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Report on geology of Leigh Creek Coalfield

REPORT ON GEOLOGY OF LEIGH CREEK COALFIELD.

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INTRODUCTION.

Following a request by the Premier of South Australia an inspection of the Leigh Creek Coalfield was made on December 5th to December 8th, 1941. My opinion was sought chiefly on the probability of there being a considerable tonnage of coal available which could be won by open cut mining, preferably from one section of the field, near Telford Siding.

SITUATION. The Leigh Creek Coalfield is situated in the valley of the creek after which it is named and extends from a point about three miles south of Copley (formerly Leigh Creek) railway station to about the same distance north of Lyndhurst Cottages. The greatest amount of boring and shaft sinking has been done in the vicinity of Telford Siding on the Alice Springs railway 169 miles from Port Augusta and 379 miles from Adelaide.

PREVIOUS REFERENCE.

The following is a summary of the literature referring to this area:-

(1). H.Y.L.Brown "Report on Coal-bearing area in Neighbourhood of Leigh Creek". Parliamentary Paper No.150, 1891.

Describes General Geology of Coalfield and gives results of two diamond drill bores. Geological Map and Sections. Appendix by R.Etheridge Jr. describes fossil plants and Unio shell indicating Lower Cenozoic age.

(2). H.Y.L.Brown "Record of Mines" South Australia pp 344-346, 1908.

Summarises foregoing report and gives more details of analyses of coal from No.2 Bore.

(3). Review of Mining Operations, South Australia, No.14, pp 15-16, 1911.

Details of No.3 Bore with analyses of coal.

(4). L.K.Card & L.J.Vinton "Mining Review", South Australia, No.27, pp 34-51, 1918.

Detailed descriptions of coal sections and analyses with discussion.

(5). F.Chapman & L.Cookson. "Revision of the "Sweet" collection of Triassic plant remains from Leigh Creek, South Australia". Roy. Soc. South Australia, Vol. 50, 1926, pp 163-178.

Review of flora indicates high Triassic age.

(6). Review of Mining Operations, South Australia, No.29. pp 31-35.

Reviews results of tests on methods of using coal.

(7). Review of Mining Operations, South Australia, No.30, 1919, pp 22-24.

Refers to No.5 & No.6 Bores and gives analyses of clay and ironstone.

(8). Review of Mining Operations, South Australia, No.31, 1919, pp 25-27.

Details of No.6 Bore with analyses of coal.

(9). Review of Mining Operations, South Australia, No.31, 1919, pp 35-43.

Summarises No.5 & No.6 bores and gives results of investigation into methods of using coal.

GEOGRAPHY.

Leigh Creek is an intermittent stream entrenched in a broad valley in the Flinders Range. The floor of the valley is at an elevation of about 750 feet above sea level, whereas the bordering ranges rise to evelations of about 1800 feet and are rugged and deeply dissected.

The area is one of low rainfall (about 10 inches per annum) and there are no permanent streams or large bodies of potable water. The climate is continental, with ground frosts in winter and a hot summer. Apart from river gums along the water-courses there is no timber of any value for mining purposes adjacent to the area being prospected but there is a fair amount of timber in the hilly country which would probably be suitable.

STRATIGRAPHY. Rocks of three geological ages are present:-

(1). Proterozoic (highest Pre-Cambrian) consisting mainly of finely cleaved claystone, sandstone, quartzite and dolomitic limestone, usually inclined at angles of 30 degrees or more. These constitute the bedrock of the coal measures.

(2). Triassic coal measures.

The lower part of the Triassic succession has been revealed by boring and shaft sinking but details of the higher beds are not known. Sandstones appear to be better developed in the higher part of the sequence than elsewhere. The lower part of the section as proved by No.2 and No.3 bores is as follows:-

Thickness in feet.	
1500	Shale, largely carbonaceous.
40	Coal seam.
350	Shale, in part carbonaceous, with thin coal seams. Beds generally more sandy and lighter in colour than above the coal.

The shales above the coal measures contain abundant plant remains (See Ref.No.5 for details). In specimens collected by me and examined by Dr. Alkon, the principal species is Thinnfeldia feistmantali Johnston.

Unio shells are very abundant in a zone 12 feet thick, which outcrops 96 miles north of No.6 bore and which is about 600 feet stratigraphically above the principal coal seam proved in this bore. A sample taken from the bed in which the Unio occurs has been examined by Miss Crespin for microfauna, with negative results. Apparently these Unio shells occur through a fair thickness of section. R.Etheridge Jr. (Ref.No.1) described Unio ayrensis Tate from the horizon just mentioned and recorded the genus from 622 feet in No.2 bore (870 feet above principal seam). E.Y.L.Brown states that this shell was found in the shallow No.1 bore and at intervals down to 1700 feet in No.2 bore.

Numerous carbonate of iron bands were met with in the beds above the coal seams in No.6 bore (Ref.No.7) and a hard band of finely disseminated pyrites was struck in No.3 shaft during my visit. On weathering, these bands give rise to the beds of oxide of iron which form such a common feature of the out-cropping coal measures, especially at the locality known as the Burnt Hills.

The beds below the coal seam are lighter coloured and more sandy than those above. Cores taken from them in the Telford area show rosettes of iron pyrites commonly about ½ inches in diameter. On oxidation these retain their crystal form giving limonitic pseudomorphs after pyrite.

This difference in weathering may be found to be a reliable criterion for distinguishing the beds above the

principal coal seam from those below.

In outcrop the beds closely associated with the coal are commonly gypseous.

Wherever surface exposures of coal measures can be examined, continuity of individual beds is a feature of the outcrops e.g. the comparatively thin beds of limonitic ironstone which form the Eurat Hills and similar beds adjacent to the Myrtle Springs road on the western side of the Telford area.

There is a good deal of evidence to support a correlation of the Leigh Creek coal measures with the Kelapathic sandstone Series of Tasmania, the Wianamatta Series of New South Wales and the Ipswich Series (in part) of Queensland, all of which are probably of Upper Triassic age. (See Ref. No. 5, David's Explanatory notes and Bull. No. 44 of Geol. Survey of Tasmania).

(3). Eyrian Series.

Overlying the Triassic coal measures with marked unconformity and obscuring their outcrop over much of the basin is a relatively thin cover of conglomerate, grit and marly limestone. Many of these sediments are cross bedded and much of the material in the conglomerate is poorly sorted and sub angular. The largest boulder seen in these beds is two feet in diameter and consists of dolomitic limestone like that which occurs in the adjacent bedrock.

The Eyrian sediments have been deposited on what appears to be locally a fairly even surface cut out of the folded Triassic and the adjacent bedrock.

There seems to be no direct proof of the age of these beds, but they are usually regarded as Early Tertiary (See L. Keith Ward's notes on Geological Map, South Australia, 1927). Washings of samples obtained from No. 2 bore have been examined by Miss Crespin for microfauna but with negative results.

DISTRIBUTION OF COAL MEASURES (WITH NOTES ON PROSPECTING OPERATIONS).

The area now occupied by coal measures is enclosed within a roughly elliptical area 18 miles long and five miles broad, the longer diameter of which is approximately parallel to the railway. Reconnaissance mapping by H.Y.L. Brown indicated that within this area the coal measures had been folded into at least two structural basins (See Fig. 1). The detailed mapping by R.O. Segnit (which is not yet completed) clearly shows that there are at least three such basins.

The area occupied by coal measures is naturally divided into three sections which from north to south may be referred to as the Lyndhurst Section, the Telford Section and the Copley Section.

The Lyndhurst section contains coal but is unprospected. There are several bare and inlands of bedrock showing through the coal measures and the chances of there being a considerable tonnage of coal here are not very hopeful, though it would be unwise to be dogmatic on this point until the mapping has been completed and at least one bore put down.

The Copley section is the site of the first discovery in this area of carbonaceous plant bearing shale. These shales were turned up when the railway tank was being excavated near Copley railway station and it was after examination of these in February, 1909, that H.Y.L. Brown predicted the probable occurrence of coal in the neighbourhood. Prospecting done here consists of the sinking of a shaft to a depth of 70 feet (further sinking being prevented by influx of water) and the putting down of a Government bore (No. 5) to

bedrock.

A private bore was put down also about half a mile south of No.5 bore but nothing is known about it.

No. 5 bore entered the bedrock at 677 feet. Only thin streaks of coal were found therein and as the bore was well placed to prove this section of the coalfield the prospect of any considerable reserves of coal being proved here are poor (See Ref.No.7).

The Telford section is the one which has always been regarded as offering the best promise for successful development and in which nearly all the prospecting has been done. H.C.Cognit's mapping supplemented by reconnaissance examination of the unmapped portions indicates that this is a structural basin. My impression is that it is completely separated from the Copley section and not now connected thereto as shown by E.Y.L.Brown, vide Fig.1, though coal measures were doubtless originally deposited continuously over both sections. It seems also that there is only a veneer of coal measures over the bedrock between the Telford and Lyndhurst sections in those places where the bedrock itself cannot be seen in outcrop.

Prospecting operations to the end of 1917 have been described in detail by L.Keith Ford and L.J.Linton.

At that time four bores and two shafts had been sunk in the Telford area. Subsequently another bore was put down at the southern end of the Telford section known as No.6.

This bore (which was put down in strata dipping at about 40 degrees) entered a seam of coal 21'-6" thick at 711 feet. The seam contained a band of sandy carbonaceous shale one foot thick at 723 feet. A seam of coal three feet thick was cut at 882'-6". Bedrock was entered at 918 feet.

Attention has again been given, recently, to proving the coal measures near Telford siding. Drilling is being done on both sides of the railway and a shaft is being sunk about midway between those put down in former years. The bores are being put down on a grid system under the supervision of the Director of Mines.

Several drilling plants are in operation and results are being frequently added to, hence it is too early to make anything like a final statement. To date nine bores have been completed which have proved not only that a seam of coal about 45 feet thick extends approximately E-W for a distance of 2000 feet across the railway, but which have revealed also a favourable structural condition which has an important bearing on commercial possibilities (See Fig. 2 & Fig.3).

Thirty chains north of Telford siding a shallow gully crosses the railway trending approximately E-W. This gully follows a straight course for at least 100 chains, parallel to the strike of the coal measures. The bores have shown that the south scarp of the gully represents, or is adjacent to a fault plane and that the direction of displacement has been such that at points adjacent to the south side of the gully the coal seam is about 220 feet higher than if would have been if faulting had not occurred. It appears also that the fault has intersected the seam at a point where it is of relatively good quality. North of the gully the coal seam is thin and dirty, south of it the seam is fairly consistently about 45 feet thick. (See Fig.3).

COAL.

Full details of the thickness and quality of the coal proved by prospecting operations are given in the literature cited in this report, particularly in Ref.No.4. Only one seam likely to be of commercial importance has been proved so far.

The following tables summarise data available concerning this seam:-

Thickness.

No.1 Bore.	33 feet including a one foot shale band 25 feet from top.
No.2 Bore.	47'-10"
No.3 Bore.	38'-3"
Old Main Shaft	45'-8"
No.6 Bore.	21'-6" including 1 foot shale band 17 feet from top.

ANALYSES.

Analyses of the coal show it to be fairly uniformly high in moisture content. The ash content is also fairly high though not higher than many coals in use in Australia.

Careful sampling by L.Keith Ward and L.J.Vinton shows that the upper 6 to 7 feet of the coal seam contains much less ash than the remainder of the seam.

ANALYSIS. OLD MAIN SHAFT.

	Water at 105°C.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
Top 6' of coal. (as mined)	33.70	24.50	34.90	6.60	
do do air dried	15.86	30.99	45.46	7.67	0.33
Full thickness of seam (45 feet) as mined.	27.15	25.24	33.68	13.91	
do do air dried.	14.23	27.75	41.75	16.25	0.24

Results of samples from No.2 bore show a general resemblance to the foregoing but No.3 is somewhat anomalous

ANALYSES NO.2 & NO.3 BORES.

	Water at 100°C.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
-X- No.2 Bore (air dried)	18.3	27.9	44.2	11.2	-
No.3 Bore (Air dried) (Thickness 38'-3")	13.5	31.7	35.7	18.7	-

-X- Note. Thickness of seam 47'-1" only 22'-3" analysed but fairly representative of full thickness.

At the southern end of the Telford section 2½ miles distant from the old Main Shaft the coal has the following composition:-

ANALYSES NO.6 BORE.

	Water at 105 C.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
As raised.	20.00	25.50	36.40	18.08	-
Air dried.	15.96	27.38	37.65	18.99	0.11

In many coalfields depth of burial is a factor influencing the composition of coal seams, but that such an effect

is not apparent at Leigh Creek is illustrated in the following table in which the fixed carbon percentage on the air dried samples given above has been re-calculated on an ash-moisture free basis:-

	Depth to coal.	Moisture per cent.	Fixed carbon Ash-moisture free.
Main shaft.	240'	14.23	60.06
No.3 Bore.	600'-6"	13.50	52.76
No.6 Bore.	711'	15.96	57.88
No.2 Bore.	1496'-8"	10.30	63.67

The processes of coal formation are not thoroughly understood, but it is known that if a seam in process of formation is exposed to the atmosphere, subsequent prolonged and deep burial have little effect on its composition; the process of coal formation apparently is arrested and cannot be started again.

Possibly this is the history of the Leigh Creek coal. If so, evidence of erosion of the seam may be found when more exposures are available.

CLASSIFICATION.

L.Keith Ward and L.J.Sinton who have had good opportunities to study the coal describe it as follows:-

"The uppermost portion of the coal seam contains a larger number of bright lustrous bands than the lower portion; although bands possessing a bright lustre do occur right through the seam. The duller coal is noticeably tougher than the lustrous variety. The seamlets of argillaceous matter do not occur in continuous and definite bands such as would enable them to be picked out and discarded during mining. They are small - few exceeding ½" maximum thickness - and they merge gradually into the coal, both horizontally and vertically

They point out that the coal is difficult to classify, but suggest that it may be correctly placed in the sub-bituminous group. I have not seen a working face of coal and hence cannot compare the seam with those seen in other parts of Australia.

The fragments of coal lying about the old main shaft do not suggest close relationship to lignite. Pieces of bright coal closely resemble some of the Mesozoic coal from northern New South Wales. On the other hand short pieces of core taken from No.F bore had a brownish tinge and banding was not obvious therein.

On the basis of analysis most of the coal would be placed as suggested by Keith Ward and Sinton with the lowest ranking bituminous coals, say a high ash Bituminous D (sub-bituminous) of Parr's classification. The coal from No.3 bore with nearly equal volatile matter and fixed carbon is nearer that of typical lignite than sub-bituminous coal. The average analyses for this type and the next lowest grade (lignite) are:-

Grade.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Calories.
Bituminous D.	10.31	33.06	41.29	7.34	0.73	5459
-X- Lignite.	34.57	27.16	30.05	8.21	0.53	3747

-X- (Quoted from C.S.Fox, Mem.Geol.Survey.India No.57, 1931, p.172.)

The calorific value of air dried coal from borehole B 1 is 8717 B.t.u.(4794 calories) and from borehole C 4, 7769 B.t.u. (4273 calories). This is in fair agreement with values calculated from the proximate analyses using Goutal's formula, namely, main shaft 4573, No.2 bore 4392, No.3 bore 4010 and No.6 bore 4000 calories.

CONCLUSIONS.

There is evidently a considerable reserve of coal available in the Telford section but there is no point in attempting to put this into figures, because it is not the aggregate tonnage which matters but that which can be worked profitably or which is readily accessible in emergency.

Fortunate combination of the factors mentioned on page 4 brings an area of coal near Telford siding within easy reach from the surface either by shaft sinking or by open cut. It is here that prospecting obviously must be and is being concentrated. As the reserve position changes with every borehole completed, detailed discussion of the results already achieved is not called for. At present there is a probable reserve in the triangle formed by the old main shaft, borehole C.4 and borehole F.1, of about 2,5000,000 tons estimated on the basis "as mined" and assuming 30 cu.ft. of coal per ton. A large proportion of this tonnage could be won quickly and cheaply if the necessity arose.

The best way of using the Leigh Creek coal has been the subject of investigation over a number of years (see Ref. 6 & 9) and this investigation is continuing, hence that aspect is not referred to in this report.

Development of the field by open cut or shaft sinking to a depth of at least 250 feet will not be hampered by sub-surface water. On this point Keith Ward and Winton state:-

"The coal measures contain a small amount of saline water, which is too highly mineralised for use in boilers. As the workings were drained, the water was found to be confined to the shale forming the floor. No water exudes from the coal itself in the mine openings. The total quantity of water is relatively small, and the water level in the old workings was easily reduced by bailing during recent mining operations."

The blanket of Eyrian sediments east of the railway and the alluvium of Leigh Creek west of it make it impossible to follow any individual bed in the coal measures and thus get some definite pointer to the probable behaviour of the coal seam in these localities. What evidence there is, however, suggests uniformity in conditions of deposition over considerable distances, and structural regularity along the strike. In other words the geological setting favours the view that there is a good chance of finding extensions of the conditions proved by boring east and west from Telford. It is quite impossible to attempt to forecast how the coal seam itself may behave, even if the structural conditions remain constant, as comparitively minor changes in geological conditions may have unlooked for economic consequences.

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