

Bore No.	Approx. Thickness of Coal Seam Ft.	ins.	Sum of Sample Intervals Ft.	ins.	Total Rock Bands ins.	Total Excluded Bands ins.	Total Coal Plies - included Band Analysed Ft.	ins.
1T	8	11	8	6	9	4	8	2
2T	7	7½	5	6½	8¾	1½	5	4¾
3T	8	9½	7	11½	13	2	7	9½
4T	9	4½	8	6½	15½	4½	8	2
5T	9	3½	8	4½	12	1	8	3½
6T	9	4¼	8	0½	15	2½	7	9¾
7T	9	4	8	1¾	16¼	2¾	7	11¼
8T	9	5½	8	4¼	19¾	5¾	7	10½
11T	8	9¾	7	5	14	3½	7	1½
12T	9	10½	8	5¾	17¼	2	8	3¾
13T	8	6½	7	10	10½	1	7	9
14T	9	11¾	8	3¼	17½	0	8	3¼
15T	9	10½	8	8½	18½	3¼	8	5¼
16T	9	1¼	8	5	13½	4¾	8	0¼
17T	9	6½	8	1¼	16¾	2½	7	10
1S	8	4½	8	2½	17	14½	7	0
2S	10	6	9	11½	8	1½	9	10
3S	7	11	7	6	5¾	0	7	6
4S	8	5½	7	9	9	0	7	9
	173	1½	154	0¾	257	56¾	149	4

The total thickness of all bands is, therefore, about 21 ft. 5 ins. or approximately 12% of the sum of the coal profiles penetrated.

Turning to Table on page 20 it can be seen that the class interval 37.0% to 38.9% volatiles is represented by 40 ft. 5 ins. of sample intervals. Neglecting "excluded" bands the ratio of this total (40 ft. 5 ins.) to total coal profine (173 ft. approx.) is approximately 23%. Similarly from Table on page 19 a ratio can be calculated for the class interval 35.0% to 36.9% volatiles and expressed as 27%. Rock bands have been calculated as 12% and, by difference the residual class intervals of volatile values (28.7% to 34.7%) are represented by 38%. Now assuming a mean seam thickness of 9 ft. these ratios can be expressed as thicknesses thus:

Mean Barrett's Seam Divided in Proportion to Classes of Volatile Values.

Class Interval Volatile Values %	Total Sample Intervals Ft.	Ratio of Total Sample Thickness to Total Coal Profile (174'5") %	Thickness of Mean Seam (9'0") Represented Ft.	ins.
33.0 to 34.9	65	38.0	3	5
35.0 to 36.9	47	27.0	2	6
37.0 to 38.9	40	23.0	2	1
Rock Bands	22	12.0	1	0
	174	100.0	9	0

The argument can be pursued little further. The following Table stated a ranking of calorific values for the class intervals (a) 37.0% to 38.9% and (b) 35.0% to 36.9% volatiles as sorted from Tables on pages 19 and 20.

(a) 37.0% to 38.9% Volatiles	(b) 35.0% to 36.9% Volatiles
12,780	12,310
12,860	12,540
12,990	12,570
13,020	12,670
13,080	12,700
13,080	12,730
13,090	12,730
13,100	12,740
13,140	12,760
13,180	12,850
13,210	12,870
13,230	12,930
13,300	12,940
13,360	12,990
13,380	13,300
13,410	13,000
13,440	13,060
13,510	13,140
13,530	13,150
13,540	13,220
	13,230
	13,240
	13,300
	13,300
	13,310
	13,350
	13,380
	13,380
	13,410
	13,440
	13,440
	13,520

Ranked Ash Values.

(a) 37.0% to 38.9% Volatiles	(b) 35.0% to 36.9% Volatiles
5.8	5.9
6.0	6.6
4.8	6.9
7.2	6.9
7.3	7.4
7.6	7.5
7.7	7.5
8.1	7.7
8.2	7.9
8.3	7.9
8.3	7.9
8.4	8.0
8.7	8.1
8.8	8.2
9.0	8.2
9.6	8.2
9.8	8.6
10.1	8.7
10.2	8.9
11.4	8.9
	9.0
	9.0
	9.6
	9.9
	10.0
	10.3
	10.5
	11.3
	11.4
	12.0

This information is too meagre convincingly to infer significant averages. By inspection of Table (a) on page 22 however, it may be considered that an approximate median value of the order of magnitudes 13,180 is significant. By inspection of Figure 2 for this value an ash content of about 8.5 can be interpolated. Repeating the argument and entering Table above the data in Table below can be inferred. Ash and calorific values of the lower class interval must be neglected as data are too variable.

Mean Barrett's Seam, Proximate Analysis

Class Interval Volatiles Value %	Thickness of Mean Seam Represented Ft.	ins.		Possible Ash Content %	Possible Calorific Value B.Th.U's.
30.0 to 34.9	3	5	"AA"	?	?
35.0 to 36.9	2	6	"BB"	8.8	13,000
37.0 to 38.9	2	0	"CC"	8.5	13,180
Rock Bands	1	1 *			
	9	0			

The scatter shown in Figure 2 and Figure 3 signifies a great variation of bulk properties of the seam. This variation is shown well by Figure 10 in which something approximating a smooth curve might be expected, or at least a more consistent definite trend. It thus becomes clear that the seam must also be treated in terms of individual plies (which one might expect to have possessed some depositional consistency) rather than in bulk, in order to obtain quantitative consistency over the considerable area in which the seam was traced by drilling.

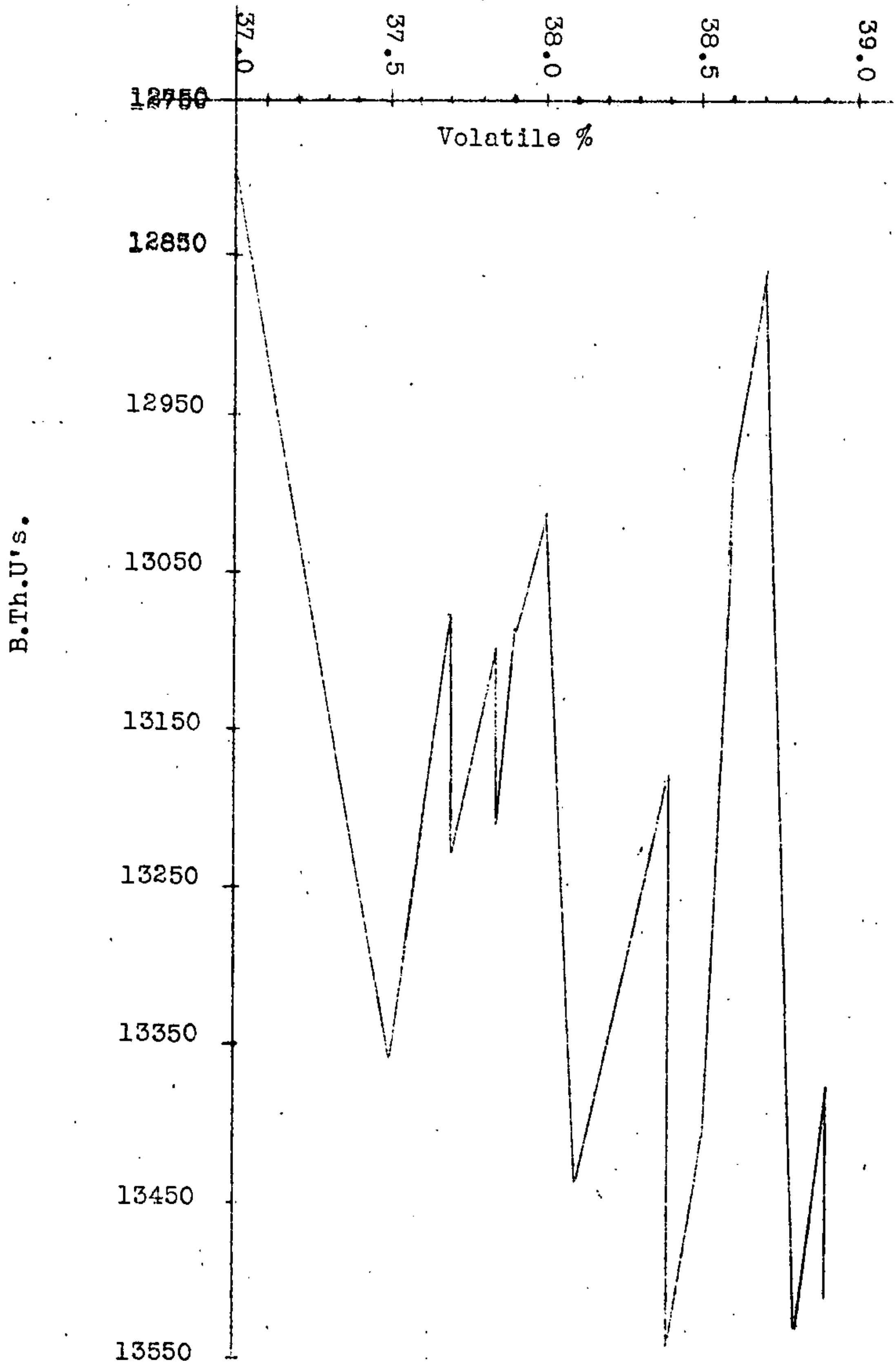
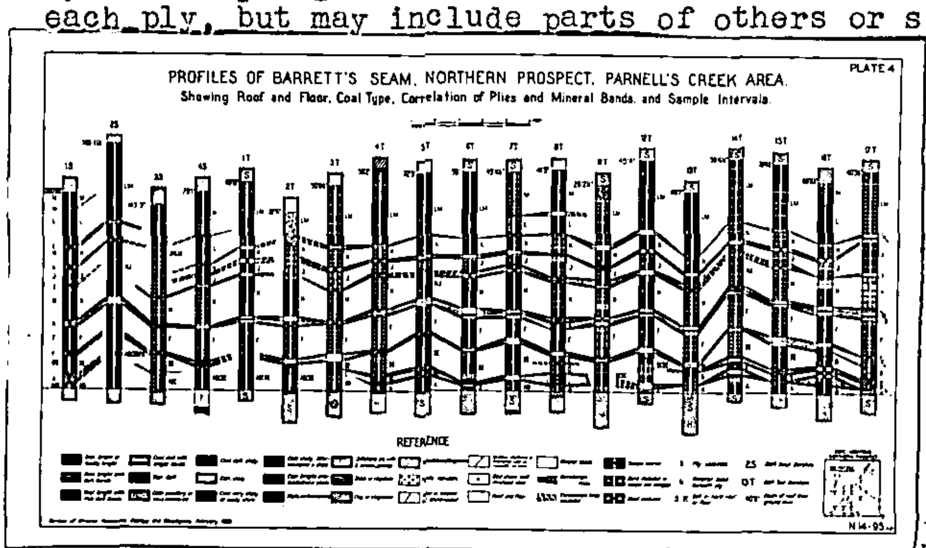


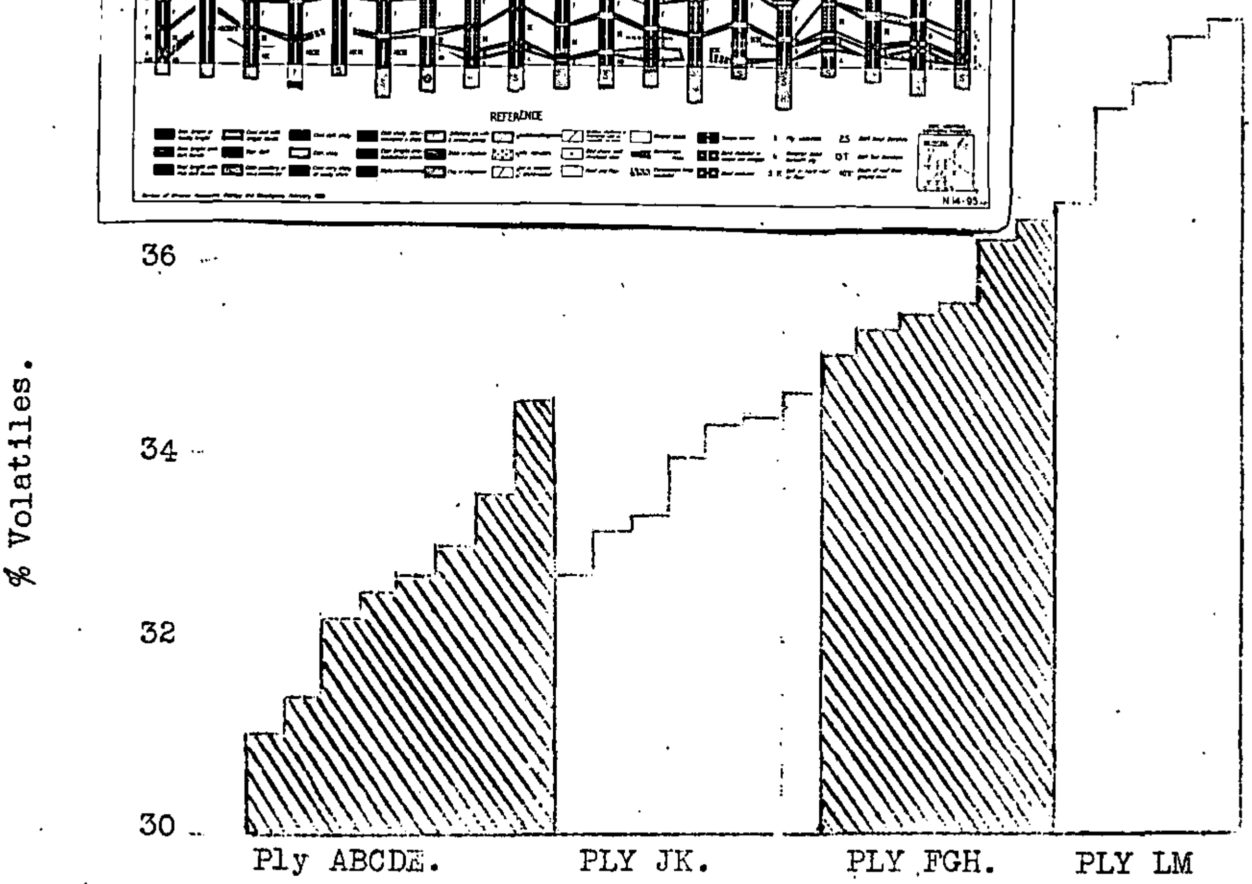
Fig.10

4.4. NOTATIONS OF PLIES IN BARRETT'S SEAM.

Plate 4 gives an approximate correlation between the plies in all cores which encountered Barrett's Seam. To facilitate correlation the type of coal as logged is shown by symbols which also attempt to give some slight quantitative geological distinctions (See 4.6.1. below).

The boreholes were not spaced closely enough to make correlations quite certain but some bands are undoubtedly very persistent. Those plies that have been distinguished are lettered from the bottom up and, as far as possible, the rock band at the base of each ply so lettered is given the lower case latter of the ply immediately above. Some plies, such as L and M are only rarely separated by a band (m) and hence are generally conjoined (in the gross ply LM). Four such main gross plies have been chosen in the following (See 4.5) considerations of mean analyses; these were largely determined by the sampling intervals which were not necessarily taken for each ply, but may include parts of others or several.





Weighted Mean Analyses
(See Table Page 32.)

4.5. QUALITY CONSIDERED PLY BY PLY.

Whereas in 4.3. above the quality of the seam is considered statistically as a unit without reference to individual plies except insofar as the original samples for analysis were selected more or less on a ply basis, the following is a consideration of each ply at least as far as the samples correspond with the plies differentiated by the correlation shown in Plate 4.

Ply M.

Analysis of Ply M and Mean.

	H.M.	V.	F.C.	ASH.	B.Th.U's	Approx. Thickness.
M 4S	3.0	37.7	49.5	9.8	13,080	23"
M 7T	3.7	37.9	49.4	9.0	13,090	22½"
M 8T	3.2	36.6	53.6	6.6	13,350	21½"
M16T	3.3	38.6	48.0	10.1	13,080	13"
S	13.2	150.8	200.5	35.5	52,600	80"
A.M.	3.3	37.7	50.13	8.88	13,250	20"
W.M.	3.3	37.6	50.36	8.76	13,152	

Ply L.

Analysis of Ply and Mean.

	H.M.	V.	F.C.	ASH.	B.Th.U's	Approx. Thickness.
L 4S	3.8	37.5	51.5	7.2	13,360	13½"
L16T	3.8	38.8	51.4	6.0	13,530	18½"
S	7.6	76.3	102.9	13.2	26,890	32"
A.M.	3.8	38.15	51.45	6.6	13,445	16"
W.M.	3.8	38.31	51.46	6.5	13,459	

Ply LM.

Analysis of Ply LM and Mean.

	H.M.	V.	F.C.	ASH.	B.Th.U's	Approx. Thickness.
LM 1T	3.7	38.4	49.5	8.4	23,180	33"
LM 3T	3.6	37.7	49.9	8.8	13,140	27½"
LM 4T	3.2	38.6	48.0	10.2	12,990	18"
LM 4T	3.9	38.4	51.9	5.8	13,540	19½"
LM 5T	2.6	38.9	50.3	8.2	13,380	9"
LM 5T	3.1	38.9	51.2	6.8	13,510	23"
LM 6T	3.0	38.0	49.4	9.6	13,020	34"
LM11T	5.4	33.3	51.2	10.1	12,340	30"
LM12T	2.3	38.5	50.9	8.3	13,410	35½"
LM14T	3.2	38.4	50.3	8.1	13,300	32½"
LM15T	4.2	37.8	50.3	7.7	13,210	33¾"
LM17T	3.9	36.8	48.5	10.8	12,740	32"
LM 2S	2.4	38.7	50.2	8.7	12,860	39½"
S	44.5	492.4	651.6	111.5	170,620	367¼"
A.M.	3.4	37.9	50.1	8.6	13,120	28.3
W.M.	3.43	37.81	50.09	8.66	13,088	

Note that samples from top and bottom of Ply LM occur thus:

S = Sum A.M. = Arithmetic Mean W.M. = Weighted Mean.

Analysis of Higher & Lower Parts of Ply LM.

LM 4T higher	3.2	38.6	48.0	10.2	12,990	18"
LM 4T lower	3.9	38.4	51.9	5.8	13,540	19½"
LM 5T higher	2.6	38.9	50.3	8.2	13,380	9"
LM 5T lower	3.1	38.9	51.2	6.8	13,510	23"

which suggests that the top half is of rather lower quality than the bottom but that the worst quality may be within the very top few inches.

Probable Ply LM.

Analysis of Probable Ply LM and Mean.

* Fractions indicate likely proportion of the ply included in the sample.

* 9/10 LM 1S	1.5	38.8	50.7	9.0	13,040	26"
? LM 3S	3.2	38.1	51.1	7.6	13,440	24"
S.	4.7	76.9	101.8	16.6	26,480	50"
A.M.	2.4	38.5	50.9	8.3	13,240	25"

Weathered Ply LM.

? LM 2T	5.5	30.3	50.4	13.8	11,350	17"

Ply KLM.

Analysis of Ply KLM.

KLM 13T	3.4	37.0	48.2	11.4	12,780	41"

* Fractions indicate likely proportion of the ply included in the sample.

K * 1/3 LM 6T	3.6	35.2	49.8	11.4	12,570	18½"
S.	7.0	72.2	98.0	22.8	25,350	59½"
A.M.	3.5	36.1	49.0	11.4	12,670	29¾"
W.M.	3.5	36.5	48.77	11.4	12,736	

* Fractions indicate likely proportion of the ply included in the sample.

Ply KL.

Analysis of Ply KL and Mean.

KL 7T	4.7	35.3	51.0	9.0	12,670	16"
KL 8T	2.8	33.2	52.5	11.5	12,680	17¾"
S	7.5	68.5	103.5	20.5	25,350	33¾"
A.M.	3.8	34.3	51.8	10.3	12,680	17"

Ply K.

Analysis of Ply K and Mean.

K 3T	4.1	32.4	51.2	12.3	12,380	20"
K 5T	4.2	34.5	48.5	12.8	12,280	9"
K14T	4.2	34.4	48.2	13.2	12,340	8"
K 4S	4.0	32.4	51.1	12.5	12,230	10"
S	16.5	133.7	299.0	50.8	49,230	47"
A.M.	4.1	33.4	49.8	12.7	12,310	11¾"
W.M.	4.1	33.14	50.15	12.6	12,321	

Ply JK.

Analysis of Ply JK and Mean.

JK 1T	4.6	33.5	49.2	12.7	12,230	8½"
JK 4T	4.3	32.9	51.0	11.8	12,340	11½"
JK11T	2.8	31.7	52.0	13.5	12,310	16"
JK12T	2.7	33.4	53.0	10.4	12,860	16"
JK15T	5.0	31.6	52.3	11.1	12,260	13"
S	19.4	163.1	257.5	59.5	62,000	65"
A.M.	3.9	32.6	51.5	11.9	12,400	13"
W.M.	3.72	32.55	51.77	11.85	12,358	

Possible Ply JK.

? JK 3S	3.5	33.3	51.7	11.5	12,580	23"

Ply J.

Analysis of Ply J and Mean.

J 8T	2.8	36.1	52.2	8.9	13,150	11"
J17T	5.0	32.9	50.1	12.0	12,120	15½"
S	7.8	69.0	102.3	20.9	25,270	26½"
A.M.	3.9	34.5	51.2	10.5	12,640	13¼" ?
W.M.	4.09	34.22	50.97	10.72	12,548	

Ply HJK.

Analysis of Ply HJK and Mean.

HJK 2S	2.4	35.2	50.4	12.0	12,310	35½"
HJK16T	4.4	33.9	50.4	11.3	12,300	30"
S	6.8	69.1	100.8	23.3	24,610	65½"
A.M.	3.4	34.6	50.4	11.7	12,310	32¾"
W.M.	3.32	34.59	50.4	11.68	12,300	

Possible Ply HJK

HJK 2T	5.3	33.8	52.7	8.2	12,750	18½"
¼ HJK 1S	2.5	34.0	50.9	12.6	12,350	21"
S	7.8	67.8	103.6	20.8	25,100	39½"
A.M.	3.9	33.9	51.8	10.4	12,550	19¾"

Ply HJ.

Analysis of Ply HJ and Mean.

HJ 4S	4.1	36.2	51.8	7.9	12,930	20½"
HJ 3T	4.2	36.3	52.6	6.9	13,300	15"
HJ 5T	3.2	35.9	51.0	9.9	12,850	20"
HJ 6T	3.5	35.6	49.6	11.3	12,730	22"
HJ13T	3.8	34.3	50.2	11.7	12,620	24½"
HJ14T	4.2	34.5	50.5	10.8	12,400	21½"
HJ 7T	4.0	34.7	51.8	9.5	12,880	26¼"
S	27.0	247.5	357.5	68.0	89,710	149¾"
A.M.	3.9	35.4	51.1	9.7	12,820	21½"
W.M.	3.86	35.25	50.97	9.88	12,837	

Ply H.

Analysis of Ply H and Mean.

H 3S	3.7	35.6	52.5	8.2	13,220	13½"
H 1T	4.1	37.8	49.8	8.3	13,100	20½"
H 4T	3.7	36.7	52.1	7.5	13,310	16"
H 8T	2.9	35.7	54.5	6.9	13,520	17"
H11T	2.6	35.9	53.3	8.2	13,380	15¾"
H12T	2.3	36.2	53.4	8.1	13,440	17"
H17T	4.5	35.9	51.7	7.9	13,140	16"
S	23.8	253.8	367.3	55.1	93,110	115¾"
A.M.	3.4	36.2	52.5	7.9	13,301	16½"
W.M.	3.14	36.2	52.34	7.87	13,290	

Ply HZ.

HZ15T	5.1	35.4	50.9	8.6	12,760	17¾"

"Ply" Between F and H.

½ F ¾ H 1S	2.3	36.4	52.6	8.7	12,940	20"

Ply FG.

FG 2T	3.9	35.0	50.8	10.3	12,700	17½"

Ply F.

Analysis of Ply F and Mean.

F 4S	4.2	36.2	52.2	7.4	12,990	16½"
F 3S	4.5	34.6	52.7	8.2	13,030	12"
F 3T	4.7	33.0	48.2	14.1	12,010	15"
F 4T	3.9	35.3	50.8	10.0	12,730	17"
F 5T	3.2	37.7	51.8	7.3	13,230	13½"
F 6T	3.7	35.7	51.0	9.6	13,000	14¾"
F 7T	3.6	36.5	52.2	7.7	13,300	9½"
F 8T	3.6	32.1	51.8	12.5	12,500	14"
F11T	2.4	36.2	53.4	8.0	13,440	16"
F12T	2.5	35.9	53.7	7.9	13,410	15½"
F13T	3.6	36.1	51.3	8.9	13,060	14½"
F14T	4.8	35.1	51.9	8.2	13,000	16¾"
F15T	4.7	35.1	49.7	10.5	12,540	15"
F16T	3.9	36.9	52.3	6.9	13,380	13½"
F17T	5.0	36.1	51.4	7.5	13,230	18"
S	58.3	532.5	774.4	134.7	194,850	221¼"
A.M.	3.9	35.5	51.6	8.98	12,990	14¾"
W.M.	3.9	35.5	51.6	9.01	12,980	

Ply DEF.

DEF 2S	2.8	32.3	45.7	19.3	11,130	31½"

Ply ABD ½ F.

ABD ½ F 1S	2.3	34.5	53.1	10.1	12,760	16½"

Ply D.

Analysis of Ply D and Mean.

D15T	5.2	32.5	48.0	13.4	12,050	11¼"
D14T	5.5	31.7	50.4	12.4	12,200	12½"
D12T	2.7	31.9	49.7	15.7	12,080	11¾"
D 7T	4.1	31.5	48.4	16.0	11,900	15½"
D 6T	4.3	30.8	46.2	18.7	11,320	14"
D 5T	3.4	33.1	46.2	17.3	11,720	15½"
D 1T	4.5	36.7	49.8	9.0	12,870	14½"
S	29.7	228.2	338.7	102.5	84,140	95
A.M.	4.2	32.6	48.4	14.6	12,020	13½"
W.M.	4.5	32.64	48.3	14,714	12,012	

Ply ABCDE.

Analysis of Ply ABCDE and Mean.

ABCDE 17T	5.3	33.5	49.1	12.2	12,340	12¾"
ABCDE 16T	4.8	32.9	49.7	12.6	12,230	20½"
ABCDE 13T	4.5	30.7	46.6	18.0	11,340	13"
S	14.6	97.1	145.4	42.7	35,910	46¼"
A.M.	4.9	32.4	48.4	14.2	11,970	15⅓"
W.M.	4.85	32.44	48.68	14.08	12,010	

Ply ABCD.

Analysis of Ply ABCD and Mean.

ABCD 11T	3.2	31.8	52.3	12.7	12,450	14¾"
ABCD 8T	3.2	28.7	45.7	22.4	11,020	16¼"
ABCD 4T	4.2	31.1	45.6	19.1	11,260	15"
ABCD 3T	5.2	31.5	47.8	15.5	11,580	14¾"
ABCD 2T	4.5	31.8	50.3	13.4	12,020	12"
ABCD 3S	4.3	31.5	49.5	14.7	11,910	17½"
ABCD 4S	4.5	34.4	51.5	9.6	12,610	11½"
S	29.1	220.8	342.7	107.4	82,850	101¾"
A.M.	4.2	31.5	48.95	15.3	11,836	14½"
W.M.	4.13	31.39	48.79	15.67	11,792	

Ply ABC.

Analysis of Ply ABC and Mean.

ABC 5T	3.4	34.0	48.4	14.2	12,190	9½"
ABC 1T	5.4	28.8	39.3	26.5	9,790	20"
ABC 2S	3.0	32.1	46.6	18.3	11,240	11½"
S	11.8	94.9	134.3	59.0	33,220	41"
A.M.	3.9	31.6	44.8	19.7	11,073	13½"
W.M.	4.26	30.93	43.45	21.34	10,750	

Ply AB.

Analysis of Ply AB and Mean.

AB 15T	4.4	32.0	45.1	18.5	11,400	9½"
AB 7T	4.6	36.5	53.0	5.9	13,240	5"
S	9.0	68.5	98.1	24.4	24,640	14½"
A.M.	4.5	34.3	49.1	12.2	12,320	7¼"
W.M.	4.47	33.55	47.82	14.15	12,032	

Ply A.

A 14T	4.5	33.0	48.9	13.6	12,230	8¼"

Summary of Mean Analyses by Plies.

M	3.3	37.6	50.36	8.76	13,152	80"	4
L	3.8	38.31	51.46	6.5	13,459	32"	2
LM	3.43	37.81	50.09	8.66	13,088	367¼"	13
?LM	2.4	38.5	50.9	8.3	13,240	50"	2
KLM	3.5	36.5	48.77	11.4	12,736	59½"	2
KL	3.8	34.3	51.8	10.3	12,680	33¾"	2
K	4.1	33.14	50.15	12.6	12,321	47"	4
JK	3.72	32.55	51.77	11.85	12,358	65	5
?JK	3.5	33.3	51.7	11.5	12,580	23	1
J	4.09	34.22	50.97	10.72	12,548	26½"	2
HJK	3.32	34.59	50.4	11.68	12,300	65½"	2
?HJK	3.9	33.9	51.8	10.4	12,550	39½"	2
HJ	3.86	35.25	50.97	9.88	12,837	149¾"	7
H	3.14	36.2	52.34	7.87	13,290	115¾"	7
HZ	5.1	35.4	50.9	8.6	12,760	17¾"	1
½F¾H	2.3	36.4	52.6	8.7	12,940	20	1
FG	3.9	35.0	50.8	10.3	12,700	17½"	1
F	3.9	35.5	51.6	9.01	12,980	221¼"	15
DEF	2.8	32.2	45.7	19.3	11,130	31½"	1
ABD½F	2.3	34.5	53.1	10.1	12,760	16½"	1
D	4.5	32.64	48.3	14.7	12,012	95"	7
ABCDE	4.85	32.44	48.68	14.08	12,010	46¼"	3
ABCD	4.13	31.39	48.79	15.67	11,792	101¾"	7
ABC	4.26	30.93	43.45	21.34	10,750	41"	3
AB	4.47	33.55	47.82	14.15	12,032	14½"	2
A	4.5	33.0	48.9	13.6	12,230	8¼"	1

By inspection of above Table and Figure 11 it is clear that there are four natural groupings of the plies. Overlapping (e.g. KLM) composite plies may, of course, be influenced more by one than another of their constituents but their frequency is low and an arbitrary choice of a group for including them in is permissable. The groups or gross-plies are approximately (1) ABCDE, (2) FGH, (3) JK, (4) LM, and by further weighting the mean the following gross-ply analyses are deducted :

Gross Ply Mean Analyses.

LM	3.35	37.72	50.14	8.8	13,090	588¾"	33%
JK	3.74	33.66	51.13	11.44	12,435	300¼"	16.8
FGH	3.7	35.62	51.62	9.33	13,095	542	30.2
ABCDE	4.16	32.15	47.9	15.81	11,766	354¾"	20.0
						1785¾"	100.0

Continuing the same process a final mean proximate analysis for the whole of Barrett's Seam is :

3.7 35.3 50.3 10.8 12,710

Gross Ply Thicknesses.

It is now possible to convert the analyses of Table above to ply thicknesses based on a mean seam of 9 ft. (8 ft. excluding most rock bands).

Mean Ply Thicknesses (Approx.)

LM	2'7"	36.5	to	38.5% volatiles	*
JK	1'4"	33.1	to	34.6% volatiles	*
FGH	2'5"	35.0	to	36.4% volatiles	*
ABCDE	1'7"	30.9	to	34.4% volatiles	*
Bands	1'1"				
	9'0"				

This Table can be compared with Table on Page 23 deduced from statistics of the seam in bulk.

* See Figure 11

4.6 DEPOSITIONAL FEATURES.

4.6.1. Geological Descriptions of Coal.

The borelogs (Appendix IX) contain geological descriptions of coal bands, plies etc., varying from a fraction of an inch to three or four feet according to differences observed by the logger. Because the descriptions were field observations no attempt was made to give them a petrographic basis nor was any physical test applied except in cases of doubt as between shaly coal and carb. shale, where an approximate s.g. test (not measurements) may have been made. It can be seen from Plate 4 which has been compiled from the detailed descriptions, that with minor variations, eleven graded distinctions are made by the loggers:

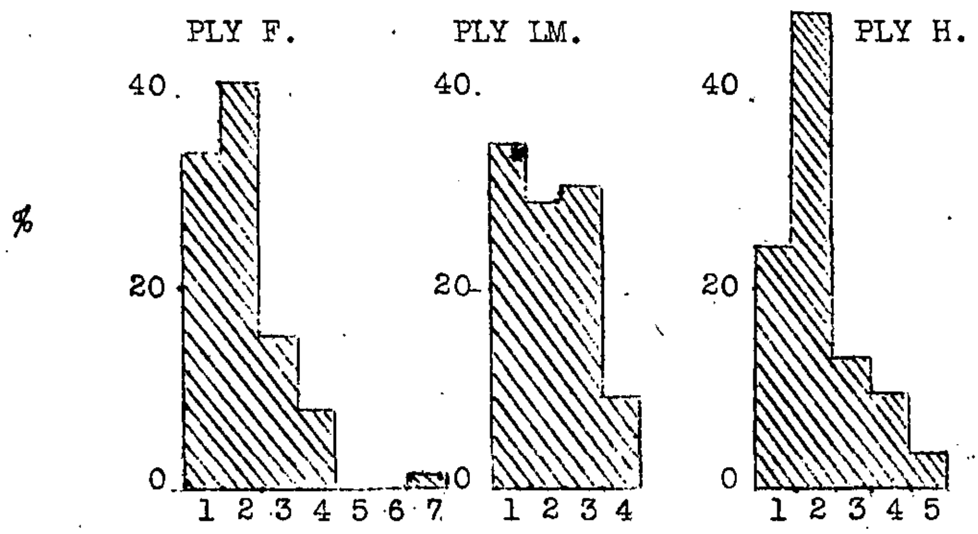
1. Coal, bright or mostly bright
2. Coal, bright with (more, or less) dull bands
3. Coal, bright with thin dull bands
4. Coal, dull with bright bands
5. Coal, dull
6. Coal, powdery, or smut, weathered
7. Coal, dull, shaly
8. Coal, shaly
9. Coal, very shaly or coaly shale
10. Coal, (Shaly, bright, dull) interlaminated with shale
11. Shale, carbonaceous

to which may be added:

12. pyritic, marcasitic
13. bed is cleaved, slickensided
14. bed consists of broken, shattered or fractured coal as revealed in core.
15. bed shows a well developed cleat

The presence of ankerite, calcite etc. veins, limonite stains and so on may also have been noted. The greatest extent of quantitative description is contained in such relative terms as "mainly bright", "few dull bands" and so on.

Fig.12 Fig.13 Fig.14



Types of coal according to geological description.

Plate 4 shows that individual plies vary very much over short distances and the value of these descriptions for geological correlation is small. Different plies show a characteristic coal composition in terms of the descriptions; thus the figures above show the percentage composition of the total length of ply cored for the plies H, F and LM. The lateral persistency of these compositions cannot be determined until many more profiles are available, but is likely to be low.

The following Tables show that within each descriptive term there exists a wide variation of chemical properties determined by proximate analyses. Clearly shaly coal is recognised with certainty but the bulk descriptions of other than shaly coal does not correlate with the proximate analyses at least in the few cases taken.

Comparisons of Coal Types with Analyses.

Bright.

LM	1T	3.7	38.4	49.5	8.4	13,180
F	5T	3.2	37.7	51.8	7.3	13,230
D	5T	3.4	33.1	46.2	17.3	11,720
?	5T	3.4	34.0	48.4	14.2	12,190
LM	6T	3.0	38.0	49.4	9.6	13,020
K	6T	3.6	35.2	49.8	11.4	12,570
F	6T	3.7	35.7	51.0	9.6	13,000
?D	7T	4.1	31.5	48.4	16.0	11,900
?	7T	4.6	36.5	53.0	5.9	13,240
LM	12T	2.3	38.5	50.9	8.3	13,410
?	12T	2.3	36.2	53.4	8.1	13,440

Mainly Dull.

?	2T	5.5	30.3	50.4	13.8	11,350
F	11T	2.4	36.2	53.4	8.0	13,440
?	17T	4.5	35.9	51.7	7.9	13,240

Coal Dull with Bright Bands.

HJ	3T	4.2	36.3	52.6	6.9	13,300
F	3T	4.7	33.0	48.2	14.1	12,010
H	4T	3.7	36.7	52.11	7.5	13,310
F	4T	3.9	35.3	50.8	10.0	12,730

Coal Shaly Interlaminated with Shale.

(5)	1T	5.4	28.8	39.3	26.5	9,760

Bright Coal with Some Dull Bands.

(2)	17T	5.0	32.9	50.1	12.0	12,120
(1)	14T	3.2	38.4	50.3	8.1	13,300
(1)	11T	5.4	33.3	51.2	10.1	12,340
F	2T	3.9	35.0	50.8	10.3	12,700

Coal Dull and Bright with Shaly Coal.

		4.2	31.1	45.6	19.1	11,260

Carb. Shale with Some Bright and Dull.

3.2	28.7	45.7	22.4	11,020

Conversely, taking the descriptions for the 12 analyses showing volatile contents of 38.0% and above :

38.0	Bright
38.1	Bright & dull, mainly bright
38.4	Bright
38.4	Bright & dull
38.4	Bright with some dull
38.5	Bright
38.6	Bright with some dull bands
38.6	Bright and dull
38.7	Bright
38.8	Bright and some dull
38.9	Bright with some dull
38.9	Bright with rare dull.

It is apparent that bright coal preponderates but that the group is confined to the seams L, M or LM where some consistency might be expected.

The evidence is not conclusive but it seems that most of the geological descriptions in common use are almost without value, at least in the case of Barrett's Seam, can be discounted without loss and should be replaced, if at all, by quantitative descriptions which will serve either to correlate the seam or ply geologically or give some prescience of the proximate analysis.

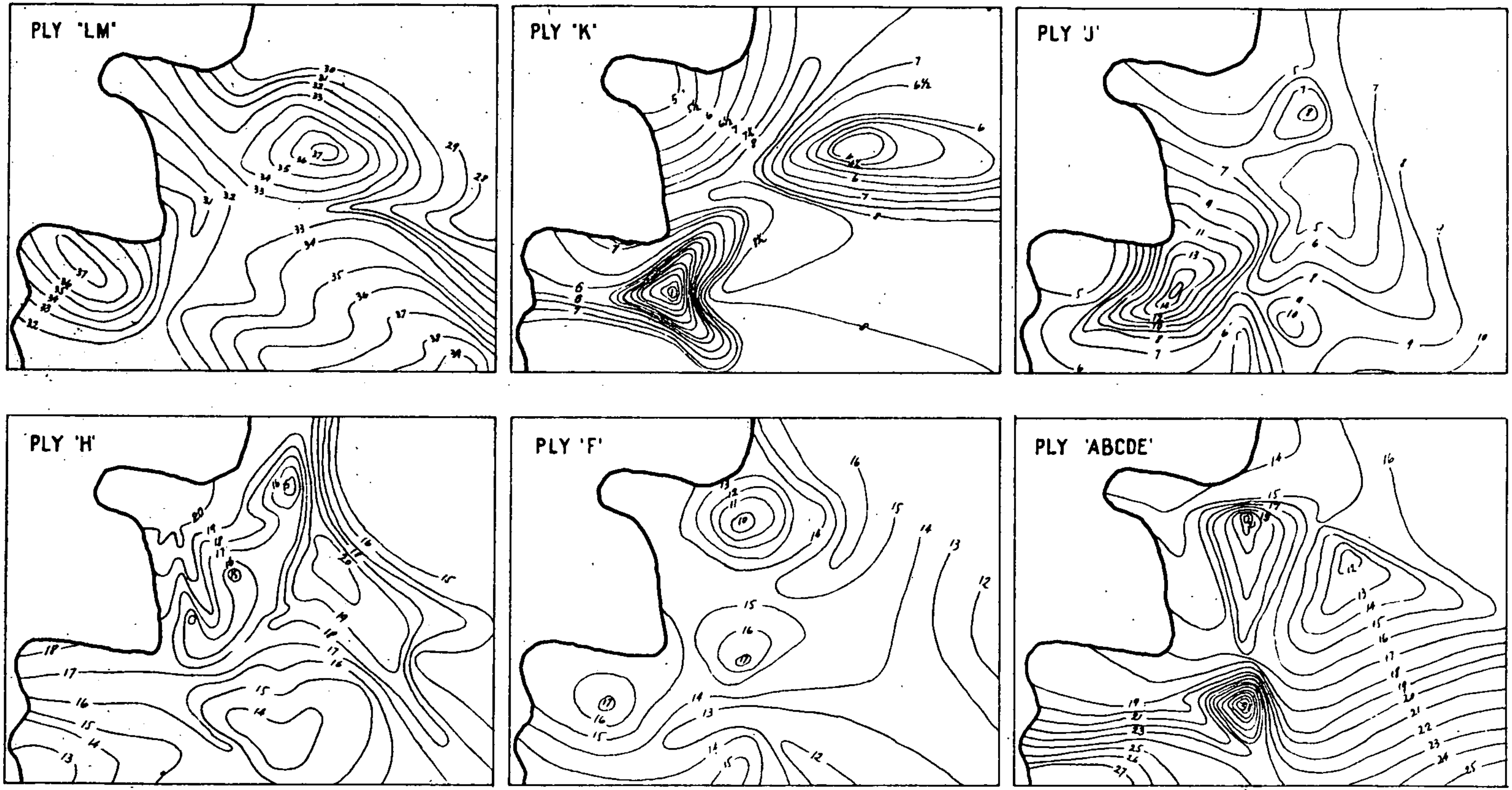
4.6.2. Roof, Floor, Bands and Plies.

No physical or chemical tests were made of either roof or floor of Barrett's Seam. In a few bores the logger has stated whether roof or floor is hard or soft and these are noted in Plate 4. Generally both are soft at the coal seam contacts. In bores 5T, 7T and 15T the underlying greywacke occurrs within 6" of the coal floor and in 11T within slightly over 1 ft. Roof and floor are always argillaceous.

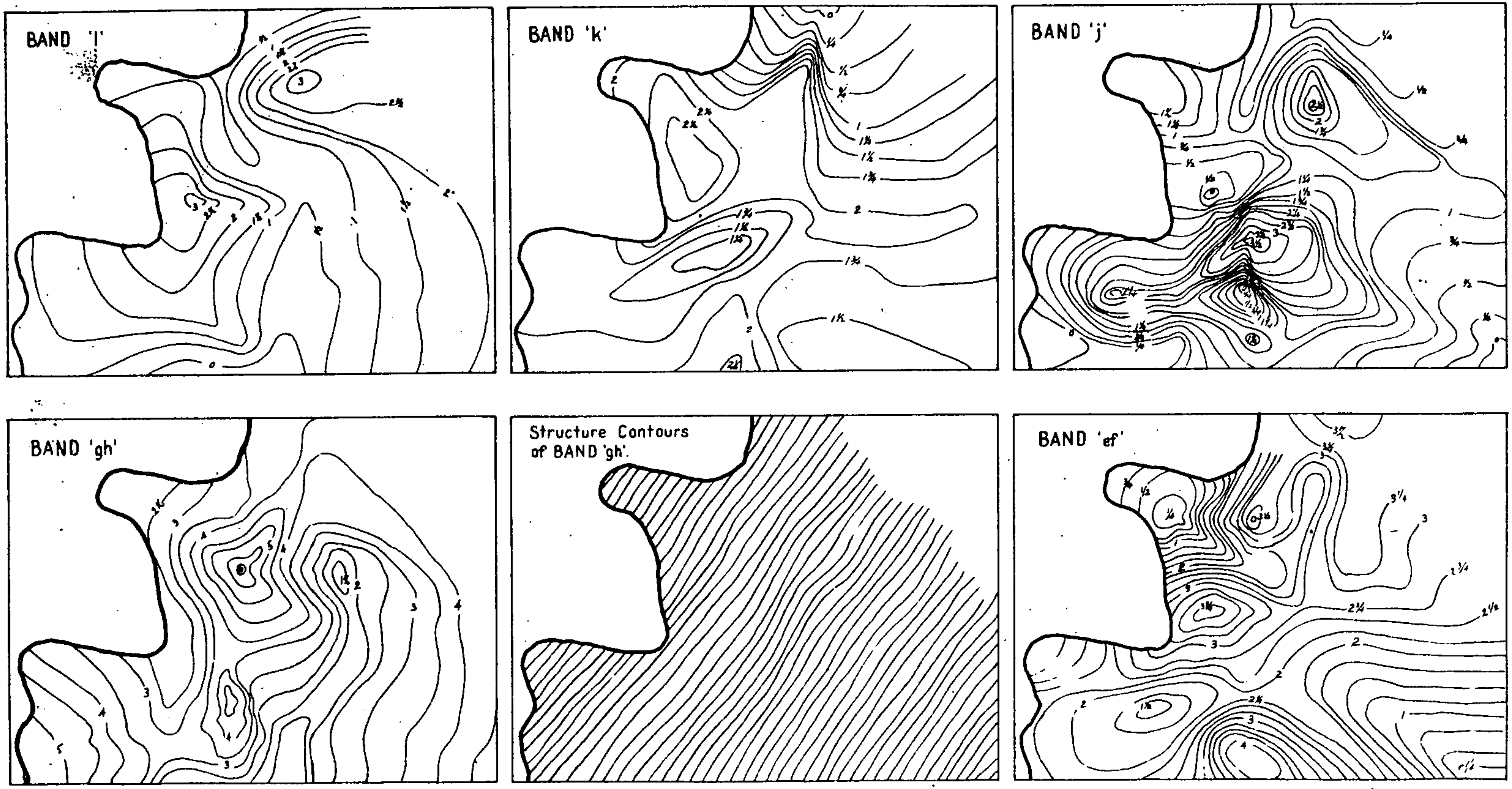
The bands, which make up about 12% of the seam profile, are about equally clay or claystone and siltstone and tend to be rather soft. The clay is very often laminated very finely, forming a paper-shale when dry, and is generally brownish to grey-brown; it is often mottled white, occasionally pyritic, and commonly charged with disseminated siderite. In places it is montmorillonitic and slacks very readily in water. The siltstone is often sandy and brown-tinged with more or less clayironstone admixed.

The coal seam deposition makes a hesitant start as shown by the high ash and many bands occurring below band f. Above this a fairly good quality coal is deposited in Plies F and H. Plies J and K, associated with three closely spaced bands J, K, and L, are rather inferior, while the best quality coal in Ply LM grades upwards into inferior coal and the roof.

ISOPACHS OF COAL PLIES IN BARRETT'S SEAM



ISOPACHS OF MINERAL BANDS IN BARRETT'S SEAM



An attempt (reduced in Plate 14 opposite) has been made to draw isopachs for the main plies and seams but it is not possible to draw serious conclusions as to the course of intermediate sedimentation or any areas of relatively uninterrupted coal deposition.

Plate 1 gives structure contours on the top of Barrett's Seam and Plate 2 at the bottom, while Plate 14 shows structure contours at the bottom of Band gh (the most persistent band). No considerable anomalies occur but the bore spacing may not be close enough to draw contours sensitive to small irregularities.

4.7. GRAY-KING CARBONISATION DETERMINATIONS.

The Chief Geologist issued instructions that samples of coal currently being investigated for likely open cut prospects should be subjected to some form of test for its suitability as gas coal. No test at that stage of work could be relied upon as a certain criterion for the following reasons :

1. Only small and statistically inadequate samples were obtainable from boreholes; this is a specially prominent difficulty in the case of gas tests, for gas works require a variety of special properties.

2. It was impossible (a) to obtain the quantity (200 to 250 tons) or (b) to organise the facilities for a full retort test, which is conclusive.

3. No facilities existed for any but a (laboratory) Grey-King test, the inadequacy of which is clearly apparent from its procedure and was stressed by the several authorities consulted. (Joint Coal Board, State Mines Department, Australian Gas Company et al.

The N.S.W. State Mines Department kindly agreed to attempt a determination and modify the test as seemed suitable. Of three boreholes so tested one, BMR 17T, was located in the Northern Prospect and involved Barrett's Seam.

The borehole BMR 17T had already been drilled with 100% linear recovery in coal, the coal sampled and analysed. It was considered that this constituted a reasonable control. Another hole was located within a yard or two of BMR 17T, drilled to roof and cored through Barrett's Seam. The core recovery was again 100% and the borelog very nearly identical with that already recorded for the previous bore. The core, however, was not sampled by the Bureau so that the analyst should be in a position to have all the material available for his determination.

The State Mines Department reported (Appendix XII) the following results :

Gray-King Determination, Barrett's Seam BMR 17T.

Yield per ton	Sample 2875	Blend as used in Gas Works
Coke cwt.	13.0	12.7
Tar galls.	8.5	13.1
Gas c.f. (30"60°F)	12,200	12,800
Therms	85.4	94.7
Calorific Value of Gas(B.Th.U's c.f.)	700	740
Gravity of Gas	0.47	0.48
Therms per ton	75 *	78 *
Calorific Value of Gas (Works)	540 *	
Moisture	4.3	2.5
Volatile	36.3	38.5
Fixed Carbon	50.6	50.5
Ash	8.8	8.5
Coke	Cw.	Cw.

* Calculated.

The State Mines Department also reported that "There are a number of discrepancies between the log supplied by the BMR and the core received in the laboratory" and this difference can be checked from their report (Appendix XII) and the BMR borelog. It is not considered to be significant.

The proximate analysis for State Mines Department 2875, which can be referred to Ply LM is some way, in volatiles, below the weighted mean of all analyses of all Bureau samples of that Ply submitted to and analysed by the State Mines Department, but is only slightly less (0.5%) than the sample from the original BMR 17T which itself has the lowest recorded volatile fraction for the Ply except the slightly weathered (5.4% moisture) BMR 11T.

It can be said that according to this test of one sample of the best ply of Barrett's Seam the coke produced in a gas works retort would be poor quality and by comparison with a typical coal blend used in a gas works the coke yield would be high while the tar and calorific value of gas produced would be low.

The determination is inclusive but others might prove valuable.

4.8. WEATHERING.

4.8.1. Evidence of Weathering.

BMR 18T was located so that only part of Barrett's Seam was encountered and that wholly weathered. Bores BMR 2T and 11T showed physical weathering of the upper ply (LM) of Barrett's Seam. The hygroscopic moisture content of the samples from 2T was high (ca. 5.4%) to 32' and in 11T (5.4%) to 30'. However, 17T showed uniformly high moisture content (av. 4.75%) throughout from about 40' to 50' although no physical weathering was obvious. Similarly high moistures seem to occur adventitiously elsewhere, as in 15T between 86' and 87' and 82' and 84'; again in 14T between 63' and 65'. Bore 4T also has a high moisture (5.4%) at 47'9" to 49'5" although plies above this level in the same bore show lower moisture (3.7%) from 46'6" to 43'3". The mean moisture content for the seam is 3.7% Other seams than Barrett's were not penetrated within the weathered zone.

It is therefore probably safe to assume a weathered zone of 30' from surface which may increase somewhat beneath main creeks.

4.8.2. Estimates

4.8.2.1. Barrett's Seam (9 ft. thick).

Overburden : coal = 3:1

(a) Gross (weathered and unweathered coal undifferentiated)

Area - 66.3 acres.
Tonnage - 908,500

(b) Net (coal unweathered).

For this estimate, a zone of weathering to a depth of 30' is assumed. From the outcrop of the seam to the 21' overburden isopach, all the coal is within the weathered zone. From the 21' isopach to the 27' isopach, unweathered coal increased in thickness from 0' to 6'. The area lying between the coal outcrop and the 21' overburden isopach is 7/9 of the area over which the gross tonnage was computed. The part of the gross tonnage which is completely weathered is thus 707,000 tons. Between the 21' and 27' overburden isopachs the average thickness of unweathering coal may be taken as $\frac{0+6}{2}$ ft. i.e. 3 ft. and as this is found over 2/9 of the gross area, and the thickness is 1.3 of the normal seam thickness, then this unweathered coal in this net area is :

2/9 x 1/3 x 908,500 i.e. 68,000 tons over an area of 15 acres (2/9 x 66.3 acres.)

Thus reserves within the 1:3 ratio are :

<u>68,000 tons</u> over 15 acres

The weathered coal within this ratio aggregates

<u>840,000 tons</u>.

Ratio 1:5

(a) Gross

Area - 116 acres
Tonnage - 1,590,000 tons

(b) Net

Weathered coal between the 27' to 45' overburden isopachs stops at the 30' isopach and since this amount would practically be negligible, it is not taken into consideration.

The weathered coal up to the 5;1 ratio limit is the same as for the 1;3 ratio i.e. 840,000 tons. The net tonnage is then :

750,000 tons (1,590,000 - 840,000) over an area of 64.7 acres.

Ratio 1;7

(a) Gross

Area - 181.3 acres
Tonnage - 2,485,000 tons

(b) Net.

The amount of weathered coal is 840,000 tons, leaving a net tonnage of 1,645,000 tons over 130.0 acres (181.3 - 51.3)

Ratio 1;9

(a) Gross

Area - 227.3 acres
Tonnage - 3,117,000 tons

(b) Net

Amount of weathered coal is again 840,000 tons, leaving a net tonnage of 2,277,000 tons over 176.0 acres (227.3 - 51.3)

4.8.2.2. Liddell Seam Lower Split (6 ft. thick).

Ratio 9;1

(a) Gross

Area - 45.9 acres.
Tonnage - 413,000 tons

(b) Net.

All this seam is weathered except for that part over an area of 6 sq. ins. (seen from sections) on map, actually 5.5 acres representing 49,500 tons.

Upper Split (8 ft. thick)

Ratio 9:1

(a) Gross

Area - 58.8 acres
Tonnage - 705,000 tons

(b) Net.

Of the gross amount approximately 2.5 are weathered, leaving 23.5 acres with 282,000 tons.

4.8.2.3. Artie's Seam.

Lower Split (8 ft. thick)

Ratio 9:1

(a) Gross

Area - 70.7 acres
Tonnage 850,000 tons

(b) Net.

Approximately 1/3 is weathered, leaving 47 acres with 566,000 tons.

Upper Split (6 ft. thick.)

Ratio

(a) Gross

Area - 64.3 acres
Tonnage - 578,000 tons

(b) Net.

Approximately 1/3 is weathered leaving 43 acres with 386,000 tons.

SUMMARY OF RESERVES.

SEAM	Overburden / Coal Ratio	Gross Area (Acres)	Net Area. (Acres)	Gross (Tonnage.)	Net (Tonnage.)
Barrett's	3:1	66.3	15.0	908,500	68,00
	5:1	116.0	64.7	1,590,000	750,00
	7:1	181.3	130.0	2,485,000	1,645,00
	9.1	227.3	176.0	3,117,000	2,227,00
Liddell Lower	9:1	45.9	5.5	413,000	49,50
Liddell Upper	9:1	58.8	23.5	705,000	282,00
Artie's Lower	9:1	70.7	47.0	850,000	566,00
Artie's Upper	9:1	64.3	43.0	578,000	386,00
Total Tonnages				5,663,000	3,560,00

TOTAL TONNAGES OVER NORTHERN PROSPECT.

SEAM	GROSS	NET	AMOUNT WEATHERED
Barrett's	6,310,000	5,470,000	840,000
Liddell Lower Split	2,340,000	1,976,500	363,500
Liddell Upper Split	2,280,000	1,857,000	423,000
Artie's Lower Split	1,873,000	1,589,000	284,000
Artie's Upper Split	992,000	800,000	192,000
	13,795,000	11,692,500	2,102,500

SECTION 5

OVERBURDEN.

5.1. CONSTITUENT ROCK TYPES.

The constituent beds of the overburden are lenticular; boreholes have not been sited close enough together to accurately locate the extent of the many lenses penetrated: it has not been thought wise therefore, to attempt a detailed overburden section. Borelogs show that seven descriptive terms were used for the overburden. These are listed below in order of magnitude as recorded in total linear overburden penetrated :

	Proportion	S.G. (av.)	Cu. Yds.	
Greywacke	47%	2.47	3,269,000	
Sandstone	16%	2.5	1,113,000	Conversion
Clay	16%	2.45	1,113,000	factor to
Clay shale	7%	2.5	495,000	tons approx.
Siltstone	7%	2.49	495,000	
Claystone	5%	2.40	398,000	1.88
Sand (usually ferruginous.)	1%	2.7	69,000	
Shale	$\frac{3}{4}$%	2.43	52,000	
Clayironstone	$\frac{1}{4}$%	3.43	17,000	

The amount of overburden is given (See 4.1) very approximately for each estimate of coal reserves beneath maximum overburden to coal ratios of 3, 5, 7 and 9 to 1.

The terms sandstone, sand and clay refer to more or less weathered rock. The overburden is predominantly arenaceous. Within the soil profile the weathered greywacke does not retain much of a resemblance to unweathered greywacke. The clay is also mostly within the soil profile. Claystone, siltstone, shale and claystone may grade imperceptibly into one another laterally and vertically. Clayironstone and siderite may exist as stringers, nodules, replacement of fossil wood, lenses, bands and irregular semi-or wholly diagenetic masses. The petrology is briefly considered in Section 5.3 below.

5.2. PHYSICAL PROPERTIES.

Some approximate specific gravity (bulk density) determinations were made by M. Reynolds, BMR Muswellbrook laboratory.

Greywacke f. grd. wd.		2.32
" v.f. grd.		2.51
" m.c. grd.		2.46
" m.c. grd)	Tough	2.51
" m.c. grd.)		2.52
Siltstone gy.		2.47
		2.51
Silty claystone		2.40
Shale gy. silty in part		2.50
		2.44
		2.29
Shale silty		2.43
Clayironstone w. wh. calcite veins		3.43
Hd.gy.bds. siderite w. cone in cone structure		2.78
Sdy. ironstone red.br.		2.79
Sideritic siltstone		2.63
Doleritic rock		2.75

The arenaceous rocks are very hard, generally compact with low porosity. Cementation is usually total but pressure welding has not been observed, the rock deriving much of its tenacity from the wide variation of grain sizes and irregular grain shapes which greatly reduce interstitial space in the coarser grades. The siltstone is commonly dense with a large clay fraction some of which is often sideritised.

The area is apparently unfaulted and there is proportionally a minimum of dynamic effects. Jointing and fissuring if it exists, has not been obvious in cores, but subvertical jointing is so common elsewhere in similar beds that it may well obtain here in places. The lenticular shape of the beds and the irregular current bedding combine to prevent well marked cleavage, even in the more argillaceous rocks, for bedding planes rarely exist; in its most massive form the greywacke is a freestone with a barely perceptible tendency to break horizontally. Lenses may, however, tend to fracture at their surfaces.

Weathering oxidises the ferrous carbonate and dissolves the calcium carbonate cements, and no doubt provides planes of weakness by oxidising clayironstone, which often bonds masses together, to limonite and other hydrated oxides. Thus some of the greywacke is altered from hard greenish white to soft, and sometimes incoherent brown rock, but much retains its hardness and coherence even in the brown oxidised state. Drilling rates are considered elsewhere (See Section 7).

5.3. PETROLOGICAL CONSIDERATIONS OF SEDIMENTS.

A number of rock samples were taken and sections cut from them during the coring of Bayswater BMR No. 1 Deep Scout Bore. The sectioning was done at Canberra and supervised by W.Dallwitz. Although the beds penetrated are very lenticular in shape, all boring has demonstrated a considerable similarity of the Tomago sediments so that the rocks from Bayswater will not greatly differ from those in the Northern Prospect. A few sections from other areas were cut and examined by W. Dallwitz; these will be reported on when the appropriate area is considered in later Records. Examinations of the following rocks were made at the Maitland field office. Samples and slides are retained in the Bureau collection.

The rock samples chosen for sectioning were of five orders (1) rudites (2) arenites (3) lutites (these terms are as used by Condon *) (4) rocks containing siderite in a characteristic form and (5) tuffs.

The rudites were the following in order of maximum size of phenoclast:

Sample.	Approx. Depth.	Phenoclast.
RW 24	520 ft.	3.5 cms.
13	520	2.0
11	184	1.9
22	514	1.6
8	158	1.0
7	146	0.9

In the hand specimen all of these are very similar. They vary from greywacke with occasional pebbles or gritty greywacke with scattered pebbles to fine conglomerate of the greywacke type. The overall colour is light to medium grey. The phenoclasts are polygenetic, much the same in all samples, the commoner being (1) very weathered green ? volcanic rock (2) grey-brown quartzite (3) light brown porphyry (4) various grey to brown cherty rocks (5) rare vein quartz (6) blackish quartzites (7) ? basalt (8) brownish altered sandstone (9) jasperoid chalcedonic rocks. They are commonly rounded to subrounded, a few subangular, and are often well weathered though indurated in the process of cementation. The rock is hard, firmly cemented and not very porous.

Under the microscope it is difficult to distinguish and name the rock types present as detritus: they are better distinguished in the hand specimen. Free quartz grains, mostly euhedral, are fairly common but few accessory minerals have survived alteration. Most of the rock fragments are fine grained, cherty or quartzose. Sample 7 contains a small pebble with micrographic intergrowth of quartz and felspar.

Cementation occurs by four methods which appear in all samples : (1) reaction; the boundaries of the grains, particularly between the quartzites and some less easily recognisable grains, are seen to merge into each other indefinitely at their contact; (2) recrystallisation (or enlargement); this is very well developed in Sample 7, especially between chalcedonic pebbles, between which a chalcedonic cement has grown: (3) degradation; this probably constitutes the main cause of cementation; the weathered pebble and grain surfaces have formed a continuity with a clay-based matrix which invaded the less resistant grains, in particular the plagioclase felspars; (4) carbonation; this is a normal interstitial infilling of carbonate and occurs in the more porous samples; what appears to be a carbonate and may be calcite or siderite or both, fills occasional interstices; frequently the carbonate is impure, containing some of the clay fraction; it is reactive and occasionally replaces an entire detrital grain which retains some of its original shape, or invades it leaving, as in

* Descriptive Nomenclature of Sedimentary Rocks BMR Nov. 1951.

Sample 23, a curious skeleton-crystal or scopulitic structure. There seems to be no evidence of pressure welding.

The samples of arenites are as follows ;

Sample	Approx. Depth.	Max Grain Size.	Av. Grain Size.
RW 6	128 ft.	2.6	1.0 mms.
20	507	1.6	0.32
15	391	1.2	0.3
30	856	1.45	0.24
33	964	0.84	0.36
18	484	0.6	0.16
14	369	0.68	0.12

Again, in the hand specimen, the arenites are seen to be very similar, varying from whitish grey to medium grey; the whitish variety looks faintly green when wet. All are hard, compact, not very porous, moderately well sorted and have a pepper and salt appearance due to the presence of dark rock and carbonaceous fragments and quartz or light rock fragments. The finer grained varieties are very tough. Bedding is rarely apparent but is irregular when present. Dilute hydrochloric acid has a very slight effect on all samples.

Under the microscope the grains are seen to be of very much the same rock types as the rudite phenoclasts with more or less quartz and very few ferromagnesian or other accessory minerals. The grains vary in shape from elongate to sub-rounded but rarely show the high sphericity of many of the rudite pebbles; many are angular to subangular, the angularity varying inversely with size. The quartz and felspar are singularly fresh, more or less euhedral; the quartz grains are commonly fractured crystals retaining several perfect faces and undamaged coigns. Cherty (chalcedonic) and quartzite fragments are dominant. There is much interlocking of grains, interstices being filled with smaller grains, so reducing porosity. The fraction below arenite grain size (say 0.12 mms) is quite small, probably rarely above 10% if sideritic material is excluded. All estimates given here of the proportion of constituents of the rocks are very approximate only, determined by rough inspection of the section.

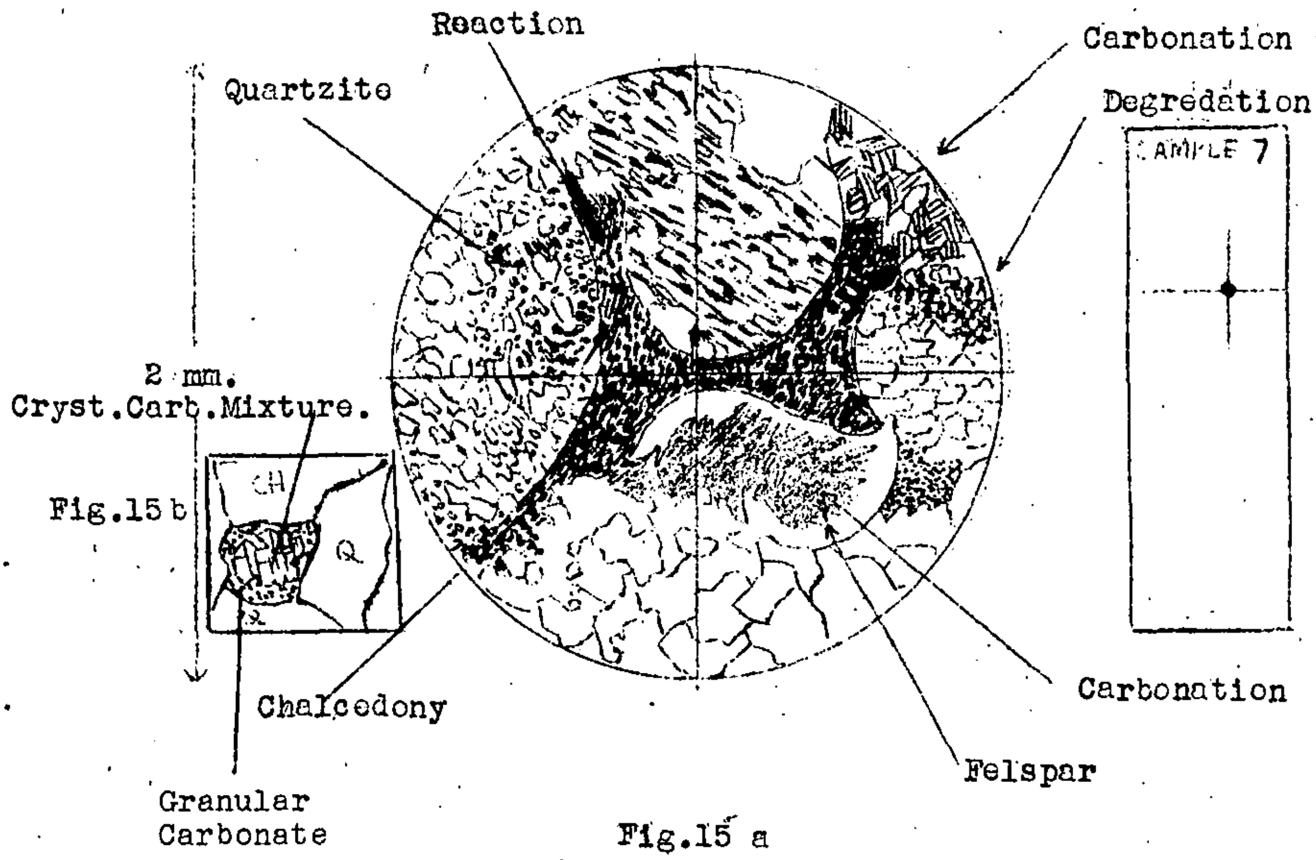


Fig.15 b

Fig.15 a

Sample	Estimated detrital quartz fraction.
RW 6	7%
20	7
15	5
30	8
33	7
18	10
14	10

Plagioclase always occurs and potash felspars are common, but the total felspar fraction is always less than 5% The felspars while retaining their euhedral shape are commonly weathered to some extent.

Cementation of the arenites is the same as the rudites (See Figure 15(a) above). The carbonate cement exists in two forms (1) a brown granular material, probably clayey ferrous carbonate and (2) a crystallisation of this which almost invariably consists of small crystals of mixed carbonates, calcium, ferrous and probably magnesium, in solid solution (See Figure 15(b)).

The carbonate cement attacks rock fragments as well as the clayey degradation cement and the surface of felspar and other grains. It forms with clayey material an indeterminate mixture with aggregate polarisation. There is evidence that the absence of mica and other ferromagnesians in the presence of fairly fresh plagioclase may be due to attack, or at any rate replacement, by carbonate; some of the degradation cement is clearly sericitic. A few grains are evenly coated with dark brown granular ferrous carbonate.

Sample		Estimate of Carbonate Content.	
Rw 6		10%	
20		10	
15		25	including clay
30		20	
33	less than	5%	
18		30	
24		15	including clay

In all borelogs the name greywacke has been given to these arenites. The writer introduced this term during the logging of the Bayswater bore and has since retained it in use for sediments elsewhere not with any great conviction of its pertinence but as an attempt to accord with Condon's classification and to publicise the low quartz, high comminuted rock content. The barbarism "sub-greywacke" might be more acceptable but the term sandstone cannot be used.

Samples of the lutite group are all chosen close to the arenite-lutite gransize boundary, thus :

Sample	Max.Grain Size.	Av. Grain Size.	Approx. Depth.
RW 12	0.63 mms	0.1 mms.	186 ft.
2	0.2	0.12	48
13	0.5	0.26	336
38	0.25	0.09	1148
37	0.35	0.1	1131
21	0.3	0.07	204
5		0.04	113
19	0.7	0.09	488
103	0.15	0.04	1342
100			1339

Except in grain size most of the samples differ little from the arenites. The higher proportion of carbonate in some cases reduced the cohesion of the grains but in others may produce a uniformly well cemented and non-porous rock. There is a tendency for coarser lutites or finer arenites to be jointed but jointing appears to lessen as the clay fraction increases. Generally the larger the clay fraction the darker grey the rock and the higher the carbonate content the lighter the rock in colour except where ferrous carbonate preponderates.

The quartz fraction consists of very angular grains and increases inversely as the grain size size except in more clayey lutites.

Sample.	Estimated Quartz Content.
RW 12	15%
2	27
13	30
38	50
37	50
21	40
19	30
5	15
103	Mainly non-detrial
100	Mainly non detrital

Plagioclase, rare potash felspar, biotite, sericite, chlorite and rare olivine occur in most samples. The more clayey varieties naturally contain much mica.

It is often very difficult to distinguish the clay from the sideritic clay and other carbonate fractions. Very approximate estimates of the carbonate contents are :

Sample.		Estimated Carbonate Content.	
RW 12		5%	
2		70	including clay
13		7	
38	less than	1	
37		5	excluding veinlets
21		5	
19		5	
5	less than	5	
103		80	carbonate and clay
100		100	calcium carbonate with ? devit. glassy shards.

As in the arenites the carbonate is usually complex and exists in a granular clayey form or minutely crystalline.

In the granular form there is evidence that it was deposited contemporaneously with the detritus as a plastic precipitate in the form of flocculi. Occasionally calcite veinlets occur along joint planes. Sample RW 2 is almost a carbonate rock with a fairly large clay fraction and scattered quartz grains. Sample RW 103 is a marl and RW 100 a pure limestone possibly of tuffaceous origin as there are faint suggestions of devitrified glassy shards.

Rocks composed mainly of ferrous carbonate (siderite) are very varied. It is certain that few rocks from rudites to clays are without some proportion of siderite. The following samples consist mainly of siderite in order of grain size of the small detrital fraction they contain :

Sample.	Approx. Depth.	Form of Siderite.
RW 31	861	Equal siderite and clay with scattered quartz and rock grains.
26	743	As above
35	1118	As above
32	948	Sphaerosideritic iron-stone
25	728	Clayironstone.

The clayironstone is normal. An analysis of a nodule is as follows : *

Gangue	17.3
Alumina, etc.	6.1
Iron carbonate	65.6
Calcium carbonate	4.5
Magnesium carbonate	5.5
Organic matter, moisture etc.	1.0
	100.0%

The mixed silty or sandy siderite contains ferrous carbonate either as small, ill-defined crystals or as irregularly shaped flocculi which are finely granular and reticulate, showing a fine network structure of darker lines in the brown mass. In carbonaceous rocks these flocculi may coalesce into irregular globose masses along the bedding planes, often surrounded by woody tissue, suggesting an origin between layers of or within vegetable tissue. These flocculi can also occur scattered along the bedding planes of the arenites. Sample RW 32, a dense black ironstone, is a beautiful example of sphaerosiderite, containing perfect zoned spherulites of siderite. Clearly the invasion of the siderite into arenites is, and some nodules are, diagenetic; some of the flocculi are deposited as such along with the detritus, possibly by a co-precipitation process and others, particularly the globose material and spherulites, are formed in situ within the soil profile. The reticulate structure may substantiate a flocculous, precipitated origin.

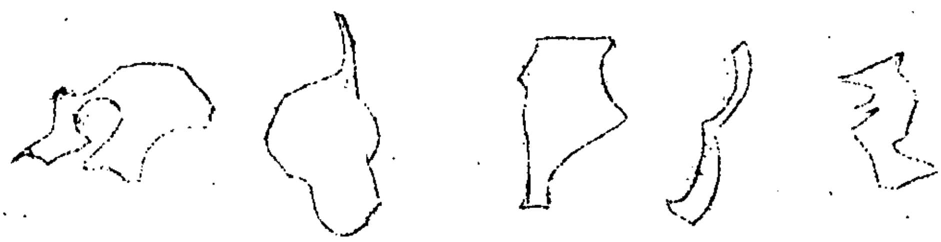
Tuffs are quite common but, of course, particularly noticeable when occurring during the tranquil conditions of coal-seam deposition. Sample RW 111 from 1,412 ft. is an excellent example of a crystal tuff occurring between layers of carbonaceous shale. Carbonaceous shale containing scattered plagioclase

* Analysed by N.S.W. Geological Branch 29/12/52 Ref.3027, for BMR.

crystals breaks off sharply and is replaced by a 1½" band of crystal tuff which is perfectly graded upward from incoherent crystals to fine bentonitic clay. Cementation may have been prevented by the impervious clay seal above and below. No quartz is present, nor many accessory minerals. About 25% consists of plagioclase euhedral, cracked, embayed and stained, 10% consists of macerated woody material with well preserved cellular structure and 15% of fine grained cherty, angular rock fragments. The residue is of clay material.

A remarkable rock from about 1342'4", sample RW 104, gives the appearance of black, welded crystalline ash with its upper surface pitted with circular depressions 2-4 mms. diameter. It is about 3" thick, and has a curious pitted fracture throughout. Under the microscope the groundmass is brownish and indeterminate. The rest consists of irregular, often deeply embayed quartz fragments of shapes which could not survive water transport.

Fig.16



Quartz grains showing extreme irregularity.

Corroded and embayed plagioclase.

Many of these fragments are completely shattered. Some primary calcite, mica and small pieces of brownish woody tissue are present.

There is a probability that the frequent fresh plagioclase found in the rudites and arenites is derived from pyroclastic material, retransported by water. The crystal tuff of Sample 111 must have been deposited from the air. The ashy rock of Sample 104 may be a form of ignimbrite deposited by a nuee-ardente, and the shattering and surface vesiculation may have been caused by cooling in shallow water; the vesiculae are filled with laminated shale. The presence of woody tissue seems to dispose of any possibility of its being a stringer from a sill.

The area is too limited and the petrological investigation too sketchy to draw conclusions as to the source of sediments and detailed nature of deposition. At least 1,500 ft. of sediments (and probably over 3,000 ft.) are remarkably similar, appear to be derived from one major source. The nearby Carboniferous suggests a likely supply. The fresh felspars suggest that transport may have been both rapid and of no great distance and this is borne out by the angularity of grains; there is little evidence of a supply of reworked sediments. A proportion of detrital fragments is almost certainly of volcanic origin, redeposited in water or distributed as airborn dust and ash. The high proportion of siderite, lenticularity, cross bedding, scour and fill, grey colour and so on are typical of normal coal deposition. The absence of massive seat earths and gannisters are unusual features but are, of course, common to the whole coalfield. The relationship between siderite and other carbonates which exist together in uneasy balance, is a fascinating source of speculation. The evidence brought to light by boring does not contribute seriously to the problem of an autochthonous or allochthonous origin of the coal nor to the prevailing climatic temperature.

The lenticulation of coarser sediments is again seen throughout the argillaceous deposits. Apparently associated with this feature, and also with tuffaceous clays and the presence of recrystallising carbonate, is the frequent occurrence of an interesting variety of cone-in-cone structure. Cores have consistently brought to light this structure, not hitherto described in detail, always associated with bentonitic clays or shales and generally with clayironstone. It consists of thin calcareous bands up to 1 ft. thick, of no great lateral extemt. The bands themselves comprise a succession of minutely plicated veins and veinlets of calcite, often traversed by secondary veins. The small plications imprison lenticles of clay. Both the clay and calcite may be partly sideritised. The bands usually rest upon grey, blue-grey or white bentonitic clay or shale and are frequently surmounted by a band of clay-ironstone. The plicated veins may be contorted to such a degree that they form conical structures and may be associated with slickensiding or apparent chatter-marks in the clay (Plates 6 and 13.)

This type of structure may have been referred to in a borehole sunk in 1884 when "5 ins. soapy clay shale with fibrous calcareous veins" and "8 ins. clay shales, soapy, with irregular calcareous veins ⅛" to 1½" thick" were described by David, Mem. Geol. Survey of N.S.W., Geology No.4, 1907, Page 211. These occurred in Tomago Measures in the Maitland District. During the Bureau Boring Programme in the Newcastle Region the phenomenon was noticed in several bores, particularly in the Buchanan Maitland Area, but always in Tomago sediments, never in the Newcastle Stage. It is quite possible that it is confined to the Tomago Stage and if so provides a valuable diagnostic feature. The fact that it is found in almost every stage of development may also throw some light on the growth of cone-in-cone structures. It seems likely that the conditions necessary for the formation of the initial plicate structures depend upon minute lenticulation of alternate sideritic and (probably) ashy clay that becomes altered to bentonitic clay in time. The lenticles of siderite above and below the clay layer meet from time to time forming nodes which act as centres of crystallisation of the siderite. The outward growth of crystalline siderite will then naturally have a conical tendency as nodes further and further from the centre become incorporated, while the clay lenticles are isolated entirely. It seems likely that at an early stage the siderite may become replaced by calcite which may be at least in part contributed from the clay. Stages of development from slight sideritic plications to elaborate calcite cones have been observed. The "chatter-marks" (See Plate 6) may result from movement of the clay as crystallisation alters the volume, or they may be merely small isolated lenticles of clay which simulate "chattering" (i.e. movement). The association of slickensiding does, however substantiate movement, probably of the "stick-slip" kind. It may be noted that bentonitic clays are found in which the lenticle boundaries are coated with secondary carbonate (? ankerite) and this may supply an alternative method of growth.

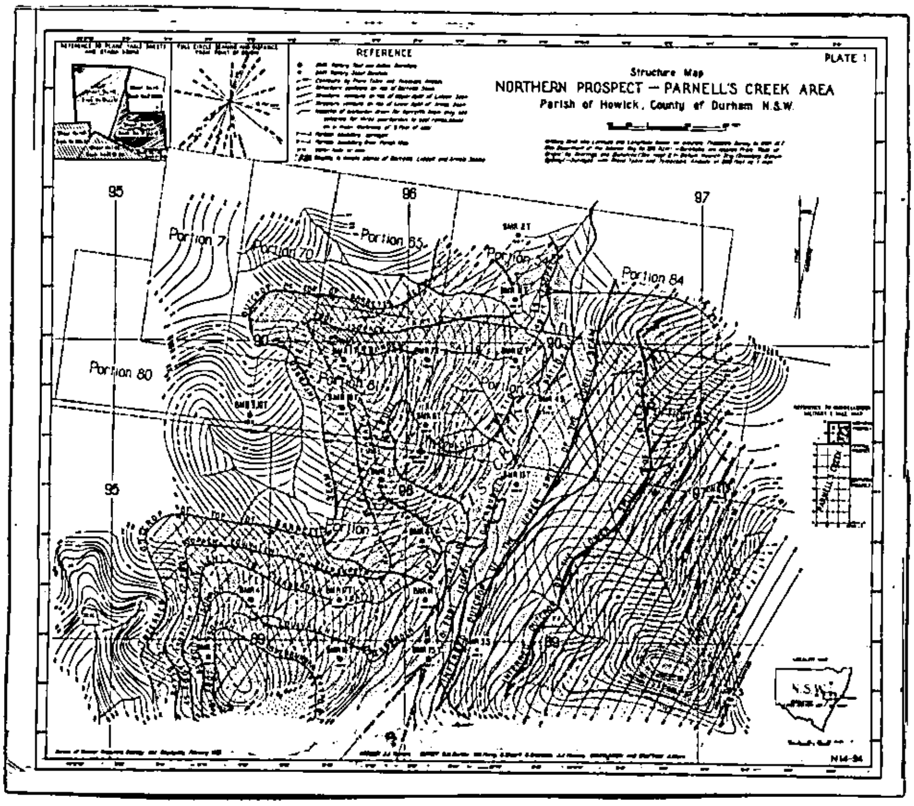


PLATE 1
REFERENCE
Structure Map
NORTHERN PROSPECT — PARNELL'S CREEK AREA
Parish of Howick, County of Durham N.S.W.
95
96
97
Portion 7
Portion 70
Portion 85
Portion 84
Portion 80
Portion 61
N.S.W.
N14-94

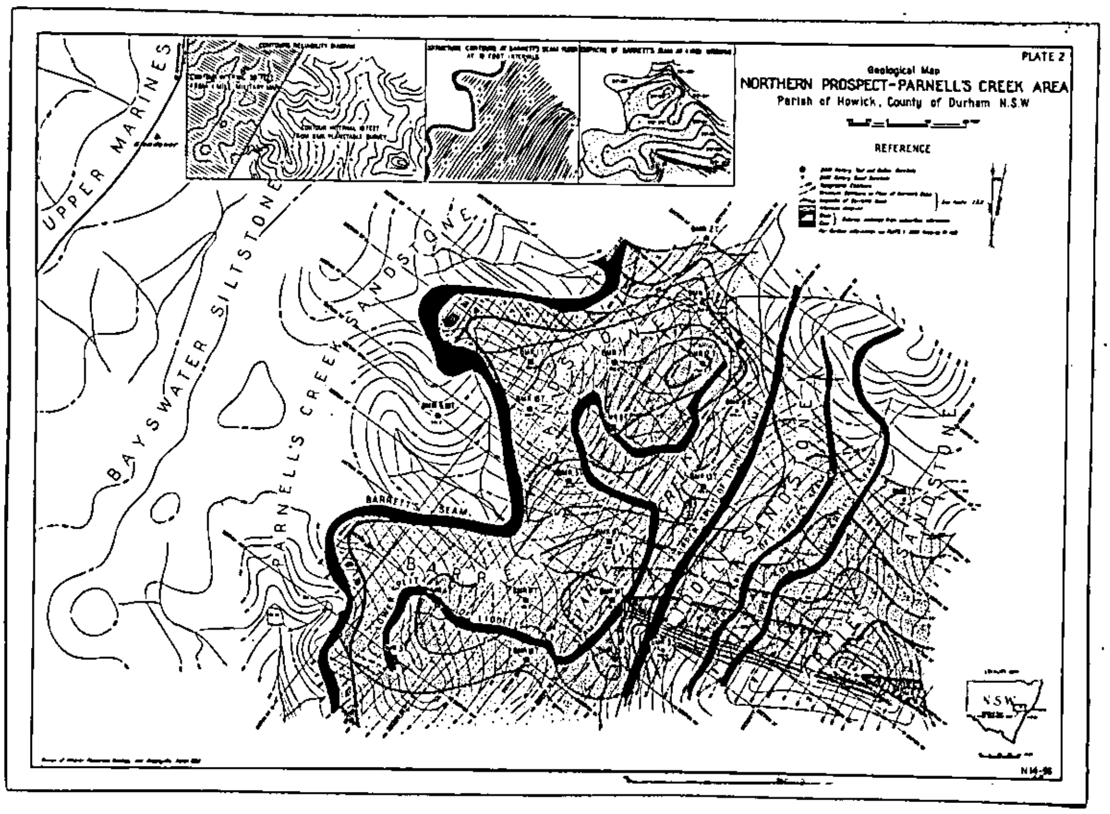


PLATE 2
Geological Map
NORTHERN PROSPECT-PARNELL'S CREEK AREA
Parish of Howick, County of Durham N.S.W
REFERENCE
UPPER MARINES
BAYSWATER SILTSTONE
PARNELL'S CREEK SANDSTONE
BARRETT'S SEAM
SANDSTONE
N.S.W.

SECTION 6

GEOLOGY.

6.1. REGIONAL GEOLOGY.

The Permo-Triassic Basin of Central-Eastern New South Wales extends over an area of 16,000 sq. miles. In the north the limits of the basin pass through Newcastle, Muswellbrook and Gunnedah, the western boundary near Wollondilly, Lithgow, Kandos and Dubbo and the southern limit near Nowra. Within this basin lie the coal-measures of the Northern Coal-field extending from Newcastle, through Cessnock, north near Muswellbrook to Gunnedah. The Parnell's Creek Area forms part of the Muswellbrook-Singleton Coal District of the Northern Coal-field over which rocks of the Tomago Stage of the Upper Coal Measures make an extensive outcrop.

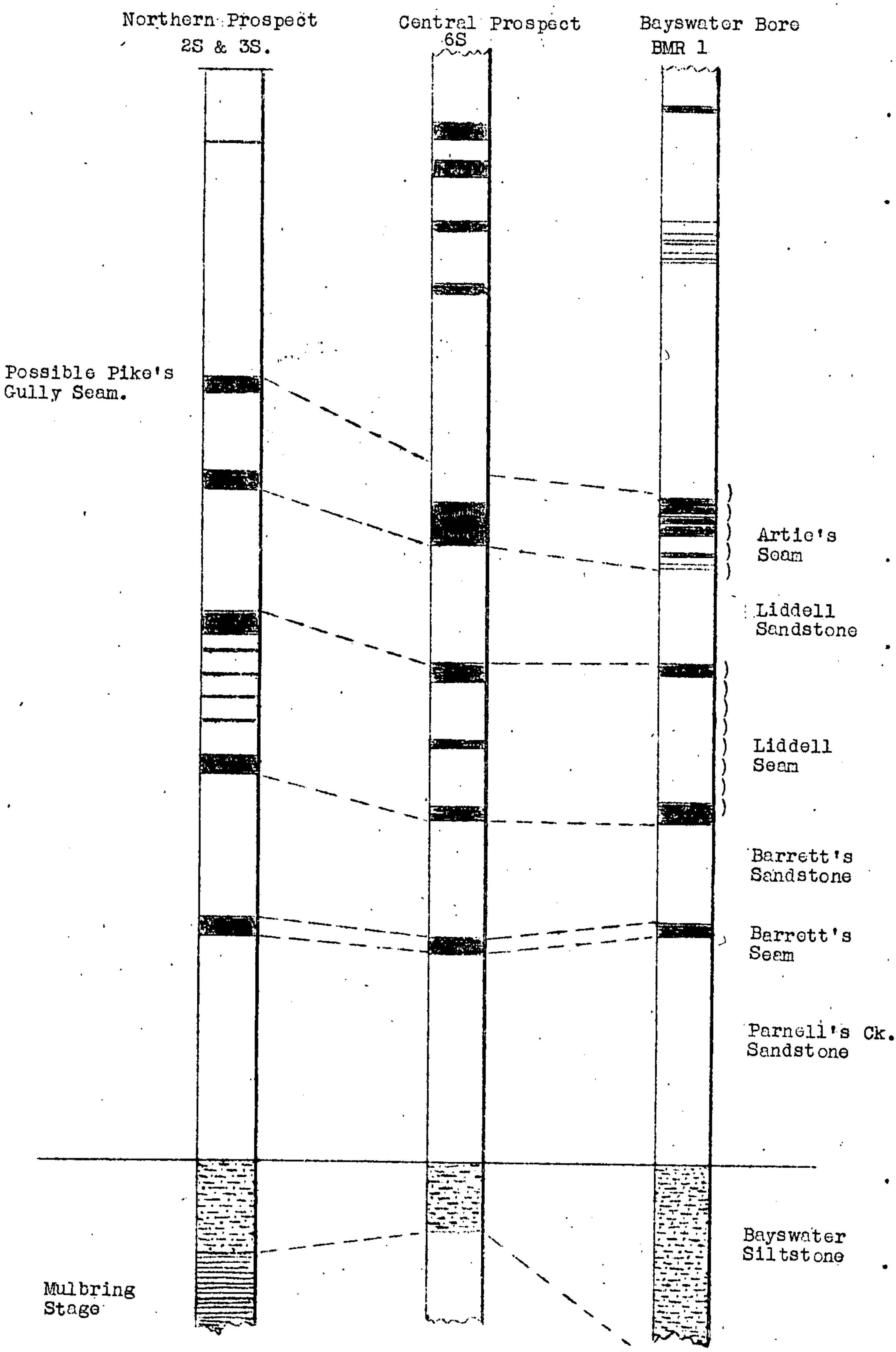
6.2. LOCAL GEOLOGY.

While the uppermost limit of the Tomago Stage has been placed very arbitrarily in this district, the lower limit to the Tomago Stage can be placed precisely and naturally. Great use has been made of this boundary so that where it was possible without undue inconvenience, BMR bores have passed through this boundary to assure a definite correlation.

Between the strata of the Tomago Stage and the Mulbring Stage of the Upper Marine Series is found a varying thickness of strata transitional in environment of deposition from marine to freshwater. Within the Northern Prospect of Parnell's Creek Area, bores 2S, 3S and 4S passed through these transition strata to the Mulbring Stage. Other BMR bores giving data on these transition strata are Parnell's Creek BMR 5 to 10S inclusive, 12S, 17S and 22S, and most fully, the Bayswater BMR 1 Bore.

The name suggested for these transition strata is Bayswater Siltstone because a type section is provided by the Bayswater BMR 1 Bore, there being but the scantiest surface outcrop data.

Fig.17



Northern Prospect
2S & 3S.
Central Prospect
6S
Bayswater Bore
BMR 1
Possible Pike's
Gully Seam.
Artie's
Seam
Liddell
Sandstone
Liddell
Seam
Barrett's
Sandstone
Barrett's
Seam
Parnell's Ck.
Sandstone
Bayswater
Siltstone
Mulbring
Stage

6.2.1. Bayswater Siltstone and Contiguous Strata.

6.2.1.1. Type Section.

The Bayswater BMR 1 Bore stopped at a depth of 1,500 ft. in black claystone which can be followed upwards to a depth of 1,258 ft. into black shale and grey to black claystone frequently pyritiferous and/or siliceous. Marine micro-fossils were collected from this rock-unit between 1,258 ft. and 1,500 ft. and determined by Miss Irene Crespin (Appendix XI). Quantitive faunal analysis of this section was not attempted since it was not possible to free the tests from the claystone; the micro-fossils were observable only on broken surfaces. The three forms identified are Ammodiscus multicinctus, cf. Basslerella, and Nodosaria serocoldensis. The rocks of this section have an extremely uniform grain-size and are clearly the uppermost 242 ft. of the Mulbring Stage of the Upper Marine Series.

Immediately above a depth of 1,258 ft. is a grey siltstone which exhibits a difference of grain-size with the underlying 242 ft. of claystone and shale. This first occurrence above the Mulbring Stage claystone of a rock-type with silt grain-size, except for any accidental deposits such as crystal tuffs, is regarded as the termination of a dominantly marine deposition and the commencement of deposition under brackish conditions or the alternation of marine and freshwater conditions.

It is suggested that the formation separating the upper limit of the Mulbring Stage from the lower limit of the Tomago Stage be called the Bayswater Siltstone after its type bore. The Bayswater Siltstone fills all the requirements of a stratigraphical unit: (a) the lithology, viz. greywacke siltstone and dark-grey claystone, is uniform throughout, both vertically and laterally; (b) its upper and lower limits are easily recognized, being responses to changes in the depositional environment; (c) it is a natural unit and not an arbitrarily defined one.

The maximum thickness is 79'3" in Bayswater BMR 1 Bore, minimum thickness 15'10" in Parnell's Creek BMR 2S.

The type core section of the Bayswater Siltstone is kept by the Joint Coal Board, Cessnock.

6.2.1.2. Other Sections.

The Bayswater Siltstone in Parnell's Creek BMR 3S is 50'11" thick and is directly overlain by an edgewise conglomerate of claystone and siltstone fragments in a sandstone matrix. In this bore at a depth of 381'7", i.e. 80'8½" below the base of the Bayswater Siltstone, is recorded a distorted internal cast of a lamellibranch with both valves partly preserved (Plate 5); F.W. Booker expressed the opinion that this shell is Astartila sp. indet.

6.2.2. The Parnell's Creek Sandstone Member.

The greywacke sandstone overlying the Bayswater Siltstone represents clearly the inception of a fresh-water environment which proceeded to give a rhythmic deposition of greywacke sandstone and coal seams with minor siltstone and claystone or shale deposits. Because of this rhythmic sedimentation it is considered that each of the sandstone and coal units are members of the one formation. The lowest member of this closely-knit association of rocks is the Parnell's Creek Sandstone, so-named after the area over which it has been thoroughly examined both on the surface and sub-surface. Cored complete sections of this unit were obtained from Parnell's Creek BMR Bores 2S, 4S, 5S, 6S, 7S, 8S, 10S, 17S, 19S and 22S and Bayswater BMR 1; cored partial sections from Parnell's Creek 9S and 12S.

The maximum thickness of 186'0" is recorded from Bayswater BMR 1 and minimum of 57'4" from Parnell's Creek BMR 22S. * The highest frequency of thickness in Parnell's Creek Area lies between 80' to 90'. The main rock-type is a fine to coarse-grained greywacke sandstone with cement mainly argillaceous, in parts calcitic or sideritic. Carbonaceous detritus is very profuse and often helps to pick out the cross-bedding and scour-and-fill structures which characterise this bed. Siltstone and claystone lenses, diastems and minor slumping are other typical features of this member. Descriptions of the rock-type in this member may be found in Section 5.3 and in the relevant borelogs.

The upper limit of this bed is the termination of sandstone as the dominant rock-type and the commencement of siltstone, claystone or shale or a coal seam (which in the Parnell's Creek Area is Barrett's Seam). Part of the Parnell's Creek Sandstone Member can be correlated with the Saltwater Creek Sandstone (Foskett, 1952). The description of the Parnell's Creek Sandstone Member and the overlying Barrett's Seam indicates the general rhythmic pattern which is repeated with little modification throughout all the sections recorded from Parnell's Creek bores.

6.2.3. Barrett's Seam.

Throughout Parnell's Creek Area Barrett's Seam is the first coal seam found above the base of the Tomago Stage. Within the Northern Prospect this seam is constant in thickness, seam composition, coal type and quality, and stratigraphic position.

Foskett ((2) sheet 3, 1953) shows the outcrops of Barrett's and Artie's Seams in the (J.C.B.) Pike's Gully Area and the outcrop of the Liddell Seam drawn as far south as the south-east corner of Portion 54, Parish of Howick which is within the north-east part of the Northern Prospect of Parnell's Creek Area. The outcrops of the Liddell Seam shown in Foskett's report and these Records show a remarkable proximity. From this it seems certain that these Records are in full accord with Foskett in so far as recognition of the Liddell Seam is concerned. Similarly both agree on the recognition and naming of the lowest coal seam (Barrett's) which is the only seam underlying the Liddell Seam in the area. Thus the claim that Barrett's Seam is the lowest seam of the Tomago Stage in the Parnell's Creek Area is well substantiated.

6.2.4. Barrett's Sandstone Member.

Booker and Adamson ((1) 1951) named a number of sandstone members of the Tomago Stage, applying the proper noun of the name of the coal seam underlying the sandstone member. Accordingly .

* Not reported in detail here.

BMR BORE NO.		PARNELL'S CK. SANDSTONE BED		BAYSWATER BED.	
		Interval	Thickness	Interval	Thickness
2S	Parnell's Ck.	376'5½" to 469'8"	93'2½"	469'8" to 485'6"	15'10"
3S	" "	151'3½" " 249'11½"	98'8"	249'11½" " 300'10½"	50'11"
4S	" "	94'6" " 192'8"	98'2"	192'8" "? 218'6"	25'10"
5S	" "	310'0" " 391'6"	81'6"	391'6" " 421'1½"	29'7½"
6S	" "	568'4" " 661'1½"	92'9½"	661'1½" " 678'0"	16'10½"
7S	" "	165'4" " 240'8"	75'4"	240'8" " 263'0½"	22'4½"
8S	" "	397'9" " 483'1½"	85'4½"	483'1½" "? 500'0"	16'10½"
9S	" "	204'11½" " 300'6"	? 95'6½"		
10S	" "	399'4" " 495'0½"	95'8½"	? 495'0½"	
12S	" "	134'11½" "? 237'6"	? 102'6½"	237'6"	
19S	" "	355'5" "? 437'5"	82'0"	? 437'5" "? 447'0"	9'7"
22S	" "	269'10" " 327'2"	57'4"	327'2" " 348'3"	21'1"
17S	" "	528'1" " 611'10"	83'9"	611'10" " 638'5"	26'7"
1 & 6S	Farrell's Ck.	717'2"			
1	Bayswater	992'9" " 1178'9"	186'0"	1178'9" " 1258'0"	79'3"

the sandstone strata overlying Barrett's Seam have been called the Barrett's Sandstone. The nomenclature of Booker and Adamson (3) implies the status of formation for strata which, as suggested above, may be considered but members of the one formation, and if so better referred to as the Barrett's Sandstone Member. These strata are essentially the same as those of the Parnell's Creek Member.

6.2.5. The Liddell Seam.

Within the Northern Prospect three bores, 1S, 2S and 3S penetrated the Liddell Seam splits; 3S bored through the lower split only.

In 1S the Liddell Seam is found to have an aggregate thick ness of 16'1" over an interval of 54'10" from the depths 168'9" to 223'7". Throughout this interval the maximum thickness of strata completely free from coal is 24'3". Depths of coal in this section are :

Depths of Coal, Bore 1S.

168'9" 177'6"	8'9"
184'8½" 184'9½"	1"
185'2½" 185'7½"	5"
185'10½" 186'3"	4½"
193'3" 194'5"	1'2"
194'7" 195'4"	9"
218'10" 220'11"	2'1"
221'4½" 221'11½"	7"
222'8½" 222'11"	2½"
223'2" 223'4"	2"
223'7" 225'3"	1'8"
	16'1"

The separation of the two splits increases to the south, where in 2S, the Liddell Seam has an aggregate thickness of 13'10" over an interval of 71'0" with maximum thickness of strata free of coal in this interval 33'9". Detail of coal positions and thickness is :

Depth of Coal, Bore 2S.

234'2" 241'6"	7'4"
245'10" 246'7"	9"
251'6" 251'9"	3"
260'6" 260'9"	3"
264'5" 264'8"	3"
298'5" 300'3"	1'10"
301'8" 302'1"	5"
302'3½" 302'6"	2½"
302'7½" 305'2"	2'6½"
	13'10"

It is apparent from the figures quoted above, that most of the coal is grouped into what have been called the Upper and the Lower Split. The thickness of the Upper Split in BMR 1S (BMR 2S) is 8'9" (7'4") and the Lower Split 6'5" (6'9"). The Lower Split in 3S is 5'11" thick.

It is clear that these individual coal beds are all part of one coal seam, for while the strata between the Upper Split and the Lower Split are crowded with thin coal bands, the strata above the Upper Split and below the Lower Split are free from any such bands, the next encountered coal being a discrete coal seam.

W.E. Foskett ((2) 1952) traced the splitting of the upper section of the seam along the strike from Newdell as far south as Portion 53, Parish of Howick, which is within the Northern Prospect. The data provided by the percussion bores of the J.C.B. (especially 33B and 34B) in Portions 84 and 53, Parish Howick, agree exactly with the data of these Records concerning the Liddell Seam splits.

The strata found between the splits consist of varying amounts of greywacke sandstone, siltstone and shale or claystone.

6.2.6. The Liddell Sandstone Member.

This is known in the bores 1S and 2S only and is extremely variable in thickness. In 1S the greatest thickness of sandstone bands found above the Liddell Seam and below Artie's Seam is 3'10½" and aggregate thickness over this interval is

$10'10\frac{1}{2}"$, whereas in 2S over the same stratigraphical interval the thickest band in 28'5" and the aggregate thickness of sandstone is 35'0". 1S and 2S are about 2,000 ft. apart. Siltstone is the other principal constituent of this member.

6.2.7. Artie's Seam.

BMR 1S and 2S are again the only holes giving information about this seam. However, just to the south in the Central Prospect there is considerably more information available. In the Central Prospect the seam is usually thicker than twelve feet and commonly contains many rock bands. As this seam is traced to the north into the Northern Prospect it is seen to divide into two discrete splits, called the Upper Split and the Lower Split of Artie's Seam. The thickness of the Upper Split in 1S (2S) is 5'4" (7'2") and the Lower Split 7'0" (8'9"). Thus the aggregate thickness in 1S (2S) is 12'4" (15'11"). These aggregates are comparable with those of the same seam unsplit to the south in the Central Prospect. There is no record of any coal bands occurring within the interval between the Upper and Lower Splits. Siltstone and claystone are the main rock-types in this interval.

In 2S there are 132'2" of rock (mainly greywacke sandstone) overlying the top of the Upper Split; apart from 11" of smut and bright coal at a depth of 31' this part of the section is free from coal. Thus either the Pike's Gully Seam is not developed in this area or the Upper Split is continuous to the north with the Pike's Gully Seam.

6.3. STRUCTURAL GEOLOGY.

Comparison between the thicknesses of rock-units recorded from Parnell's Creek bores and the Bayswater BMR 1 Bore reveal a faster rate of deposition in the Bayswater Area. The slow deposition rate in the Parnell's Creek Area may have been caused by contemporaneous uprising of the Muswellbrook Dome, so giving a condensation of the stratigraphical section.

Subsequent structures have not been observed in the Northern Prospect. Faulting is absent. No evidence of igneous activity was observed.

6.4. BIBLIOGRAPHY.

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SECTION 7

DRILLING METHODS.

7.1

Drilling in N. Prospect was of Scout and Test and Define type. Scout boring was carried out by rigs and crews owned and operated by the Bureau of Mineral Resources, while Test and Define boring was conducted by the contractors (Pacific Boring Company).

Four Scout Bores and eighteen Test and Define Bores were bored in the Prospect. In the case of Scout Bores continuous coring was applied, while Test and Define Bores were partly cored. Depth of the Scout Bores was between 220 ft. to 500 ft. while Test and Define Bores were between 45 ft. 3 ins. and 105 ft. deep. For the above two reasons, figures for the overall rate of drilling given in the following tables are not comparable.

Operations by the Bureau were carried on three 8-hour shifts per day, while the contractor's crews worked one "long-hours" shift (8-15 hours) per day (average 11½ hours).

The Bureau's drilling was carried out between 25.3.1952 and 29.5.1952 and the contractor's drilling was done from 20.7.1952 to 30.8.1952 (mostly in rainy weather).

Movement of rigs and equipment from location to location was well under one mile on the average for both Bureau and Contractor. Water supply was obtained on the spot by the contractors while the Bureau had to carry water from a distance of about three miles. An interesting feature of the contractor's organisation was that crews and drilling supervisor lived on the location.

7.2. DRILLING EQUIPMENT.

Failing 1500 and 750 rigs were used by the Bureau; a Failing 750 and a Ruston-Bucyrus with rotary attachments were used by contractor. The rotary attachment of the Bucyrus rig was designed by Mr. T.S. Bielski of Pacific Boring Company and manufactured in New South Wales. Although much slower than the Failing, this combination rig was quite suitable for coring, and the core recoveries thus obtained were just as good.

RIGS. The following are the main features of Failing Rigs:

Failing 1500.

1. Rated capacity: 1500 ft. using $2\frac{3}{8}$" drill pipe
2. Mast: 38 ft. clearance above ground. Capacity 40,000 lbs. total gross load. Raised and lowered by two double acting hydraulic cylinders with safety checks.
3. Drillhead: Rotary type with 30 inch stroke hydrauli feed, 3 speeds forward and high speed in reverse.
4. Draw Works: Spiral cut bevel gears and roller chain drive, maximum single line pull bore drun 15,000 lbs.
5. Mud Pump: Gardner-Denver FG-FXG $4\frac{1}{2}$" x 6" duplex reciprocating type power pump.
6. Prime Mover: Truck $2\frac{1}{2}$ ton Diesel engine with approximately 250 cu. in. diaplacement.
7. Pull-Down: Automatic, hydraulically operated.

Failing 750.

1. Rated capacity: 750 ft.
2. Mast: 26 ft. clearance above ground
3. Drillhead: As for Failing 1500
4. Draw Works: Double roller chain drive, maximum singl line pull bore drum 5,400 lbs.
5. Mud Pump: Failing duplex $4\frac{1}{2}$" x 5" reciprocating typ power slush pump with individual pot type valve chambers.
6. Prime Mover: Truck $1\frac{1}{2}$ ton Diesel engine.

7.3. AUXILLIARY EQUIPMENT.

7.3.1. Bureau of Mineral Resources.

(a) Drill Pipe.

$2\frac{1}{2}$" Failing Exploration Drill Pipe of 10 ft. lengths and 5.81 lbs. / ft. (with test joints) weight.

(b) Rock Bits.

Hughes, Reed and Edeco $5\frac{5}{8}$" and $4\frac{3}{4}$" soft formation rock bits were used to penetrate upper 12 - 15 ft. before running in with a core barrel.

(c) Core Barrel:

Failing double tube, bottom discharge swivel type core barrel of 10 ft. length was used. O.d. of outer tube is $3\frac{1}{8}$" and i.d. of inner tube is $2\frac{3}{8}$". Size of core cut is 3/16". The swivelhead allows the inner tube to remain stationary over the core. This type of core barrel is specially designed for coring soft formations; possible washing away of core before it enters the inner tube is greatly minimised.

(d) Core Bits.

Blanks (Type A) manufactured locally were used and inserted with "Borium" chips. These bits cut 3-15/16" hole and 2-3/16" core; they have 6 vertical watercourses of 5/15" diameter on the circumference. These bits were found quite satisfactory for coring coal as well as reasonably hard sediments. Their life span was much lower than that of diamond bits but they were much cheaper.

(e) Conductor Box.

A 12-gauge iron sheet conductor pipe 6" diameter and 3 ft. long with attached fine mesh screen for collecting cuttings was used.

(f) Drilling Fluid.

Light weight bentonite type drilling mud was used. Viscosity and gel-strength were controlled by additions of water and bentonite as required. Sand was precipitated along the mud ditch and in settling pit so that circulation pit was kept free of sand as much as possible. Mud ditches and pits were dug in the ground.

7.3.2. Pacific Boring Company.

(a) Drill Pipe. Same as Bureau.

(b) Rock Bits.

Reed $4\frac{3}{4}$" rock bits and $4\frac{1}{4}$" two way drag bit were used to drill non-coal sediments before running in with the core barrel.

(c) Core Barrel and Core Bits.

A Mindrill double-tube, bottom discharge mud barrel was redesigned and adapted by Mr. T. Bielski of Pacific Boring Company, the top half of which consists of the original Mindrill type and the lower part of Mr. Bielski's design. The adaptations include (1) a pressure relief valve to let out compressed fluid in the upper portion of the barrel. (2) A considerably shortened distance between the lower edge of the inner tube and the face of the bit. This distance is $\frac{1}{2}$" as against $3\frac{1}{2}$" in the original barrel. The advantage of this feature is that the length of contact of core with circulating fluid is greatly minimised, which is of extreme importance while coring soft and brittle formations such as coal. (3) Again in order to prevent washing away

of brittle and soft core by circulating fluid discharge holes were deviated from vertical and away from the core to throw the mud to the outside edge of the bit face.
(4) A ribbed stabilizer of special hard steel is included in top portion of the barrel; a conventilnal reamer-shell may be replaced by a similar stabilizer in the lower part of the barrel.

The above (redesigned) core barrel is used in conjunction with the bottom discharge "Mintung" core bit of Mr. Bielski's design. This bit cuts a 3¾" core; its setup is of about 73 carats. It has 8 fluid discharge holes of 5/16" diameter at 80° off horizontal. It may be of some interest here to mention that the first bit did 1,000 ft. in shale, sandstone and coal and some siderite bands. When returned to Mindrill Company for resetting a salvage of 57.55 carats was effected. At the current price of 45s. 0d. per carat the cost per foot (including a setting charge of £8.15. 6) was 10.4 pence.

(d) Conductor Box and Drilling Fluid.

Conductor box in conjunction with fabricated (galvanised iron of 10 gauge) drilling fluid ditches were used. These ditches have baffle plates spaced at equal intervals at a 60° angle and half way up the height of the ditch. They can be joined to give any desired length and are very effective in the precipitating of cuttings and sand; their use requires digging of the suction pit only.

Drilling fluid used was mainly water; however, a certain amount of mud was made from the disintergrated shales, claystones etc. during drilling.

M.C. KONECKI.

7.3 RESULTS OF B.M.R. SCOUT BORING.

The following tables summarise results obtained by Bureau of Mineral Resources and Pacific Boring Company.

Bore No.	Rig	Depth Ft. ins.	Drilled Ft. ins.	Cored Ft. ins.	No. of Coal Seams.	Overall Coal-Core Recovery %	Overall Rate of Drilling Ft. / hr.
B.M.R. 1S Parnell's Creek	Failing 1500	307 10	-	307 10	4	93.60	1.38
B.M.R. 2S Parnell's Creek	Failing 1500 & 750	500. 0	12 6	487 6	2	92.96	1.29
B.M.R. 3S Parnell's Creek	Failing 750	411 0	16 0	395 0	1	100.00	1.51
B.M.R. 4S Parnell's Creek		220 0	12 4	207 8	1	93.20	1.85

REMARKS.

Term "Drilling" includes both Drilling and Coring

"Overall" means that apart from time of actual drilling the following items were included.

(a) Moving between locations (less than 1 mile)

(b) Rigging up

(c) Digging of mudpits and ditches

(d) Plugging of bores on completion.

(e) Pulling out of casing

(f) Fishing.

(g) Combatting loss of circulation.

7.4 TEST AND DEFINE BORING AT PARNELL'S CREEK (PACIFIC BORING CO.

Bore No.	Rig	Depth Ft.	Depth ins.	Drilled Ft.	Drilled ins.	Cored Ft.	Cored ins.	No. of Coal Seams	Overall Coal Core Recovery %	Overall Rate of Drilling Ft. / hr.
B.M.R. 1T	F 750	60	3	39	0	21	3	1	99.00	Time data not available.
B.M.R. 2T	Bucy.	45	3	25	0	20	3	1	80.32	-
B.M.R. 3T	F 750	70	1	20	0	50	1	1	100.00	-
B.M.R. 4T	F 750	79	5	15	0	35	1	1	99.55	-
B.M.R. 5T	F 750	88	0	42	0	46	0	1	98.20	2.44
B.M.R. 6T	Bucy.	75	4	21	0	54	4	1	99.55	2.36
B.M.R. 7T	F 750	65	0	32	0	33	0	1	98.66	3.61
B.M.R. 8T	Bucy.	56	8	39	0	17	8	1	97.80	1.72
B.M.R. 9T	F 750	68	0	31	0	37	0	No	Coal	1.66
B.M.R.10T	F 750	79	0	11	0	68	0	No	Coal	2.47
B.M.R.11T	F 750	46	0	15	0	31	0	1	99.50	3.83
B.M.R.12T	F 750	66	0	22	0	44	0	1	97.37	4.44
B.M.R.13T	F 750	105	0	52	0	53	0	1	97.30	3.28
B.M.R.14T	Bucy.	77	0	31	0	46	0	1	99.00	1.43
B.M.R.15T	F 750	99	0	33	0	66	0	1	98.30	3.96
B.M.R.16T	F 750	89	0	42	0	47	0	1	99.00	3.18
B.M.R.	Bucy.	58	6	25	0	33	6	1	100.00	1.33
B.M.R.18T	F 750	80	0	9	0	71	0	No	Coal	3.81

GLOSSARY.

ANALYSIS a proximate analysis (See Quality) unless otherwise stated. The only samples subjected to other than proximate analyses were Gray-King Carbonization determinations (See Section 4).

AREA with capital A refers to an arbitrarily defined area selected as a working unit. If divided the divisions are called sub-Areas.

BANDS see Mineral Bands.

BEARINGS given full circle in degrees T. All boreholes are given a location by bearing and distance from a prominent land division feature such as a fence corner post. See North, Bearings are taken off the map compiled from Plane Table Sheets (Plate 1)

BOREHOLE any drilled hole. All Bureau's and Bureau contractors' boreholes drilled by rotary turntable methods. State Mines Department and Joint Coal Board boreholes may have been drilled by other methods. Some percussion holes drilled for experimental purposes. The word "well" is not used here.

BORE LOCATION the position of a borehole during and after drilling. See Bearing, Boresite.

BORELOG the log of descriptive geological information for each borehole (See Appendix IX).

BORESITE the location on the ground surface of a borehole before drilling i.e. ready located for drilling. See Bore Location.

CLEAT used in accepted sense of minute jointing peculiar to coal.

COAL unless otherwise specified refers to "geological" coal and never to coal and mineral bands. No attempt is made to designate different varieties of the bituminous coal quantitatively or petrographically. All descriptions are lithological.

CONVERSION FACTORS two in common use to convert coal volume to mass as an expression of underground reserves are (1) cubic yard = 1 long ton. This assumes a bulk density of about 1.33 for coal or 1,613 tons per acre foot. (2) 1,500 tons = 1 acre foot. This assumes 1 cubic yard = 0.929 long tons and consequently a bulk density of 1.237. The second factor is used here.

CORE the physical core brought to surface is always designated "rock core" or "coal core".

CORE INTERVAL the distance in feet penetrated in one drilling run. Experience dictated the best interval, within limits of the core barrel, for maximum core recovery in a coal seam (See Section 7). Sometimes it was found most efficient to core the entire seam.

CORE RECOVERY all estimates are linear (See Note in Appendix IX "Abbreviations") and are expressed as the linear ratio of core interval drilled to physical core recovered when pieced together if necessary. No volumetric determinations were attempted.

CORING drilling by corebit with corebarrel. All boreholes were cored throughout.

CORRELATION of coal seams: degree of reliability is given in all cases. Also used in statistical sense.

CREEKS any minor apparent water course whether or not known to flow at any time. Discretion has been exercised in maps as to the marking-in in black of a creek line for a surveyed apparent water course but the contours suggest all such as are observed.

DANT unweathered powdered or granular material resembling soot.

DEPTH always calculated from ground level. So-called drill collar is assumed to be at ground level. Length of drill pipe constantly checked by Petroleum Technology Section. Limits of depth for open cut mining are indefinite but assumed to be 110 ft. This leaves open the question of limits for successively deeper minable seams in the drilling for and reporting of which discretion is used in each case based on thickness and quality.

DESCRIPTIONS see Petrological descriptions.

DIP given in True (Military Grid) North bearing for consistency (See North.)

DIRECTIONS see North.

DISTANCES given with bearings are always in feet. See Bearings

DRILL as verb restricted to drilling with a rockbit as distinct from coring. The process of sinking any borehole is restricted to the word "boring" for clarity of reporting. Not used as noun.

DRILL COLLAR see Depth

DRILLING FLUID the colloidal suspension used in rotary drilling. Its contamination of coal cores analysed is considered negligible. Occasionally, prepared bentonite is added and boring conditions may require addition of straw, sawdust, dung, cement etc. Bottom discharge core barrels were used throughout drilling. Cores were washed free of drilling fluid before description or sampling.

FLOOR the stratum underlying the coal seam is shown in Plate 6 but no special attention was paid to physical properties or cores kept.

GRAPHIC LOG a more or less simplified graphic representation based on the borelog. Conventional signs are based where possible on Bureau Standards or are otherwise individually self explanatory.

GRID grids used for layout of drilling are planimetric, based on the Military Grid of 1" = 1m. Sheet 1948, Muswellbrook, transferred to plane table sheets. No grids, or intersections, were laid out by pegging etc. in the field. Basic Test and Define grid 900 x 600 ft. Grid naming arbitrary and set down in Sketch Plan N14/83 (not included in these Records) Location of bores on ground on grid plan only approximate to save extra surveying procedure.

INFERRED where applied to quantity indicates derivation from approximate data e.g. inferred outcrop (See Outcrop) may indicate that it was calculated on the assumption of a certain mean thickness. All such assumptions are stated in text, map etc.

ISOPACH no distinction is drawn between isopach and isochore.

JOINTING any marked jointing in rock, with special note in overburden, is noted in borelogs.

LITHOLOGY see Petrological descriptions.

LOCATION of boreholes if given (1) as bearings and distance from a Land Division feature (See Bearing) (2) in terms of Military Co-ordinates (See Grid) as surveyed by theodolite traverse from 1st. class Trig. stations shown on Military Map (See Appendix V) (3) as latitude and longitude calculated from intersections of given latitude and longitude lines with Military Co-ordinates on Military Map (See Grid.)

MAP two dimensional representations of mainly natural surface and natural underground features (See Military Map, Parish Map).

MILITARY MAP 1" = 1m., 1: 63,360, Muswellbrook Sheet 1941.

MINERAL BANDS bands of less than 1" may or may not be included in samples depending on whether they are thought to separate natural plies. Bands over 1" are always excluded from samples but may be included in the sample interval stated an analysed. Bands considerably greater than 1" are considered always to separate plies or splits. (See Appendix VI).

NORTH the need to use Military Maps oriented approximately on True North resulted in all directions being similarly oriented. In fact Military Grid North as for Muswellbrook Military Map 1" = 1m. has been used throughout, the difference between T.N. and G.N. being small. Magnetic North is consequently not used.

OPEN CUT precise mining limits are no longer laid down hence minability by this method is treated as a vague quality depending on factors unknown at time of field work. (See 4.2)

OUTCROP line of coal outcrop shown on top of seam where not given an outcropping thickness. All coal outcrops are shown on maps as inferred from subsurface data, not, though occasionally supplemented by, field observation. Other outcrops shown on maps derived from (1) inference from borehole information (2) airphotographs (3) field evidence.

OVERBURDEN all rock overlying the roof of a coal seam and calculated on basis of thickness (See Thickness) as defined herein, not on minable coal thickness.

OVERBURDEN RATIO not expressed as a fraction overburden thickness to seam thickness (See Thickness). Maximum open cut limits are taken as 10:1

PETROLOGICAL DESCRIPTIONS where possible are based on BMR "Descriptive Nomenclature of Sedimentary Rocks" Condon 1951.

PARISH MAP (See Section 3.2.7.)

PLAN representation in two dimensions of mainly other features than those on a map (See Map.)

PLANT the complete machinery for sinking a borehole.

PLY a natural division of coal seam separated by mineral band, or of strikingly different geological, not necessarily chemical, character.

PROFILE the appearance of a coal seam from roof to floor at any one place i.e. without considering horizontal variation (See Section 4); has vertical dimension only.

QUALITY chemical properties as expressed in proximate analyses i.e. essentially hygroscopic moisture, volatile content, fixed carbon, ash, calorific value stated in that order (See Appendix VII).

REGION with capital R one of two (Newcastle and Cessnock Muswellbrook) with indefinite boundaries used to distinguish main operational theatres. The Land Division Region is always specified to distinguish. A geomorphological region is also considered.

RIG plant (q.v.) but not including tools.

ROCKS see Petrological Descriptions.

ROOF the stratum overlying the coal seam is shown in Plate 6 but no special attention was paid to physical properties or cores kept.

SAMPLE the specimens of coal core selected in the manner described (See Appendix 1) for proximate analysis, not the usual form of elaborately collected representative sample of coal.

SEAM any thickness greater than 6" of geological coal considered to be fairly persistent laterally; includes all contained bands of non-coal. Seams separated by over 3 ft. of non-coal and known or believed to join are designated "splits" or "seam splits".

SEAM NAMES these are used only after consultation with State Geological Survey. Seemingly un-named (new) seams are given locality names in inverted commas pending acceptance by State Survey. Seam names are given capital letters for both name and the word Seam after the name. Degree of certainty of correlation indicated in text.

SECTION seam section takes into account horizontal variation (cf. profile) i.e. has vertical and horizontal dimensions.

SERVICES public utilities, electricity, gas, water, roads, canals, railways etc. which may impede mining operations.

SMUT black to brown weathered coal no longer retaining any of the characteristic solid properties of coal.

SPLITS See Seams

STRIKE See Dip

STRUCTURE CONTOURS drawn on top of coal seam.

THICKNESS of seam must sometimes be arbitrary decision within plus or minus an inch or two owing to adventitions coal partings in roof and floor. Thickness given never includes roof or floor. Minimum minable thickness now depends on quality, proximity to transport etc., which in turn depends on varying user-requirements; it is taken as 6 ft. Always calculated unless otherwise stated as thickness of geological coal including all bands.

TON a long ton of 2,240 lbs. avoirdupois.

TOOLS drilling equipment used in the borehole.

WATER water levels were not determined in bores. No water shows were recorded but drilling fluid may have sealed off minor ones.

WEATHERING of coal is taken as proved by a hygroscopic moisture content markedly different from the mean for samples of the seam analysed or a physical difference such as clayey or earthy texture, discolouration etc. Of overburden, is taken as proved by normal leaching, oxidation etc. In both cases post-depositional weathering only is referred to unless specified.

APPENDIX XI

Micropalaeontological Examination of Cores from The Ravensworth Bore, New South Wales

by

I. Crespin.

RECORDS 1952/30

Five core samples from the Ravensworth Bore were received for examination. These cores consisted of hard, dark grey, partly carbonaceous shale and the only fossils that could be examined were on the fractured surface of the samples. A detailed examination is given below.

Sample 113. 1'6" above bottom of core at 1351 feet.

Indeterminate organisms.

Sample 115. 1" above bottom of core at 1351 feet.

Ostracoda: cf. Basslerella

Sample 116. 1414 feet.

Indeterminate plant remains

Sample 117. 1433 feet.

Foraminifera: Nodosaris serocoldensis

Sample 118. 1441 feet 8 inches.

Foraminifera: Nodosaria serocoldensis.

Notes of the Samples.

Foraminifera and ostracoda are present in the samples but because the remains have been silicified, determination of genera and species is difficult. Two tests of foraminifera are present and these seem to be referable to Nodosaria serocoldensis Crespin. Although this species was originally described from the Lower Bowen beds in the Springsure area, Queensland, it was well represented in samples from the Kulnura Bore, near Wyong, New South Wales, between the depths of 3,778 feet and 4,490 feet, which were referred to the Upper Marine Series.

The ostracoda are poorly preserved and although several valves are visible on the fractured surface of the cores only one could be referred to a probable genus, cf. Basslerella.

This assemblage of foraminifera and ostracoda is similar to that found in the Kulnura Bore between the depth mentioned above, that is between 3,778 feet and 4,490 feet, the stratigraphic limits of the Upper Marine Series in that bore. A short account of the sequence in the Kulnura Bore by Raggatt and Crespin was published in the A.A.P.G., 1940, P.1682.

(N.B. Ammodiscus multicinctus also recorded at 1335 feet 82N/15/1 May 12th 1952.)