ART. XXXV.—*The Coalfields of West Nelson; with Notes on the Formation of the Coal.*

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Communicated by Professor James Park.

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AT the beginning of the coal period what is now west Nelson consisted of the same series of earth-blocks as now. These blocks had been subjected to denudation, and parts of the elevated blocks had been reduced to the same level as the depressed blocks; consequently, when depression of the whole took place, conglomerates and sandstones were deposited not only on those blocks with a tendency to sink, but also on the lower portions of those blocks with a tendency to rise.

A pause in depression permitted vast swamps and forests to envelop the coasts; it is possible that the centres of the valleys were still under water. Further sinking caused the vegetation to be smothered by deposits, and repetitions of the processes have produced other seams. The gradual filling-in of the central deeper portions of the graben valleys would permit of the higher seams overlapping the lower in that direction, while the sinking of the land would produce overlap in the other. It is thus possible that the higher seams may extend right across a valley, while the lower thin out toward the centre; perhaps all the seams so thin out. Where the main drainage-channels crossed the vegetation-fringe the coal-seams are likely to thin out and become impure. Again, it is conceivable that different portions of the coastal fringe, by reason of differential sinking and differential filling, would become fit for vegetable growth at different times. When all is considered, it seems probable that the coal should occur as seams thinning out in all directions, and that the beds should overlap each other in a great variety of ways. The coal has not yet been sufficiently worked to prove these contentions, but the seams of Denniston, Reefton, and Greymouth appear to conform entirely with them.

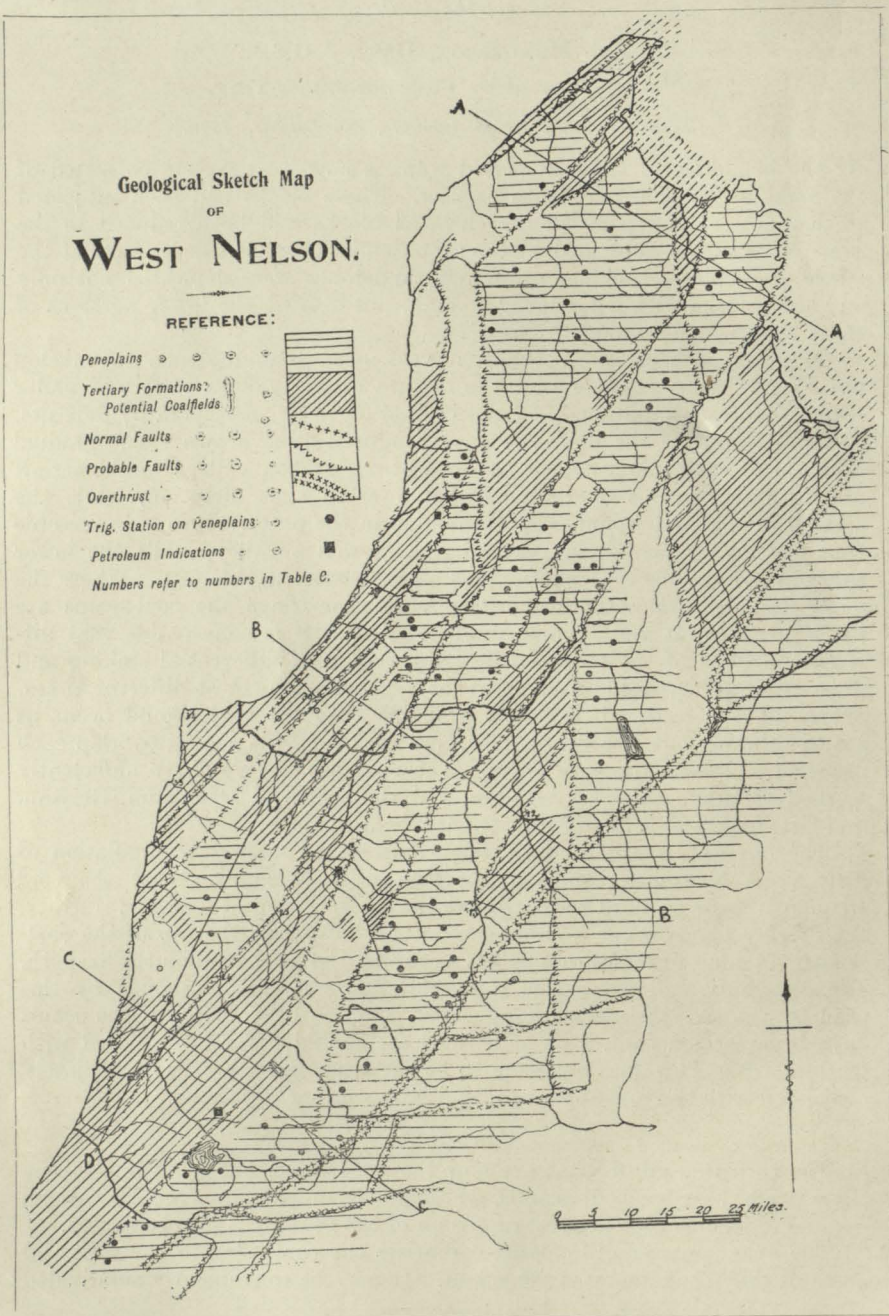
The hypothesis which considers coal-seams as altered accumulation of drift vegetable matter finds support in west Nelson, in that the coal frequently rests on hard rock without the interposition of fireclay; further, the fireclay bands occur indifferently at the bottom or the top of the coal-seams. Again, water-worn pebbles occur in the coal at Point Elizabeth. The distribution of the seams is perhaps more readily explained by this than by the growth-in-place hypothesis. On the other hand, if the seams have been formed from drift some at least should occur intercalated with marine beds. This does not seem to be the case, and the beds immediately associated with the coal appear to be either estuarine or lacustrine.

COALFIELDS.

The thrusting-up of what are now the peneplains, but what in Miocene times were base-levelled islands, through the surrounding coal-measures permits of a somewhat arbitrary division of the coal-areas into coalfields.

The Whakamarama* Coalfield comprises the coal lying to the west and north of the Whakamarama peneplain. It may be conveniently subdivided

* Hochstetter: "New Zealand," pp. 58, 84, 85. Hector: Geol. Surv., No. 4, p. 18 *et seq.*; No. 19, pp. ix–xiii. Cox: Geol. Surv., No. 15, pp. 71–73. Park: Geol. Surv., No. 20, pp. 52–57, 200–5, 237–41. Mackay: Papers and Reports relating to Minerals, 1900, C.–6, pp. 1–5.


Geological Sketch Map
OF
WEST NELSON.
REFERENCE:
Peneplains
Tertiary Formations: Potential Coalfields
Normal Faults
Probable Faults
Overthrust
Trig. Station on Peneplains
Petroleum Indications
Numbers refer to numbers in Table C.
A
A
B
B
C
C
D
D
0 5 10 15 20 25 Miles.

into two portions—that lying between the Aorere and Wanganui faults and resting on a northern extension of the Whakamarama earth-block, and that lying to the west of the Wanganui fault and fringing the coast as far south as the Big River. Only the edge upturned by the Wanganui fault of this, the Wanganui subfield, occurs above sea-level. The composition of the coal of the Wanganui section is shown in analyses 1 and 2, Table C, while analyses 3, 4, and 5 indicate the composition of the coals of the Pakawau section. Coal has been worked at West Wanganui, Pakawau, and Puponga. The seams appear to be numerous, and up to 8 ft. in thickness.

The Taitapu* Coalfield occupies the floor of Golden Bay, and the coal-measures, extensively faulted, extend southward along the valleys of the Aorere and Takaka. The seams have been worked only at Motupipi, and are there up to 4 ft. in thickness. Analyses 6 and 7, Table C, show the composition of the coal.

The Whakatu† Coalfield is limited by the Motueka, Sherry, and alpine-overthrust faults. It extends beneath the Moutere gravels in the valley of the Motueka, and beneath the waters of Blind Bay and part of Tasman Bay. Coal outcrops at various points in the Motueka Valley, in the Tadmor, at Big Bush, and near Nelson, while carbonaceous shales occur in D'Urville Island. Coal has been worked near Nelson, and reaches up to 11 ft. in thickness, but is here crushed by the alpine overthrust. The composition of the coals is shown by analyses 8, 9, and 10, Table C.

The Kawatiri‡ Coalfield occupies the Kawatiri depression. It is divided into three parts by the Motueka and Tutaki faults. Of these, the most important is the central, or Mangles, section, in which the coal is mined for local requirements at Longford and the Owen. The Matiri and Glenroy subfields are northern and southern continuations respectively of the Mangles section. The seams of the Kawatiri Coalfield range up to 30 ft. in thickness. Their composition at various points is shown by analyses 11, 12, and 13, Table C.

The Oweka§ Coalfield occurs in the basins of the Inangahua and Grey Rivers, and probably extends as far south as Ross, beneath the flats of the Taramakau and Hokitika Rivers. The main central portion of the field lies in a trough between the Inangahua and Mawhera faults, and stretches from Inangahua Junction to Ross. A series of outliers cap the hills to the east from Larry's Creek to Big River, and again near Lake Kanieri. These outliers are not so deeply foundered as the main portion of the coal-field. The seams of this field range up to 60 ft. in thickness, and have been worked at several points near Reefton. Analyses 14, 15, 16, 17, 18, 22, 23, and 24, Table C, indicate the composition of the coals.

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* Hochstetter: "New Zealand," p. 461. Park: Geol. Surv., No. 20, pp. 238–41. Mackay: Papers and Reports relating to Mining, 1896, C.–11, pp. 13–21. Bell: N.Z. Geol. Surv. Bull. No. 3 (n.s.), pp. 49–61.

† Hochstetter: "New Zealand," p. 461. Mackay: Geol. Surv., No. 12, pp. 120, 121, 129, 130; Papers, &c., relating to Mining, 1896, C.–11, pp. 27–30. Park: Geol. Surv., No. 19, p. 80.

‡ Cox: Geol. Surv., No. 16, pp. 5–9. Park: Geol. Surv., No. 19, pp. 79, 80. Mackay: Geology of S.W. Nelson, pp. 57, 59, 61.

§ Mackay: Geol. Surv., No. 15, pp. 140–50; Geology of S.W. Nelson, pp. 57–61. Cox: Geol. Surv., No. 10, pp. 78–80. Bell: N.Z. Geol. Surv. Bull. No. 1 (n.s.), pp. 78–81. Morgan: N.Z. Geol. Surv. Bull. No. 6 (n.s.), pp. 102–12. Campbell: Geol. Surv., No. 11, p. 32.

The Greymouth* Coalfield is divided into three sections by faults. The central Brunner section rests on the southern extension of the Paparoa earth-block, and Point Elizabeth and Blackball sections are downfaulted on either side. The seams are very extensively worked, and analyses 25 to 30, Table C, show their composition.

The Westport† Coalfield is analogous in structure to the Greymouth one. The central Mount Rochfort Coalfield lies on the northern extension of the Paparoa earth-block, and extends as far north as the Mokihinui. The Orikaka section, to the east, is downfaulted between the Orikaka and Mawhera faults. The coastal section, to the west, extends from the Punakaiki to north of Westport, and underlies the sea for an unknown distance. The coal of Mount Rochfort section is mined at several points, and the seams range up to 60 ft. in thickness. Analyses 32 to 37, Table C, show the compositions of the coals.

The Karamea‡ Coalfield extends from the Mokihinui to the Heaphy. Little is known of this field. Analysis 38, Table C, is of a coal from a 7 ft. seam in this field.

Structurally, the Whakamarama and Taitapu Coalfields may be considered as forming an anticline,§ with the Pakawau section as the crown and the Wanganui and Taitapu sections as the limbs of the anticline. This anticline, which plunges to the north, is really the northern section of an elongated dome, formed by the thrusting-up of the Whakamarama earth-block through the coal-measures. This dome was never complete, as the coal-measures never covered the earth-block entirely. The Aorere and Wanganui faults probably grade into flexures in depth and also towards the north. A similar anticlinal structure prevails in the Greymouth and Westport fields, and probably also at the southern end of the Whakamarama earth-block in the Karamea field. The Whakatu field has probably a synclinal structure sloping to the north, and this structure has been brought about by the dragging-up of its edges by faulting. The Kawatiri field is probably boat-shaped for similar reasons; but the symmetry of the basin has been destroyed by the Motueka and Tutaki faults, which leave the Matiri and Glenroy sections as elevated shelves. The structure of the Oweka field is in the main monoclinal, although, if the Orikaka subfield in the north and the Blackball subfield in the south be regarded as parts of this field, the structure becomes synclinal at these points.

Composition.

It is generally admitted that, omitting cannel coal, &c., all coals have been formed from vegetable matter of initially similar composition. The transformation of this vegetable matter is due to a fractional distillation, and the quality of the resulting coal depends on its relative completeness. The most generally recognized factors controlling this transformation are time, heat, and crustal movements.

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* Haast: Geology of W. Nelson, p. 104 *et seq.* Hector: Geol. Surv., No. 4, pp. 24–27; No. 20, p. xiii; No. 21, p. xxxviii; No. 9, p. iv. Cox: No. 10, p. 81. Campbell: No. 11, p. 31. Mackay: Geology of S.W. Nelson, pp. 57–61.

† Haast: *Loc. cit.*, p. 113. Hector: Geol. Surv., No. 4, pp. 22–24; No. 9, p. iii; No. 18, p. 156; No. 21, p. xxxiii. Cox: No. 10, pp. 106–20. Denniston: No. 10, pp. 121–71. Mackay: No. 18, p. 161 *et seq.*; No. 21, pp. 76–97.

‡ Haast: *Loc. cit.*, p. 116. Bell: N.Z. Geol. Surv., 2nd Ann. Rep. (n.s.), pp. 7–9. Webb: *Loc. cit.*, pp. 24–27; 3rd Ann. Rep. (n.s.), pp. 21, 22.

§ Hector: Geol. Surv., No. 19, p. x.

It is important to distinguish between the effects of natural distillation and atmospheric weathering. The following table shows the progressive effect of natural distillation :—

Table A.

Fixed Carbon.	Hydro-carbons.	Water.	Ash.	Locality.	Reference.
38·26	40·51	20·41	0·82	Charleston ..	Col. Lab., 29.
39·16	40·63	18·46	1·75	Giles Creek ..	J. Henderson.
42·70	41·00	13·70	2·60	Motupipi ..	Col. Lab., 41.
42·13	41·72	10·27	5·88	Golden Ridge ..	,, 41.
46·60	43·32	8·87	1·21	Burke's Creek	,, 28.
48·59	43·15	4·84	3·42	Seddonville ..	,, 41.
49·15	46·75	3·20	0·90	Blackball ..	,, 37.
56·43	39·68	2·10	1·87	Denniston ..	,, 41.
58·69	39·26	1·00	1·05	Millerton ..	,, 41.
76·38	19·25	0·93	3·44	Paparoa ..	,, 38.
90·90	5·10	0·80	5·20	Fox's River ..	,, 35.

It will be noted that the change from the brown coals to the best of the sub-bituminous is accompanied by a diminution of the water and an increase in both fixed carbon and hydrocarbons. Further change takes the form of an increase of fixed carbon at the expense of the hydrocarbons, the small percentage of water being decreased very slowly. With atmospheric weathering, on the other hand, the percentage of water is increased; but the main change takes the form of a decrease in the hydrocarbons, causing an apparent increase in the fixed-carbons percentage. A comparison of the odd numbers with the next following even numbers in Table B will make this clear as far as sub-bituminous and bituminous coals are concerned.

Table B.

—	Fixed Carbon.	Hydro-carbons.	Water.	Ash.	Locality.	Reference.
1	54·31	33·81	10·46	1·42	Burke's Creek ..	J. Henderson.
2	42·42	49·20	7·28	1·10	Same seam ..	Col. Lab., 42.
3	54·18	34·69	9·54	1·59	Blackball ..	,, 22.
4	49·15	46·75	3·20	0·90	,, ..	,, 37.
5	50·00	38·70	5·80	5·50	Rise, Point Elizabeth	,, 38.
6	44·08	43·00	5·85	7·07	Dip, Point Elizabeth	,, 41.
7	52·40	38·90	6·70	2·00	Mokihinui ..	,, 38.
8	48·59	43·15	4·84	3·42	,, ..	,, 41.
9	66·12	28·82	4·25	0·81	Denniston ..	,, 11.
10	56·43	39·68	2·10	1·87	,, ..	,, 41.

A glance at Table C, on page 305, will show that the coals of west Nelson have a very wide range of composition, and it is to this wide range in the qualities of the various coals that the confusion of classification of the beds in the past has been mainly due.

Von Hochstetter* divided the coals of west Nelson into two series—Mesozoic and Tertiary—mainly on account of the difference in composition. Von Haast† does the same. Cox‡ divided the coals between the Lower Greensand and Cretaceo-tertiary on stratigraphical grounds; but, evidently influenced by the difference in composition, Hutton§ placed the coals of Nelson and Motupipi in the Oamaru series, and those of Pakawau, Wangapeka, Westport, Greymouth, and Reefton in the Amuri series, of Cretaceous age. Hector‖ has pointed out the anomalies connected with this classification, and has shown that, as far as west Nelson is concerned, the palaeontological evidence upon which Hutton relied for his classification was very incomplete. Park¶ at first recognized two coal-horizons, but now, as the result of later investigation, places the Wanganui and Inangahua, Westport, and Greymouth coals in the Oamaru series, of Lower Miocene age. Von Ettingshausen,** from an examination of the fossil plants, considered the strata at Pakawau, Wangapeka, Greymouth, and Reefton of Cretaceous age. Hector†† placed all the coals of west Nelson at the base of his Cretaceo-tertiary, but considered that the coals occur in an upper and a lower horizon. Mackay‡‡ placed the seams in the Cretaceo-tertiary, and did not express any opinion as to their occurrence in different horizons.

From the above it will be seen that very considerable difference of opinion has existed as to age and relationships of these beds.

The writer will attempt to show that the coal-seams may occur in one series of beds. Wherever the basement rock of the coal series is exposed the coal-seams rest either hard on the basement rock or on sandstones and conglomerates immediately overlying it. Such is the case in the Pakawau field, at Motupipi, Nelson, the Owen, Reefton, Charleston, Denniston, and other points. In the Greymouth field the semi-anthracites of Paparoa, the sub-bituminous coals of Blackball, and the brown coals of Moonlight Creek all lie very near the basement slate.

At Point Elizabeth the rocks are downfaulted, and the coal rests upon a considerable thickness of sandstone and shale. These lower beds may possibly represent the coal-measures of Mount Davy. At West Wanganui the coal overlies sandstone, &c., but the basement rock is nowhere visible. These coals have been downfaulted, as is indicated by the difference in strike of the comparatively elevated outliers near Golden Blocks, and there is nothing to show that the West Wanganui coals overlie these or the Pakawau coals.

Again, with the seams at Moonlight, Blackball, and Paparoa, which are taken in ascending order of elevation and carbonization, it is difficult, if not impossible, to account for their relative positions except on the assumption that they all belong to the same horizon and owe their present positions to faulting, and their various compositions to different distillation-conditions. Again, in no section do the brown or sub-bituminous coals actually overlie the bituminous seams, nor do the limestones—which at

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* Hochstetter: "New Zealand," pp. 58, 59, 85.
† Haast: Geology of W. Nelson.
‡ Cox: Geol. Surv., No. 15, pp. 71–73; No. 16, pp. 5–8.
§ Hutton: Trans. N.Z. Inst., vol. 22, p. 387.
‖ Hector: Geol. Surv., No. 21, p. xxxv.
¶ Park: "Geology of New Zealand," 1910, p. 293.
** Von Ettingshausen: Trans. N.Z. Inst., vol. 23, p. 241.
†† Hector: Geol. Surv., No. 18, p. xxxii *et seq.*; No. 21, p. xxxv *et seq.*
‡‡ Mackay: Geology of S.W. Nelson, pp. 57–61; Papers and Reports relating to Minerals and Mining, 1900, C.–6, p. 4.

many places overlie, perhaps unconformably, the so-called upper seams—at any place overlie the lower bituminous seams. All these things point to the conclusion that the coals of west Nelson belong to one series, of what age is here immaterial. Some other agency than time must, then, be looked for to explain the differences in composition of the coals.

That heat is competent to produce all the changes in coal-composition is well known. Its effects are well shown at Malvern,* where a brown coal has been altered by a volcanic dyke. Such action, however, is purely local, and cannot explain the varieties of coal in west Nelson. Again, the deep burial of coal beneath other rocks, and the consequent increase of temperature, greatly hastens the distillation process. Such a theory is, however, quite inapplicable to west Nelson, where none of the coal-measures are, or appear to have been, deeply buried, and where the occurrence of the more highly carbonized coals on the higher levels seems rather to contradict the theory.

Considering, then, crustal movements: these no doubt have great influence both from the pressure exerted and the heat engendered thereby. Probably the anthracite of Fox's River and the plumbago of Pakawau† have been produced by the action of great faults. But if such be the controlling factor of this problem it is to be expected that the coal near Nelson, which is actually inverted and entirely crushed by the alpine overthrust, would be highly carbonized. It actually contains 53 per cent. of fixed carbon and 10 per cent. of water. Again, the coals of Blackball and Paparoa, separated by a fault, which presumably affected them equally, contain 50 per cent. and 76 per cent. of fixed carbon respectively. Evidently crustal movements are incompetent to account for the variations in composition of the coals.

Time, heat, and pressure have been shown to be inadequate of themselves. Another condition controlling the rate of distillation is the ready escape of the distillation volatile products. These volatile products would have opportunity to escape if the overlying strata were porous or fissured. Porosity in a rock will have little influence where great thicknesses are concerned. Great thicknesses of porous rock do not, however, overlie the coals of west Nelson, the principal overlying rocks being mudstones, and wherever these have been wholly or in part removed the coals are highly carbonized.

Applying this hypothesis to the west Nelson coalfields, we find that in the Whakamarama field the coals of the Pakawau section occur in conglomerates capping the tops of the ranges, the upper more impervious mudstones and limestones, which at one time probably covered them, being removed. The coals are highly carbonized, but on the western dip of the anticline, and to the north where it plunges, the overlying impervious beds are still in existence, and the coals merge into sub-bituminous and even brown coals. The Taitapu field has always been depressed, and the overlying impervious covering is being added to, hence the coals are brown coals. Similarly, in the Whakatu field the main central portion of the field will contain brown coal, although round the edges of the basin coals of all qualities may be found, the degree of carbonization depending on local circumstances. In the Kawatiri field the bulk of the coals will be bituminous, but in parts of the Mangles section and towards the west generally the coals may grade to brown coals beneath the limestones, &c.

* Evans: Trans. N.Z. Inst., vol. 31, p. 557.
† Cox: Geol. Surv., No. 15, p. 71.

The coals of the eastern Oweka field are more elevated than those in the central section, and the upper beds of the measures have been removed. Thus the coals are superior to those of the central portion, which in turn grade from sub-bituminous on the east to brown coals on the west. In the Greymouth field the central elevated ridge carries semi-anthracites to bituminous, the degree of carbonization decreasing towards the south as the elevation decreases. South of the Tyneside the coals will probably be sub-bituminous, as are those of Blackball and Point Elizabeth. In the latter place mudstones and limestone overlie the coal. Similarly, in the Westport field the coals of the Mount Rochfort plateau decrease in carbonization toward the north, where they will be overlaid in depth by mudstones and become sub-bituminous or brown coals. The seams of the coastal section are likely also to be brown coals, while those of the Orikaka section will grade from sub-bituminous to bituminous according to local conditions. The anthracites of Fox's River, which may be included in the coastal section, are probably of purely local occurrence. Only brown coals have hitherto been reported from the Karamea field, but it seems feasible to suppose that bituminous coals may occur on some elevated ledge.

From the above considerations, and from the analyses shown in Table C, the following table may be prepared :—

Field.	Section.	Analyses.	Quality of Coal.
Whakamarama	Wanganui ..	1, 2, and 3 ..	Sub-bituminous to brown.
	Pakawau ..	4 and 5 .	Bituminous to sub-bituminous.
Taitapu ..	..	6 and 7 ..	Brown.
Whakatu ..	..	8, 9, and 10 ..	,,
Kawatiri ..	Matiri ..	.. ..	Bituminous (?).
	Mangles ..	11	Bituminous to sub-bituminous.
	Glenroy ..	12 and 13 ..	Bituminous to brown.
Oweka ..	Eastern ..	14, 15, and 16 ..	Sub-bituminous.
	Central ..	17, 18, 22, 23, and 24	Sub-bituminous to brown.
Greymouth ..	Blackball ..	25	Sub-bituminous.
	Brunner ..	26, 27, 28, and 30	Semi-anthracitous to bituminous.
	Point Elizabeth	29	Sub-bituminous.
Westport ..	Orikaka ..	19, 20, and 21 ..	Sub-bituminous to brown.
	Mount Rochfort	35, 36, and 37 ..	Bituminous.
	Coastal ..	31, 32, 33, and 34	Brown.
Karamea ..	..	38	,,

Not even the roughest estimate of the quantity of coal available in west Nelson can be given. This is due in part to lack of data, but principally to the irregular distribution of the seams or lenses of coal throughout the measures and the rapidity with which the thickness of the seams vary. At Denniston only one-tenth of the area of coal-measures contains workable coal. There is, however, little doubt but that many hundreds of

millions of tons are available. The bulk of this will consist of brown coals in no wise superior to the brown coals of the rest of New Zealand. Of the remainder the greater proportion will be sub-bituminous in quality. The comparatively small areas containing bituminous and anthracitous coals are elevated and geologically accessible, and because of this the quantities of coal they contain are approximately known.

Table C.

—	Fixed Carbon.	Hydro-carbons.	Water.	Ash.	Sulphur.	Locality.	Reference.
1	35·76	43·63	15·40	4·21	3·86	Turimawiwi ..	Col. Lab., 25.
2	41·40	46·25	5·65	6·70	0·51	Patarau ..	,, 37.
3	47·80	42·23	5·42	4·55	0·88	Taitapu ..	,, 37.
4	59·53	32·19	5·18	3·10	0·70	Pakawau ..	,, 39.
5	52·50	40·20	5·90	1·40	1·92	Puponga ..	,, 36.
6	42·70	41·00	13·70	2·60	5·66	Motupipi ..	,, 41.
7	31·87	38·66	14·09	15·38	2·48	Takaka ..	,, 41.
8	53·59	33·80	10·20	2·41	..	Enner Glynn	,, 30.
9	44·35	31·78	21·27	2·60	3·13	Tadmor ..	,, 15.
10	59·16	30·04	6·12	4·68	..	Motueka ..	,, 33.
11	51·20	40·20	2·80	5·80	0·36	Longford ..	,, 38.
12	59·60	33·50	1·10	5·80	0·41	Glenroy ..	,, 38
13	50·11	29·76	15·12	5·01	..	Maruia ..	,, 29.
14	61·85	27·10	7·10	3·95	1·37	Ross ..	,, 41.
15	48·00	35·27	1·02	15·70	2·60	Kanieri ..	,, 39.
16	56·18	32·24	9·61	1·97	..	Murray Creek	,, 22.
17	42·42	49·20	7·28	1·10	3·89	Burke's Creek	,, 42.
18	56·98	31·37	9·57	2·18	..	Capleston ..	,, 22.
19	45·00	38·00	13·60	3·40	3·19	Orikaka ..	,, 39.
20	48·14	32·20	17·40	2·26	..	Berlin's ..	Sydney Fry.
21	64·06	11·59	10·14	14·21	..	Hawk's Crag	Col. Lab., 29.
22	39·16	40·63	18·46	1·75	0·41	Giles Creek ..	J. Henderson.
23	41·58	35·79	20·21	2·42	..	Little Grey ..	Col. Lab., 29.
24	39·23	30·30	20·06	10·41	..	Slaty Creek ..	,, 29.
25	49·15	46·75	3·20	0·90	3·68	Blackball ..	,, 37.
26*	76·38	19·25	0·93	3·44	0·27	Paparoa ..	,, 38.
27†	59·23	33·33	2·11	5·33	3·36	North Brunner	J. Henderson.
28	58·00	37·83	0·37	3·80	1·96	Tyneside ..	Col. Lab., 38.
29‡	50·79	38·23	7·90	3·08	0·44	Point Elizabeth	,, 38.
30	59·27	35·34	2·34	3·05	0·28	Mount Davy	,, 41.
31	90·90	5·10	0·80	5·20	..	Fox's River ..	,, 35.
32	34·26	31·76	20·18	13·80	..	Brighton ..	,, 29.
33	38·26	40·51	20·41	0·82	..	Charleston ..	,, 29.
34	26·83	35·31	18·24	19·62	..	Cape Foulwind	,, 29.
35*	56·43	39·68	2·10	1·87	1·70	Denniston ..	,, 41.
36*	58·69	39·26	1·00	1·05	4·11	Millerton ..	,, 41.
37	59·35	38·20	1·95	0·50	4·38	Westport-Stockton	,, 40.
38§	52·40	38·90	6·70	2·00	3·83	Mokihinui ..	,, 38.
39	38·20	39·60	19·10	3·10	4·00	Karamea ..	,, 37.

* Mean of five. † Mean of seven. ‡ Mean of eleven. § Mean of sixteen.

Petroleum.

In west Nelson traces of oil are found at Karamea, Reefton, Dobson, and Kotuku. At Reefton the oil occurs in connection with certain shales underlying the coal. As pointed out by Morgan and Webb,* the source of the oil is undoubtedly the beds of the coal series. At Karamea and Reefton the shales and claystones which carry the oil are upturned by powerful faults, and the structure is synclinal.

At Dobson the bore from which the oil issues penetrates the western limb of the Brunner anticline. Between this bore and the crest of the anticline runs a branch of the great Mount William fault, to the west of which the oil will occur. At Kotuku the oil-permeated gravels lie over the northern continuation of the Ross fault, and it seems feasible to suppose that these supplies of petroleum are soaking up along this fault. The structure of the underlying coal-beds will be monoclinal.

Summary.

(1.) The coals of west Nelson, as first suggested by Professor Park,† have accumulated as marginal (probably drift) deposits.

(2.) The coal-measures belong to one system only, and present an unbroken sequence.

(3.) The more highly carbonized coals are generally the more elevated, or, more exactly, those from above which the impervious strata have been removed wholly or in part. This "stripping" permitted a relatively rapid escape of distillation-products and a relatively rapid distillation of the vegetable matter. It should be noted that Professor Park‡ has long insisted on the influence exercised by the character of the overlying measures in determining the formation of different classes of coal.

(4.) The chances of large supplies of petroleum being found in west Nelson are not good. A certain amount may occur along faults.

Art. XXXVI.—*On the Genesis of the Surface Forms and Present Drainage-systems of West Nelson.*

By J. Henderson, D.Sc., A.O.S.M.

Communicated by Professor James Park.

[*Read before the Otago Institute, 14th September, 1909.*]

The term "west Nelson" as here used includes all that part of the north-west of the South Island which lies to the west of the main divide and north of the Taramakau. This portion of New Zealand has an area of close on 8,000 square miles, and consists of a series of earth-blocks, which at one time presented a comparatively even surface, but which have suffered such a differential elevation that some of the blocks have been raised till their surfaces are 5,000 ft. or more above the surfaces of the other blocks,

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* Morgan: Geol. Surv., 3rd Ann. Rep. (n.s.), pp. 9, 10. Webb: *Idem*, p. 23.
† Park: "Geology of New Zealand," 1910, p. 280 *et seq.*
‡ Park: "Mining Geology," 2nd ed., 1907, p. 32.