1930.
NEW ZEALAND

REEFTON COALFIELD

(REPORT ON THE), by GORDON J. WILLIAMS, M.Sc., F.G.S., A.O.S.M.

Laid on the Table of the House by Leave.

CONTENTS.

Page

(1) INTRODUCTION 2
Output of coalfield—Reasons for limited production—Scope and object of survey field-work—Previous geological work.

(2) STRATIGRAPHIC SUCCESSION IN INANGAHUA VALLEY 3

(3) THE COAL-MEASURES 3
(*a*) *Occurrence.*—Extent of field—Relationship to neighbouring formations.
(*b*) *Description of Coal-seams.*—The three main seams of coal—Existence of " No. 1 " seam—Description of Nos. 2, 3, and 4 seams.
(*c*) *Formation of Coal-measures.*—Deposition in growing depression—Overlap on margin of depression—Extension of coal-measures longitudinally and transversely.

(4) THE WAITAHU MARINE BEDS 7
Variation in character from south to north—Traces of coal—Nature of unconformity above coal-measures.

(5) STRUCTURE OF COALFIELD 8
Behaviour of thin bedded series of sediments under strain—Application of principle to Reefton field—Two types of fault—Relationship between faulting and main synclinal structure.

(6) ECONOMIC PROBLEMS 9
(*a*) *Extension of Coal-measures beneath Inangahua Valley.*—Blind outcrops—Possibility of coal pinching out.
(*b*) *Nature of Faulting which may be encountered.*—Probability of impenetrable faults—Suggestions for penetrating faults.
(*c*) *The Flattening of the Measures in Depth.*—Local belief considered unlikely—Average decrease in inclination—Value of observations on Waitahu Cliff.

(7) AMOUNT OF COAL AVAILABLE 11
Computed amount of coal available in each seam on the various leases.

(8) DEFINITION OF TERMS 12
Syncline and anticline—Monoclinal flexure—Graben—Conformity, unconformity, and blended unconformity.

REPORT.

(1) Introduction.

The output from the Reefton Coalfield amounted in 1929 to 30,016 tons, an unduly low figure for an extensive field containing some excellent coal.

The small production is attributable to several causes:—

1. The supply of coal which can be worked by "rise" methods is being rapidly depleted.

2. The majority of the mines are very small. The irregularity of the output of a small mine in a faulted field tends to drive the market to districts where constancy of supply is assured. A combined marketing scheme whereby the coal from the various mines in each seam could be pooled would overcome this difficulty, and would ensure the despatch of a type of coal which would meet the particular requirement of the purchaser. A market has frequently been lost by the sale of steam coal (No. 4 seam) as household coal (No. 2 seam).

3. The delineation of the lease boundaries bears no relationship to the trend of the major geological dislocations. Several blocks of coal have been lost owing to the inability of the neighbouring lessees to come to practical agreements for the working of coal in angles between fault-lines and lease-boundaries.

4. The unprogressive policies of all but a few lessees have increased the production-costs, by the use of inefficient plants, and have also prevented the working of the major portion of the field by others willing to mine on modern and progressive lines. Capital expenditure is to-day required more urgently than in the past, as the exploitation of coal "to the dip" cannot be profitably accomplished on a large scale without replacing the obsolete and inadequate mechanical units now operating by a central power-station.

5. The greater part of the slack coal produced on the field cannot be disposed of at remunerative rates.

6. The structural dislocations which are frequently encountered have necessitated much dead-work, which is often carried out in a haphazard manner. The expense of penetrating a fault can be minimized by the intelligent application of geological knowledge.

The present survey was instituted for the guidance of those who are interested in the coalfield. As the geological structure has now been determined, there should be no difficulty in attracting finance, which is so urgently required to reduce mining-costs to a competitive basis.

The interpretation of the geological structure has been hindered in the past by gravel terraces, by the density of the vegetation, and by the fact that the greater portion of the measures lie beneath the gravel plain of the Inangahua River and its tributary, the Waitahu River.

The old rise workings have been studied, and from the nature of the disturbances occurring in them the structure of the concealed portion of the coalfield has been deduced.

The object of the report is economic. Theoretical discussions have been introduced only where they have a direct bearing on economic problems.

Field-work.—The field-work involved in the preparation of this report was carried out between the months of December, 1929, and May, 1930. The mine plans show most underground workings in existence before April, 1930.

The greater portion of the area is covered with fern and scrub, but patches of forest remain undisturbed.

The topography was mapped by Mr. K. F. H. Walker with the aid of a plane table fitted with Indian-pattern clinometer and telescopic alidade with stadia wires. The plane-table work was superimposed on a network of triangles previously fixed with a theodolite and co-ordinating with trigonometrical stations and such boundary-pegs as could be located. Vertical and horizontal controls were introduced from time to time to avoid cumulative errors.

In addition to the topographical work, it was necessary to survey the many working-mines in the district which had not already been surveyed, and also abandoned workings where possible.

No distinction has been made on the map accompanying the report between underground and outcrop observations of dip and strike, as no mines are sufficiently deep to reveal any serious difference in readings taken vertically below one another.

Previous Work.—The Reefton Coalfield has been previously visited by geologists on numerous occasions. The first detailed discussion on the coalfield is that given by Dr. Henderson in *New Zealand Geological Survey Bulletin No. 18* (new series) on the Reefton Subdivision (1917). A further report was made by the same writer in 1921, and published in the *New Zealand Journal of Science and Technology*, Vol. 4, p. 18. A full bibliography is given in Dr. Henderson's publication of 1917, p. 7, and need not be repeated here.

(2) Stratigraphic Succession in Inangahua Valley.

The stratigraphic succession in the Reefton district is as follows:—

Recent ..		Fluviatile gravels which occupy the centre of the Inangahua Valley.	
Pleistocene ..		Fluviatile and fluvio-glacial gravels which form a series of high-level terraces at various altitudes above the base of the Inangahua Valley.	
Upper Miocene	*Greymouth Series*	(b) Awamoan Series—Includes Giles Creek coal-measures and Waitahu marine beds.	
Lower Miocene		(a) Oamaru Series—Includes Reefton coal-measures?	
Eocene?	*Mawheranui Series*	Breccia and conglomerate—Does not appear in the area described in this report.	
Gently undulating surface of older rocks.			
Lower Devonian	*Reefton Series* ..	Quartzites and fossiliferous limestones appearing in Lankey Creek and other localities.	Invaded by granite.
Probable unconformity.			
Pre-Devonian	*Aorere Series* ..	Greywackes and argillites intersected by auriferous veins. (This group of rocks is locally termed the "slates.")	

The nomenclature used above is that employed by Dr. Henderson in *New Zealand Geological Survey Bulletin* on the Reefton Subdivision (No. 18), where the various formations are described. The present report is concerned only with the Lower Miocene coal-measures of the Greymouth Series. Apart from the Recent and Pleistocene gravels, two other formations only are found in the area described in this report. They are the Upper Miocene Marine beds (herein called the Waitahu beds) and the pre-Devonian greywackes and argillites, locally termed "slates."

(3) The Coal-measures.

(a) Occurrence.

The Reefton coal-measures separate the overlying Waitahu beds from the Palæozoic basement rocks, and vary in thickness from 400 ft. to 650 ft.

They outcrop as a narrow strip, roughly half a mile wide along the base of the highlands which rise along the eastern side of the Inangahua Valley. The measures do not appear as a continuous line of outcrop, but form the low spurs which jut out from the greywacke highlands into the Recent alluvium formed by the Inangahua River and its tributaries, the Boatman's and Waitahu Rivers, and numerous smaller streams.

Along the valleys of the tributaries of the Inangahua River long tongues of alluvium stretch back across the narrow belt of coal-measures to the greywacke of the back country. The high-level gravels of the Waitahu Plateau and the plateau behind Reefton each obscure the outcrop for considerable distances.

The measures dip beneath the gravel plains of the Inangahua Valley, and lie along the base of the graben occupied by the valleys of the Inangahua and Grey rivers. The Reefton coal-measures do not, as far as is known, extend southwards beyond the low saddle separating the watersheds of these rivers. They fail to reappear on the western side of the graben, along the base of the Paparoa Range.

The measures consist of a thin-bedded series of sandstones and mudstones with several seams of coal. The sandstone is not cemented, and crumbles slowly on exposure. The relative ease with which the intervening soft mudstone is removed causes it to outcrop in low bluffs throughout the field. On account of the large number and lenticular nature of the sandstone-beds, however, the outcrops are of little use as mapping-horizons. The mudstone is soft, but cleaves readily along bedding-planes, which are invaluable in working out the structure of the fields. The coal is seldom in immediate contact with the sandstone, but is more usually associated with the mudstone-beds. Individual bands of mudstone often continue for long distances with little change in nature; they do not show the lensoid tendency which is so characteristic a feature of the sandstone-beds.

In the southern end of the field the predominating rock is mudstone; in the north it is sandstone. The change takes place gradually, by a progressive increase in the number of sandstone lenses. The distribution of the two types of sediment was governed by geographic conditions at the time of deposition. It is assumed that a river-delta extended across the area now occupied by the Waitahu Plateau, for in this area the sandstones are coarser than elsewhere, and a diminution in the proportion of sandstone to mudstone occurs southwards, and to some extent, also, northwards. Moreover, several of the seams disappear; their place is taken by an immense thickness of sandstone, grit, and conglomerate. I consider that an extensive washout occurred before the deposition of No. 1 seam, as only this seam continues across the break.

(b) Description of Coal-seams.

There were considered to be four main seams and numerous small unworkable ones on the Reefton Coalfield. They were numbered downwards as seams Nos. 1, 2, 3, and 4. The recent survey has shown seams Nos. 2, 3, and 4 to be continuous throughout the field (with the exception of the break just mentioned). I found, however, that several workings which were thought to be in No. 1 seam were actually in different seams at varying distances above No. 2 seam. "No. 1" seam is therefore a "sack name" for a number of lensoid seams.

"*No. 1*" *Seam.*—After the formation of No. 2 seam, conditions of deposition became irregular. Several bands of coarse sandstone were laid down closely above that seam, and numerous small coal-seams appear between and above the thick masses of sandstone. They have been correlated with as much certainty as is possible in an area covered with a thick growth of fern, and numbered Nos. 1, 1A, and 1B: the original nomenclature is thus retained. It is based only on the approximate thickness of sediment separating an outcrop from No. 2 seam, and is not intended to suggest the continuation of a seam from one outcrop to another.

The extension of these seams may be expected to be very irregular, and no workings should be commenced before the seam has been proved by drilling. Only rarely do they thicken sufficiently to warrant exploitation. I consider that almost every outcrop showing at the present time is a representative of a distinct lens-shaped seam lying *en échelon* with another. The irregularity is accounted for by the approaching change from littoral to marine conditions.

The most extensive workings in this seam are those developed by the Birchwood Coal Co. at the corner of the Reefton Township. The mine was closed when the thickness of the seam diminished to 4 ft. Dip workings were commenced in Reddale Valley, but were abandoned on account of the poor quality of the coal. Three seams appear on the spur between Stony Batter and Burke's Creeks. The highest is about 4 ft. in thickness, but of excellent quality. No exploitable seams outcrop on Morris's lease. It is probable that the highest seam worked at the base of the jig at Waitahu is No. 1 seam; it cannot be definitely correlated across the washout which lies beneath the plateau, but appears again on the Capleston field, where it has been worked. The thickness is about 9 ft., and the quality excellent.

On account of the irregularity of the coal-seams which lie above No. 2, it is not possible to forecast their behaviour beneath the Inangahua Plain. If boring should prove the existence of workable seams, they could most advantageously be worked by crosscuts from No. 2 seam, which will always provide the greater part of the coal mined in the field.

ANALYSES* OF AIR-DRIED SAMPLES OF NO. 1 SEAM.

Locality.	Fixed Carbon.	Volatile Hydro-carbons.	Water lost at 105°–110°C.	Ash.	Sulphur Per-centage.	Colour of Ash.	Coking Properties.	Remarks.
Waitahu Colliery	46·18	44·51	7·69	1·62	5·27	Dense, weak ..	Dirty red ..	Highest seam worked at base of jig.
Capleston ..	43·51	47·97	6·08	2·44	5·06	Dense, firm ..	Brick-red ..	Archer's lease.

* Analyses by Dominion Analyst.

No. 2 Seam.—The greater part of the coal which has been produced from the Reefton Coalfield was extracted from this seam. The thickness varies from 8 ft. to about 15 ft. The coal is hard and compact, the seam is regular, and extends from Reefton to Capleston. At Reefton the seam was worked from a dip by the Birchwood Coal Co. The coal encountered at the base of the stone dip was soft and unmarketable. On account of financial difficulties, the seam was followed for a short distance only. The softness of the coal is here ascribed to proximity to a blind outcrop, and also to the effect of the overlying water-logged slump country. In my opinion, an excellent opportunity exists for investment of capital in this locality. Much of the necessary "dead-work" has already been done. A short tramway only is necessary to transport the product to the Reefton Railway-station. The area appears to be comparatively free from structural disturbances, but should be bored before mining is commenced. The bores would prove the extension in depth, which is probable, and also a more uncertain factor—the quality of the coal.

The seam extends beneath the plateau into Reddale Valley, where it has previously been worked. Spontaneous combustion has commenced in the old workings, and a large block of coal is endangered. I understand, however, that the coal in this locality is stony and contains much sulphur in the form of marcasite (locally termed "brass").

The block between Reddale Valley and Burke's Creek has been on fire for many years. No reliable plans of the old workings exist, but it is unlikely that a workable block of "rise" coal remains in this locality. I was informed that the "dip" coal is dirty—a feature which could not be checked, as the old workings are flooded. The fault at the base of this dip is probably a continuation of the Morrisvale fault—*i.e.*, it is a downthrow.

The extensive block of rise coal between Burke's Creek and Stony Batter Creek has been worked out. The last pillars were drawn shortly after I arrived in Reefton, hence the workings could not be examined. A reliable plan of the underground workings exists, and is shown on the map which accompanies this report. The break which crosses the workings is probably a washout, and consequently has no structural significance. A thin band of stone appears in the centre of the seam. The dip workings are separated from this section by the Morrisvale fault, which is in most places a steeply dipping monoclinal fold. The largest mine in the Reefton Coalfield is now working here, where the coal is very hard, of excellent quality, and usually over 10 ft. in thickness. The coal is soft only where the cover is thin. A slow but progressive increase in sulphur and ash content may be expected in the left-hand levels.

A 2 ft. seam of very hard coal appears 25 ft. beneath No. 2 seam in the neighbourhood of Stony Batter Creek.

No. 2 seam continues throughout Morris's lease, the quality is excellent, and the thickness is maintained. Only small blocks which can be worked by rise methods remain between Stony Batter and Madman's Creeks. I do not consider that the faulted remnants of this seam along the northern side of the Stony Batter Creek can be profitably exploited. The coal which dips beneath the alluvial flat in this locality is the finest on the field. It is to be regretted that this block of coal is not systematically exploited on an extensive scale. The finance available to the small parties of co-operative tributers who are at present working the field is insufficient. Further capital expenditure is essential for the economical working of the field. At the present time the royalties demanded by the lessee prevent the working of dip sections on a large scale, which is justified by the comparative freedom from geological disturbances.

The succession at Waitahu is not obvious, on account of the approach to the washout which extends beneath the plateau, the stratigraphic sequence is disturbed, and correlation of seams with those in other parts of the field is not clear. The higher seam which has been worked at the base of the jig is probably No. 1 and the lower No. 2 seam. These seams extend southwards towards Perfection Mine, beneath a thin covering of alluvium. They are disturbed by at least one fault (the Inglewood fault), which appears to have caused a considerable displacement of strata.

This seam reappears on the Capleston field. The coal outcrop in Flower's Creek is probably No. 2 seam. Under the Boatman's River and for about 6 chains north of that river it is unworkable. In the prospectus of Hillside Collieries, Ltd. (18th August, 1927), the presence of the washout beneath the Waitahu Plateau is not mentioned. The four seams were examined farther north, and it was assumed that they continue across Boatman's River. I agree that they extend to the dip from Archer's Mine, but point out that they are generally unworkable, except in a few small isolated blocks for a distance of about 6 chains from the river. If the coal is to be worked in dip sections, it will be necessary to sink the dip from a point not less than 10 chains along a level driven in unmarketable coal from Boatman's River. The construction of this level and the haulage-costs along it will be a continual burden to a company working the dip coal on the Capleston field. An alternative is the construction of a main dip haulage-road from a point in the vicinity of Archer's Mine. On account of the extensive series of faults which would be penetrated, it is unlikely that the coal could be economically produced in large quantities in this area.

In the case of the Capleston field it is even more important that the expenditure of capital should be preceded by boring than is the case with the field farther south. Both stratigraphic and structural factors are more uncertain here than elsewhere, but the coal is generally superior in quality.

ANALYSES* OF AIR-DRIED COAL FROM NO. 2 SEAM.

Locality.	Fixed Carbon.	Volatile Hydro-carbons.	Water lost at 105–110° C.	Ash.	Sulphur Percentage.	Colour of Ash.	Coking Properties.	Remarks.
Stony Batter Creek	38·45	50·90	8·45	2·20	4·21	Dark red ..	Dense, firm ..	Upper half of seam.
,,	43·81	44·49	9·52	2·18	5·06	Dark red ..	Dense, weak ..	Lower half of seam.
Surprise Mine ..	39·98	51·11	7·86	1·05	5·37	Dark red ..	Dense, firm ..	Upper half of seam.
,, ..	45·04	43·58	10·06	1·32	4·61	Brownish red	Dense, firm ..	Lower half of seam.
Archer's Mine ..	43·68	47·17	6·97	2·18	5·12	Brick-red ..	Dense, firm ..	..
Waitahu ..	43·25	48·48	5·85	2·42	5·98	Brown ..	Dense, firm ..	Seam at top of jig.
Morrisvale Mine	43·44	46·02	9·50	1·04	4·92	Reddish brown	Dense, weak ..	Upper half of seam.
,,	46·67	40·95	11·49	0·89	4·07	Reddish brown	Dense, weak ..	Lower half of seam.
Coghlan's Mine ..	43·26	48·45	5·85	2·43	4·82	Brick-red ..	Dense, firm ..	..
Svenson's Mine ..	41·38	45·39	11·05	2·18	4·50	Grey ..	Dense, weak ..	..

* Analyses by Dominion Analyst.

No. 3 Seam.—This seam is the most irregular of the three main seams on the field. It is separated from No. 4 seam by about 100 ft. of mudstone (the thickness varies from place to place), containing thin lenses of sandstone, which is readily distinguishable from that above No. 2 seam by the fineness of the constituent grains. In the Capleston field a coarser sandstone is the predominant rock.

The seam attains a maximum thickness of 7 ft. on Archer's lease. It disappears entirely on Coghlan's lease, but reappears as a stony 4 ft. seam near Boatman's River, before splitting up and continuing through the sandstones on the southern side of that river as an irregular band of carbonaceous shale, containing some thin bands of coal which outcrop in Flower's Creek. It is again visible as a definite 5 ft. seam on the Waitahu River. The next appearance is on the hillside above Perfection Mine, and on the tramway to Morris's old workings in No. 4 seam. The continuity of the outcrop is broken south of Perfection Mine by the tongue of alluvium formed by Madman's Creek. I estimate that this seam should outcrop at the toe of the spur separating the two branches of Madman's Creek. Two mines are at present working south of Madman's Creek—Matchless No. 3 Mine on the coal which lies behind a small upthrow fault in the rise workings, and in Harris's Mine where the seam is being worked to the dip. In both of these mines the coal is clean, exceedingly hard, about 6 ft. thick, and contains no visible sulphide. The proportion of screened coal produced is higher than that obtained in any other mine in the district.

On the Burke's Creek Company's lease the coal in this seam is unmarketable on account of the excessive sulphur content. This element appears in combination with iron as the unstable sulphide, marcasite, which decomposes rapidly on exposure to the atmosphere and generates heat, which promotes spontaneous combustion. During my sojourn in Reefton an adit was commenced in Burke's Creek. The outcrop coal was tipped, together with a fair proportion of stone, to form a tramway to connect the proposed mine with the main haulage-road. Within six weeks, however, the heat generated by the decomposition of the marcasite had ignited the coal. It is therefore obvious that the working of this seam would be a difficult problem. (Marcasite can be distinguished from iron-pyrites by its silvery colour, in contrast with the bronze colour of the pyrites.) The high sulphur content of No. 3 seam at Burke's Creek continues to the southern boundary of the coalfield.

The regularity of the seam is no less changeable than the character of the coal. It is impossible to predict the behaviour of this seam for more than a few chains from an outcrop. Stone bands are frequently encountered, but disappear as rapidly as they appear; sometimes there is only a few inches of coal above or below them. The only locality in which this seam is workable is on Morris's lease, where it is the most valuable coal in the district.

ANALYSES* OF AIR-DRIED SAMPLES OF COAL FROM NO. 3 SEAM.

Locality.	Fixed Carbon.	Volatile Hydro-carbons.	Water lost at 105–110° C.	Ash.	Sulphur Per-centage.	Colour of Ash.	Coking Properties.	Remarks.
Morrisvale No. 3 dip	44·79	40·27	12·14	2·80	2·86	Light brown ..	Pulverulent ..	..
Archer's Mine ..	41·10	44·73	7·24	6·93	3·67	Pink ..	Dense, weak ..	..
Burke's Creek ..	38·99	31·81	13·68	15·52	11·42	Brown ..	Frits somewhat	Contains much marcasite (" brass ").

* Analyses by Dominion Analyst.

No. 4 Seam.—This seam is the thickest appearing on the field. It is separated from the greywacke basement rocks (" slates ") by 20 ft. of mudstone as far north as Painkiller Creek, beyond which a band of coarse sandstone develops. Beneath the Waitahu Plateau, this sandstone merges into a great thickness of current-bedded sandstone, conglomerate, and grit, which replaces all seams but one.

The gently undulating surface of the greywackes which lie a few feet below No. 4 seam was decomposed by subaerial weathering before the deposition of the coal-measures. The unconformity provided a passage for the circulation of underground waters which cemented the mudstone below No. 4 seam, and formed an indurated rock resembling, at first glance, the decomposed product of the weathering of the surface of the greywackes. Consequently difficulty is sometimes experienced in locating the exact position of the unconformity. These facts should be kept in mind when prospecting for this seam: time has frequently been wasted in prospecting for coal beneath the indurated basal rocks of the coal-measures. This point is of more importance to those interested in the mines in the adjacent Murray Creek field than in the Reefton field.

The thickness of No. 4 seam reaches a maximum of 35 ft. on Archer's lease at Capleston. In the old workings on Morris's lease, the total thickness is over 30 ft., but this includes several " dirt " bands. Between Madman's Creek and Reefton there are between 20 ft. and 30 ft. of coal. At the present time the seam is worked only in Burke's Creek, and at the corner of the Reefton Township. Old workings exist in many parts of the district, but were abandoned owing to the poor quality of the coal, which is very slow burning, and produces a large proportion of fine coal. The thickness of the seam, the ease with which it can be extracted, and the large quantity still available for working by rise methods justifies a thorough investigation into its uses.

It is thought locally that the seam should be more compact, and produce a smaller proportion of slack when mined farther from the outcrop than is at present the case. It is probable, however, that this quality will improve only slightly at depth, as the fineness of the product is brought about by the presence of innumerable thin bands of " soot." Moreover, such screened coal as is produced has the habit of comminuting in transport.

The best block of " rise " coal remaining in this seam lies beneath the hill between Burke's and Stony Batter Creeks. If a level were driven beneath this hill from either of the above-mentioned creeks, any improvement which may occur under deep cover would become apparent. If justified by the results obtained from such a drive, a long crosscut could be driven from the dip workings in No. 2 seam in Stony Batter Creek.

No. 4 seam underlies the plateau between Reefton and Reddale Valley. Some good coal is now being produced from Honey's Mine. A large block of land between Painkiller and Madman's Creeks is underlain by No. 4 seam. The block is intersected by two faults, the more southerly of which is not sufficiently profound to become a mining barrier in a seam with a thickness in the neighbourhood of 30 ft. North of the Inglewood fault this seam has a very thin cover, and is unmarketable.

An outcrop appears a few feet above the greywacke on the Waitahu River bed. The coal in this locality appears to be cleaner and harder than elsewhere, but no attempt has yet been made to exploit it. The seam extends beneath the Waitahu Plateau for an unknown distance before it is cut off by the washout. I feel justified in forecasting an extension for at least 8 chains.

No. 4 seam has been worked in several places in the Capleston field; its southern extension on this field is limited by the northern side of the washout which runs roughly along the course of Boatman's River, though the seam is thin and stony for 8 chains northwards from that river.

ANALYSES* OF AIR-DRIED SAMPLES OF No. 4 SEAM.

Locality.	Fixed Carbon.	Volatile Hydro-carbons.	Water.	Ash.	Sulphur Percentage.	Colour of Ash.	Coking Properties.	Remarks.
Waitahu River ..	41·64	36·21	11·10	11·05	3·46	Yellowish-white	Pulverulent ..	Not yet opened up.
Burke's Creek ..	43·35	40·31	9·68	9·66	2·55	Light purple ..	Dense, weak ..	Upper half of seam.
,, ..	43·05	40·06	12·65	4·24	1·16	Greyish-yellow	Dense, weak ..	Lower half of seam.
Archer's Mine ..	47·35	43·15	8·29	1·21	2·25	Reddish-brown	Dense, weak ..	Upper half of seam.
,, ..	49·51	41·44	8·39	0·66	1·27	Reddish-brown	Dense, weak ..	Lower half of seam.
Morris's lease ..	47·51	39·95	11·21	1·28	1·53	Brick-red ..	Pulverulent ..	Upper half of seam.
,, ..	46·72	38·56	13·95	0·77	0·68	Light brown ..	Pulverulent ..	Lower half of seam.
Honey's Mine ..	44·22	41·02	11·69	3·07	2·09	Pink ..	Pulverulent ..	..

* Analyses by Dominion Analyst.

(c) *Formation of Coal-measures.*

In early Tertiary times a longitudinal depression or graben originated in the area now occupied by the lower Inangahua Valley. The growth of the depression continued slowly throughout the remainder of the Tertiary era. The last movements are described on page 8, where the structure of the coalfield is discussed.

The gently undulating surface of the greywackes and granites was folded into a series of low ridges and depressions. Erosion immediately commenced to reduce the surface of the ridges and deposit the detritus in the shallow depressions. The character of the sediment which accumulated was governed by geographic conditions from time to time. These conditions changed rapidly. River-capture would occasionally occur in the initial stages of the dissection of the elevated blocks—sometimes, no doubt, brought about by differential earth-movements in a region that was tectonically unstable.

In a long narrow submerged depression a change in the drainage systems in the neighbouring land-masses would have a profound effect upon the nature of the detritus which was deposited. The character of the sediment would also be governed by local earth-movements, which would determine the depth of water at different points along the depression.

The micaceous mudstone was formed in those areas which were more deeply submerged, or which were more remote from a supply of coarse sediment brought down by rivers. The rapidly changing geographic conditions, however, did not permit the accumulation of a great thickness of this sediment. Interlaminated sandstone-beds appeared when the area was brought, either by local movements or by change in drainage systems, into the region of deposition of such a deposit, the supply of which may at any time be cut off for the same reasons as it was formed. Occasionally, when the necessary combination of conditions occurred, vegetable matter, which later formed the coal-beds, was accumulated in the manner described in the Drift Hypothesis.

A narrow strip of sediment formed in this manner along the depression, the deepening of which proceeded contemporaneously with the deposition of the sediments which crept up the gently shelving sides, which became covered by an overlapping series of sediments; thus the beds which lie on the basement rocks in the centre of the trough are older than those which immediately overlie the greywacke on the sides of the depression.

The formations which were deposited in the graben consequently form lenticular masses, the strata of which stretch for considerable distances longitudinally without marked change in facies, whilst in a transverse direction the nature of the sediments varies rapidly, and overlap is commonly observed. These features can be used to solve the economically important question of the continuation of the coal-seams beneath the Inangahua Valley.

(4) THE WAITAHU MARINE BEDS.

The coal-measures are succeeded by marine beds which vary in character and from place to place along the depression. In the southern half of the area the only rock visible is a soft homogeneous bluish mudstone, with no bedding-planes or sandy bands on which dip observations can be taken. It splits characteristically along planes parallel to the contour of the surface. A band of concretionary mudstone of unknown but probably variable thickness appears near the base of this mudstone, and is of value in locating outcrops of No. 1 seam.

A bore sunk about 1920 near the rifle butts at Reefton penetrated these beds for 500 ft. It passed through soft mudstones and fine argillaceous sandstones for the whole of this distance. Mr. James Gibson, who was in charge of the drill, informed me that a carbonaceous band, 3 ft. in thickness, was penetrated at a depth of 100 ft. As this band is at least 1,600 ft. above the highest coal-seam, it becomes apparent that carbonaceous matter may be expected throughout the Waitahu beds.

In the northern portion of the district the Waitahu beds are lithologically different. Predominate mudstone gradually gives way to a predominance of sandstone. On the Waitahu River the two types are equally developed. Farther north the mudstone has been almost entirely replaced by sandstone, of which many thousand feet are visible before the covering of high-terrace gravels obscures them from view. Thin carbonaceous or coaly bands appear as in the mudstone farther south, but are not developed sufficiently to be of economic value.

The rocks belonging to this formation were studied in some detail for a distance of 100 chains down the Waitahu River from the bridge at the coal-bins. Structural observations can readily be obtained in the banded rocks exposed along the river-bed.

The upper limit of the Waitahu beds is concealed: the base is indefinite. For several hundred feet marine beds and coal-measures are interlaminated, and no definite line of demarcation can be drawn between the marine beds and the coal-measures. Several lens-shaped masses of coarse conglomerate at various heights above No. 1 seam prove the existence of a *blended unconformity.* In the map accompanying this report, the Waitahu beds are shown lying immediately on the highest seam of coal—generally the horizon at which thin bands of sparsely fossiliferous marine rocks commence to appear between the upper laminations of the coal-measures.

(5) Structure of Coalfield.

It has been stated that the measures consist of a thin-bedded series of mudstones and sandstones. A brief discussion on the behaviour of such a series under strain will elucidate the description of the faults which have intersected the field.

The rigidity of the sandstone, which is unable to accommodate strains by cleavage, and has no cementing medium, can be contrasted with the incompetency of the interlaminated mudstone and its accompanying coal-seams. In consequence of its comparative rigidity, the thicker bands of sandstone have usually transmitted the strains set up during the formation of the graben, whilst the softer, easily cleaved mudstone accommodated itself to the broad folds of the sandstone. Along lines where the shear was sufficiently intense to rupture the sandstone a clean fracture developed; such a fracture often passes into a zone of intense folding in the mudstone. Consequently an outcrop of contorted mudstone usually indicates the proximity of a major fault.

The coal followed to some extent the contortions of the mudstone in the neighbourhood of faults, but, owing to its superior competency, usually developed a series of minute overthrusts that pass out into acute folds in the surrounding fireclay and mudstone. In localities where folding of the thick soft No. 4 seam is pronounced stony bands are developed by the drag of foreign matter along the line of fracture.

The initial stages in the development of the graben in which the coal-measures were deposited is described elsewhere. It is shown that the graben had commenced to form before the measures were laid down, and continued to develop throughout the period of deposition of the measures. In early Tertiary times the movements received renewed vitality, and the beds that had formed in the base of the graben were faulted and folded, but no major disturbances were developed in the area described in this report.

For clearness, the movements which have disturbed the coal-measures may be divided into two classes:—

(*a*) Regional movements that shaped the broad syncline along the axis of which the lower Inangahua River now flows. The syncline was developed very slowly during the formation of the coal-measures and overlying Waitahu beds. Later phases of these gradual movements folded the formations into a synclinal form.

(*b*) Local movements of a more intense nature, which corrugated the limbs of the broadly synclinal depression by a serious of step faults.

The general trend of the latter type of movement does not depart widely from the regional strike. (In the immediate neighbourhood of the large faults the beds were folded by the forces that produced the fault, hence the regional direction of strike may change locally in sympathy with the trend of the fault.)

The description of the syncline given above should be interpreted with some latitude. The faults that have disturbed the measures form only small corrugations on the surface of the syncline, which has a total width of eight miles. They are of vital importance to the mining industry, but play only a minor roll in moulding the geological structure of the district.

The most usual form of dislocation is a monoclinal flexure, with a downthrow towards the axis of the main syncline. On the lower side of the flexure the strata are usually irregularly folded for a few chains into the form of small pitching anticlines or domes—*e.g.*, the upper workings in the dip in Stony Batter Creek. Along lines of local tension in the neighbourhood of main folds small upthrow faults were occasionally developed—*e.g.*, Matchless Mine, and at the present base of the dip in Stony Batter Creek. Faults of this type are clean-cut, and do not extend for more than a few chains.

The majority of the faults on the Capleston field are upthrows from the west; nevertheless, the beds continue to outcrop at lower and lower points westwards. The small upthrows which have so effectively hindered the progress of mining do not counteract the general westward dip of the eastern limb of the syncline.

On account of the relatively small throw of the faults, it is possible to estimate with reasonable accuracy the depth of coal at any point beneath the Inangahua Valley. It may confidently be stated that no faults encountered will be so large as to render impracticable the winning of coal which lies behind them.

(6) Economic Problems.

The supply of coal which can be worked by "rise" methods on the Reefton Coalfield will be exhausted within the next few years. Consequently, in the near future the whole of the output from the field will be derived from the higher levels of the seams which dip beneath the alluvial plain of the Inangahua and Waitahu rivers.

The measure of success which is attained in winning coal from dip section depends on three main issues:—

(*a*) The extension of the seams beneath the valley:
(*b*) The nature and extent of the faulting that may be encountered:
(*c*) The flattening of the measures in depth.

The present report is not concerned with artificial difficulties with which investors are confronted, and which are impeding the progress of mining to a greater extent than geological uncertainties.

For the guidance of those interested in the industry, these three issues are discussed in the sequel. The amount of available data is admittedly insufficient to warrant dogmatic conclusions; my opinions are deduced by analogy with neighbouring fields, and by assumptions based on established geological facts. Proof can be obtained only by drilling, which is an essential complement to geological work of this nature.

(*a*) *Extension of Seams under Inangahua Valley.*

The quantity of available coal is an important factor which governs the size, type, and permanency of proposed haulage and pumping plants. The following discussion is based on the Burke's Creek section, but is equally applicable at Waitahu and Capleston, except in the line of the washout mentioned elsewhere.

There are two ways in which the seams may be lost (apart from structural possibilties).

(i) Blind outcrops—*i.e.*, the line of intersection of the coal-seam with the suballuvial surface: The exact underground configuration is indeterminable without drilling, but the approximate position of a blind outcrop can be judged by continuing the contour of the adjacent hills beneath the alluvial flat. It is important that the slope which is carried underground should be that of the surface of the coal-measure strata only, as the greywacke hills behind the narrow strip of coal-measures have a higher relief on account of their superior resistance to denudation.

A glance at the map accompanying this report shows that the circular outcrops that appear when the dip of the strata is less than the slope of the hillside seldom occur. Hence it may be confidently assumed that similar conditions prevail along the suballuvial surface, and that proposed dip headings will not break through into the alluvium.

The upper levels in the dip sections will, of course, be stopped laterally by blind outcrops, which will be encountered farther and farther from the main dip heading, with increasing depth. The approach to a blind outcrop is indicated by a softening of the coal, abundant iron-stains, and inflow of water. The alluvium of the valleys is composed of greywacke and granite pebbles and sand, and consequently holds vast quantities of water, which will drain into the mine should the levels be driven close to the alluvium. The additional pumping-expenses outweigh the revenue obtained from the few tons of coal extracted at the blind outcrop. The inflow of water into several of the dip sections now working might easily have been reduced by foresight in this connection.

(ii) The second possibility which must be considered is the approach to the edge of the coal-seam. It has been shown that the continuity of the strata is more regular longitudinally than transversely, with respect to the depression in which the measures were formed. In a north-easterly direction the three main seams continue for a distance of over six miles with little variation in character or thickness. In a transverse direction, however, marked changes occur in a short distance. The coal-measures fail to reappear at the base of the Paparoa Range, on the western side of the depression: this may be due to their being faulted against the granite, but more probably to pinching out. In the opposite direction also evidence is incomplete. The coal-measures at Murray Creek, about two miles south-east of the Reefton Coalfield, rest immediately on the basement rocks. The stratigraphic succession, however, changes completely in two miles. The correlation is not obvious, as the intervening coal-measures have been removed by erosion. The relative age of the two coalfields cannot be determined with certainty, but, on account of overlap of beds, the oldest beds on the Murray Creek field are probably newer than those of Reefton. The evidence is sufficient to demonstrate a rapid change in facies transversely across the depression.

A study of the coal-seams in the neighbouring coalfields shows that on nearing the edge of a seam the ash content increases rapidly, and thin stone bands appear within the seam. The deepest mine on the Reefton Coalfield extends beneath the valley for a horizontal distance of 10 chains, and in this distance no deterioration in the quality of the seam is perceptible.

There are, then, three seams which extend in a north-easterly direction for six miles, and in a perpendicular direction for half a mile without noticeable change in character or in thickness; but in a distance of two miles in the latter direction the strata change so completely that correlation is impossible. It may be reasonably inferred that a similar change occurs in the opposite direction, but it is unlikely that the alteration in facies will be so rapid, as deposition near the centre of the depression would be more regular than that along the margins.

A consideration of the foregoing evidence leads me to believe that the coal-seams may reasonably be expected to extend for at least two miles (horizontal distance) beneath the valley. At great depths haulage and pumping costs will increase rapidly, and a point will be reached beyond which the coal cannot be profitably produced; its position will fluctuate in accordance with market conditions, but it is unlikely that mining will reach a greater depth than 2,000 ft. The coal attains this depth at a horizontal distance of about 75 chains from the outcrop.

I consider, therefore, that it is probable the seams continue beneath the plain beyond the limits of profitable mining. The behaviour of the coal-seams at greater depths is a matter of no economic importance.

(b) The Nature of the Faulting which may be encountered in Dip Workings.

In the extensive field of coal which extends beneath the Inangahua Valley the only faults which can be located are continuations of those which outcrop on the exposed portion of the field. No specific movements in the remainder of the field can be found by geological means. The rocks which form the toes of the spurs which project farthest into the alluvial flat are marine mudstones which cleave in places which appear at first glance to be true bedding-planes, but on close examination prove to be cracks formed by subaerial agencies, parallel to the contour of the surface.

In the section of this report dealing with the structure of the field it is shown that major faults —*i.e.*, dislocations—the throw of which is so great that they are economically impenetrable, are not likely to be encountered. It was shown that the faults are divisible into two classes:—

(*a*) Downthrows: Usually monoclinal flexures.
(*b*) Upthrows: Clean-cut faults.

The former extend for many chains, and are of greater importance than the latter, which are seldom as much as 5 chains long. In the northern end of the field, however, upthrows are the predominant form of dislocation. The dip of a monoclinal flexure seldom reaches verticality, and as there is not often an actual rupture of strata an attempt should be made to "keep" the coal. The production of coal which lies at so steep an inclination will, naturally, not be directly remunerative, but unless the field has previously been bored in detail it is the safest policy. When the coal commences to flatten, a stone drive for haulage purposes can be immediately put in hand in the overlying strata, in a direction which has been computed from the positive data obtained in the small shaft. The extension of the main dip through strata over the coal-seam which has been thrown down by a monoclinal flexure may (as in the dip in Stony Batter Creek) cut one of the small upwarps which lie behind the main fold; but, on the other hand, it might pass over the coal, and involve additional unnecessary expense in driving again at a steeper angle.

When small upthrows are met (the following does not apply to the Capleston field, where the upthrows are often of considerable magnitude), which seldom extend for more than 5 chains, it is advisable to endeavour to drive round them in coal before commencing a horizontal stone drive—the throw of the fault will then be known, and the stone drive, if such be necessary, can be placed in the most advantageous position for haulage purposes.

To sum up, in the southern part of the field the upthrow faults are clean cut, and have a small throw and prolongation, whilst the downthrow movements are folds which extend for considerable distances, and have throws amounting in some cases to 100 ft.

If any doubt exists as to which class a fault belongs the character of the neighbouring strata should be examined. It will often pay to excavate roof and floor for a few feet, in order that any necessary stone-driving may be intelligently prosecuted. In the lease held by the Burke's Creek Company the penetration of sandstone is indicative of a downthrow, whilst mudstone (usually with fine sandstone lenses) will be encountered at an upthrow fault when mining in No. 2 seam. On Morris's lease this applies only to a limited extent, for No. 2 seam is overlain immediately by several feet of mudstone with coal bands, which will be penetrated before the sandstone is reached. In the case of an upthrow on this lease, mudstone will be encountered as on the adjoining lease, but beneath it lies a sandstone similar to that above the seam. Hence a fault will probably be a downthrow if mudstone with numerous coal-streaks is found, and an upthrow in the case of mudstone which contains little or no trace of coal.

When mining in other seams, or in other parts of the field, a glance at the map accompanying this report will show in a simplified form the general succession of strata in the neighbourhood of a seam. Stone drives can then be advanced accordingly.

(c) The Flattening of the Measures in Depth.

It is commonly supposed in Reefton that the inclination of the coal-seams will commence to decrease beneath the toes of the spurs which project into the alluvial plain. The assumption is founded on one or two coincidences. The height to which the alluvium rose up the former valley-slopes is a factor entirely independent of the structural movements which folded the strata.

The beds are folded into a broad north-easterly-trending syncline. The average dips on the exposed portion of the coalfield must decrease gradually to zero at the base of the trough, and then increase progressively up the western limb of the syncline.

The width of the syncline from the outcrop of the coal-measures to a point on the opposite limb where the coal-measures might be expected to appear is about eight miles. Consequently, a dip of, say, 25° decreases to zero in a distance of four miles—*i.e.*, 6° 15′ per mile. The inclination of the coal-seams, therefore, decreases 6° 15′ in every horizontal mile.

It is stated elsewhere that coal will probably not be profitably produced at a greater depth than 2,000 ft. At this depth the horizontal distance of the coal from the entrance to the mine is about 75 chains. Consequently the decrease in the dip amounts to, say, 5° 52′ within what may be termed "mining distance." The calculations are based on the assumption that the syncline is symmetrical, but the change in average dip is so small in the area which could be worked that a slight degree of asymmetry will alter the results only slightly.

It should be clearly understood that the inclinations mentioned are *average* dips, which can be found approximately by averaging a representative series of dips taken at regular intervals within, say, 5 chains of a given point along the line of dip.

Some idea of the dip of the beds nearer the centre of the syncline can be obtained from observations on the Waitahu marine beds, which stretch out for some distance towards the axis, along the north bank of the Waitahu River. The inclination of the beds along these cliffs is slightly less than that of the underlying coal-measures into which they pass in depth, through a blended unconformity. The inclination of the beds deposited in a growing depression decreases from the lowest to the highest members of the series.

(7) Quantity of Coal available.

The figures are computed on the assumption that the conclusion reached in the discussion of the coal-seams beneath the alluvial flats is correct.

Such factors as the regularity of the seam (as regards both thickness and quality) have been taken into account in arriving at the probable available tonnage of coal in the field, the extent of which has to be estimated on admittedly insufficient data.

The assumed thickness is a safe minimum, used for the purpose of computation only; it is not intended to represent the average thickness of the seam. It is fixed after consideration of the habits of the seam; thus the thickness of a coal-seam which is very irregular has been reduced considerably from that of the outcrop. The figures for seams Nos. 1 and 3 should be accepted with reservation, as these seams are markedly irregular. If the field is bored, the conservative estimates given can be adjusted according to the proved thickness of coal.

The tonnage computations are based on 100 tons per inch pe acre. The quantity thus obtained is the probable *available* tonnage of coal, which is less than the total tonnage in the field by an amount allowed for loss of coal along faults, coal left for support, coal lost in working, &c.

"Rise" Coal.

Seam.	Locality.	Area.	Thickness.	Tonnage.
		Acres.	Feet.	
4	Reefton to Reddale Valley	63	15	1,134,000
	Reddale Valley to Burke's Creek	36	15	648,000
	Burke's Creek to Stony Batter Creek	20	15	360,000
	Stony Batter Creek to Madman's Creek	11	20	264,000
	Madman's Creek to Painkiller Creek	40	20	960,000
	Waitahu	12	15	216,000
	Capleston Field	34	20	816,000
				4,398,000
3	Reefton to Stony Batter Creek	*	..	..
	Stony Batter Creek to Madman's Creek	†	..	..
	Madman's Creek to Painkiller Creek	12	5	72,000
	Waitahu	9	5	54,000
	Capleston Field	‡	..	..
				126,000
2	Reefton to Reddale Valley	56	10	672,000
	Reddale Valley to Burke's Creek	§	..	..
	Burke's Creek to Stony Batter Creek	†	..	..
	Stony Batter Creek to Madman's Creek	†	..	..
	Madman's Creek to Painkiller Creek	21	10	252,000
	Waitahu	10	6	72,000
	Capleston Field	62	10	744,000
				1,740,000
1	Reefton to Reddale Valley	19	4	91,000
	Reddale Valley to Burke's Creek	6	5	36,000
	Burke's Creek to Painkiller Creek	*	..	..
	Waitahu	6	6	43,000
	Capleston Field	31	6	223,000
				393,000

* Unworkable. † Worked out or almost worked out. ‡ Probably unworkable. § Destroyed by fire.

"DIP" COAL.

(a) Coal lying above 1,000-ft. Level.

Seam.	Locality.	Area.	Assumed Thickness.	Tonnage.
		Acres.	Feet.	
4	Area south of lease held by Burke's Creek Company ..	356	15	6,408,000
	Lease held by Burke's Creek Collieries, Ltd.	160	15	2,880,000
	Lease held by W. J. Morris	246	20	5,904,000
	Area north of Morris's lease	139	15	2,502,000
	Capleston Field	162	20	3,888,000
				21,582,000
3	Area south of lease held by Burke's Creek Company ..	*	..	..
	Lease held by Burke's Creek Collieries, Ltd.	*	..	..
	Lease held by W. J. Morris	359	5	2,154,000
	Area north of Morris's lease	104	4	499,000
	Capleston Field	†	..	..
				2,653,000
2	Area south of lease held by Burke's Creek Company ..	312	10	3,744,000
	Lease held by Burke's Creek Collieries, Ltd.	170	10	2,040,000
	Lease held by W. J. Morris	354	10	4,244,000
	Area north of Morris's lease	133	8	1,277,000
	Capleston Field	162	10	1,944,000
				13,249,000
1	Area south of lease held by Burke's Creek Company ..	67	4	322,000
	Lease held by Burke's Creek Collieries, Ltd.	†	..	..
	Lease held by W. J. Morris	†	..	..
	Area north of Morris's lease	104	6	749,000
	Capleston Field	90	6	648,000
				1,719,000
	(b) Coal lying between 1,000 ft. and 2,000 ft. Levels.			
4	Reefton Township to Waitahu	798	15	14,364,000
	Capleston Field	142	15	2,556,000
3	Reefton Township to Waitahu	405	4	1,944,000
	Capleston Field	†	..	..
2	Reefton Township to Waitahu	828	9	8,942,000
	Capleston Field	142	9	1,534,000
1	The quantity of coal lying above No. 2 seam at this depth cannot be safely determined.			

* Unworkable. † Probably unworkable.

(8) DEFINITION OF TERMS.

Syncline.—The trough of a rock fold is termed a syncline.

Anticline.—The arch of a rock fold is termed an anticline. In a sheet of corrugated iron the ridges represent anticlines, and the troughs represent synclines. The line running along the base of a trough is termed the synclinal axis. The sides of an anticline or syncline are called the limbs. Folds may be symmetrical or asymmetrical.

Monoclinal Fold.—When the strata are bent from the normal dip for a distance and then resume the original plane, the fold is said to be monoclinal.

Graben.—A graben is a long narrow strip of country which has been depressed between two main faults or series of faults. Grabens do not necessarily coincide with valleys, but usually do, as the depressed rocks are newer, and therefore generally less consolidated than the older rocks which outcrop along the sides of the depression.

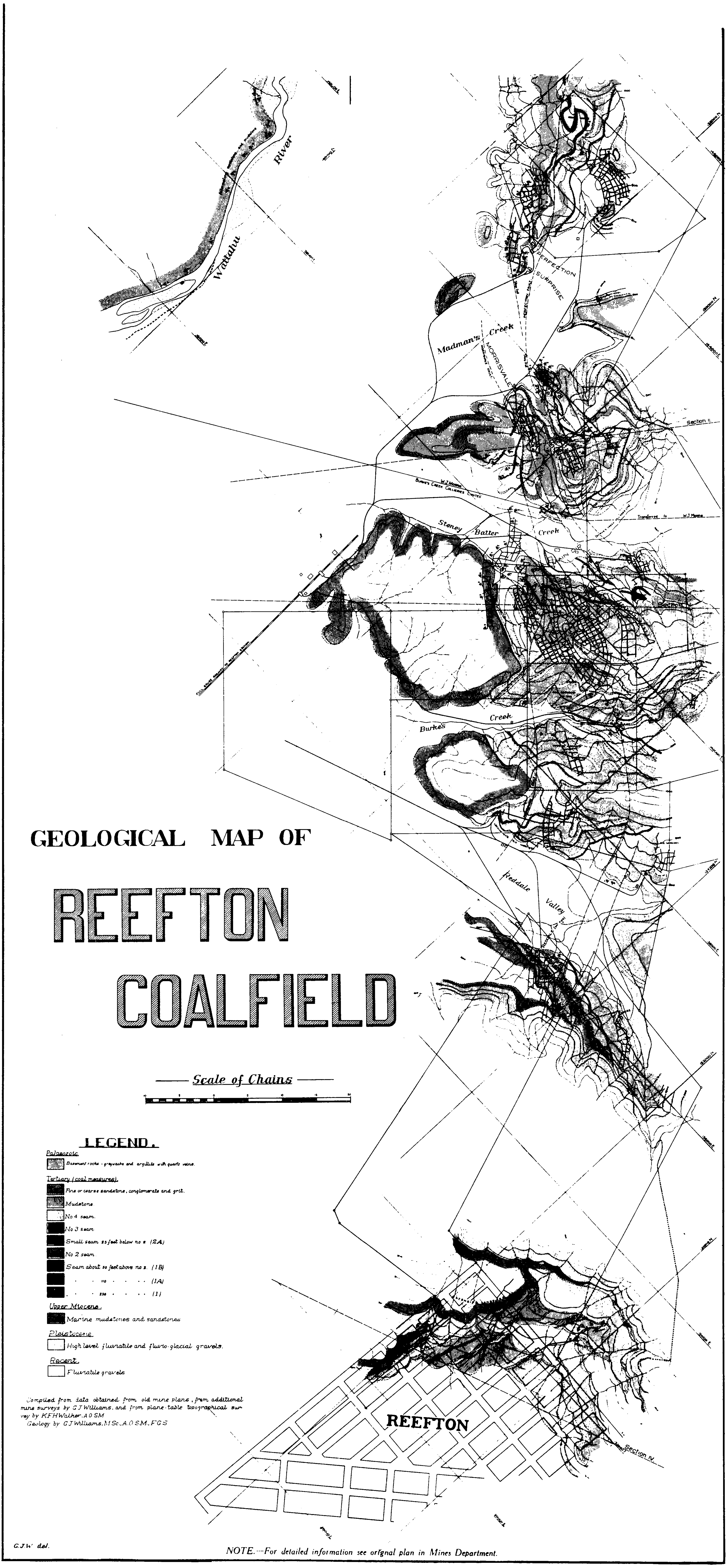
Conformity.—When a series of strata has been deposited in such a manner that the stratification-planes are parallel to one another, the strata are said to be conformable.

Unconformity.—When a series of conformable strata rest on the folded or a denuded surface of an older series of beds there is an unconformity between the beds. In cases where the inclination of a series of beds varies from that of the lower beds, but where the change in inclination is gradual, the unconformity is said to be blended. Such a break is caused by deposition contemporaneously with the tilting of the beds.

Approximate Cost of Paper.—Preparation, not given; printing (500 copies), £15.

By Authority: W. A. G. SKINNER, Government Printer, Wellington.—1930.

Price 6d.]

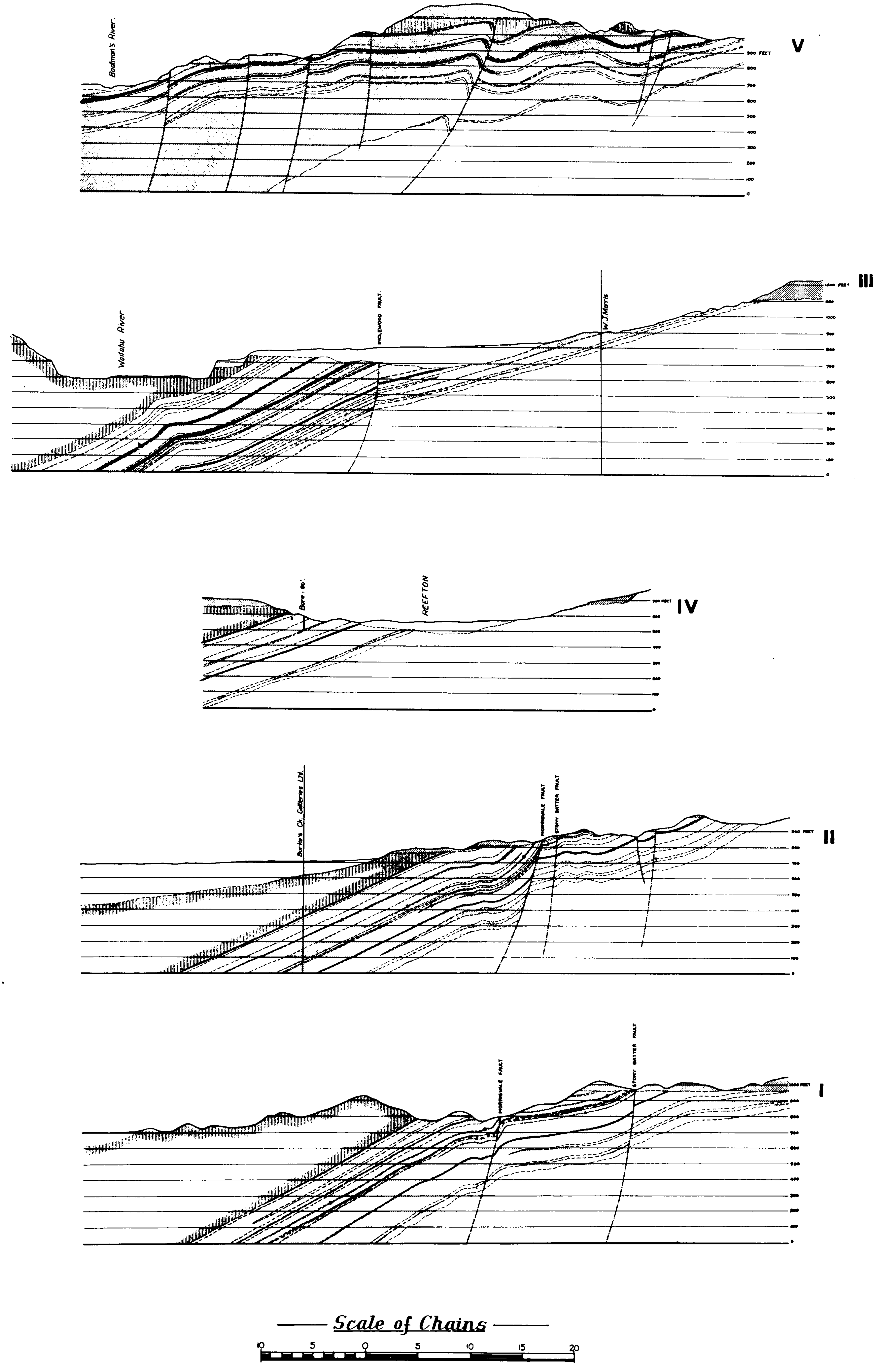


GEOLOGICAL MAP OF
REEFTON COALFIELD
Scale of Chains
LEGEND.
Palaeozoic
Basement rocks - greywacke and argillite with quartz veins.
Tertiary (coal measures)
Fine or coarse sandstone, conglomerate and grit.
Mudstone.
No 4 seam.
No 3 seam.
Small seam 25 feet below no 2 (2A)
No 2 seam.
Seam about 50 feet above no 2. (1B)
110 (1A)
230 (1)
Upper Miocene.
Marine mudstones and sandstones
Pleistocene
High level fluviatile and fluvio-glacial gravels.
Recent.
Fluviatile gravels
Compiled from data obtained from old mine plans, from additional mine surveys by G.J.Williams, and from plane-table topographical survey by K.F.H.Walker, A.O.S.M.
Geology by G.J.Williams, M.Sc., A.O.S.M., F.G.S.
Inangahua River
Madman's Creek
PERFECTION
SURPRISE
MORRISVALE
Section II
Stoney Batter Creek
Burke's Creek
Freddale Valley
REEFTON
Section IV
G.J.W. del.
NOTE.—For detailed information see orignal plan in Mines Department.

C–2b.

[illegible]

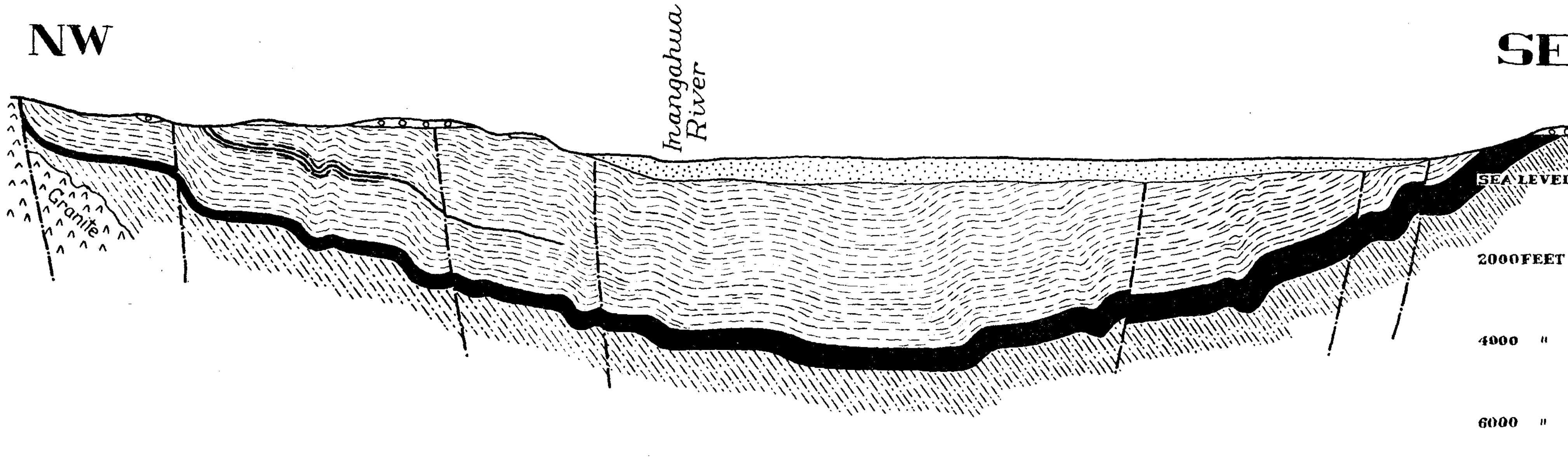

Section V
CAPLESTON
Boatman's
River
CRONADUN ROAD
Creek
WAITAHU PLATEAU
Bridge
River
Waitahu
Section III



G.J.W. del.

REEFTON COALFIELD

C—2b.



Hypothetical Section

Showing Extension of REEFTON COAL MEASURES *under Inangahua Valley*

- Recent
- Pleistocene
- Waitahu Beds
- Reefton Coal Measures
- Basement Rocks
- Coal Seams (Giles Creek lignites).

Scale of Chains

80 0 80 160 240

G.J.W.