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Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BULLETIN

No. 41

The Smithton District

BY

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TABLE OF CONTENTS

TABLES

PLATES

The Smithton District.

I.—INTRODUCTION.

(1)—Preliminary Statement.

During 1927 and succeeding years the Development and Migration Commission carried out an investigation into the economic position of Tasmania, the proposals for a full investigation having been accepted by the State Government, and the Commission having been requested by the Hon. the Prime Minister—

> "To investigate the present position in Tasmania, and recommend as to any method in which assistance can usefully be rendered in that State."

The investigation included the mineral industries and the geological survey. The Commission obtained the services of Dr. W. G. Woolnough, Geological Adviser to Commonwealth Government, to investigate, report, and recommend upon the usefulness and scope of geological maps in Tasmania. Dr. Woolnough visited Tasmania during April and May, 1928, and travelled over nearly every part of the State. His report is included as Appendix II. in the "Fourth Interim Report on Investigation Into Present Position of Tasmania." The Commission endorsed the recommendations of Dr. Woolnough, and recommended that provision be made for the carrying out of the programme when arriving at the amount of financial assistance to be given Tasmania for that year.

In his report Dr. Woolnough stressed the necessity for geological maps, and regional geological mapping designed to elucidate the geology and structure of the Pre-Devonian rocks. As the best means of accomplishing this, it was recommended that the following three tracts be surveyed:—

(*a*) An east-west strip across the entire north coast.

(*b*) An east-west strip from the west coast to the western edge of the Central Plateau, through the Rosebery-Mt. Murchison area.

(*c*) A north-south strip through the Latrobe-Railton-Mt. Roland area to connect the above two strips.

Recommendations were also made as to the staff required, constitution of the field parties, &c.

The recommendations in the Commission's report were accepted by the State Government, and the necessary amount of money was included in the estimates for 1928-29. The necessary staff for the first part of the plan was not appointed until April, 1929, and field operations began in July, 1929.

The Smithton district was selected as the most suitable one in the northern coastal strip, and surveying operations began on the Smithton sheet (a quadrangle with sides equal to one-sixth of a degree in length).

During the above periods various recommendations were made and schemes drawn up for the undertaking of a topographical survey of the State. These did not reach any finality, and immediately before the commencement of field operations the Director of Mines (Mr. A. McIntosh Reid) ordered the carrying out of topographical as well as geological surveys. The topographical work had to be performed in such a manner that it would be available to any geodetic and topographical surveys undertaken later. The carrying out of detailed topographical as well as geological surveys considerably reduced the speed of the surveys. It was therefore necessary to adopt the quarter-sheet (a quadrangle with sides equal in length to one-twelfth of a degree) in order to obtain results in the form of maps within a reasonable time. Survey operations were begun in the north-eastern part of the Smithton sheet, and were extended to cover the Smithton north-east and south-east quarter-sheets.

This report therefore describes the geology of the Smithton north-east and south-east quarter-sheets and includes maps of same.

(2)—General Statement.

The field work was commenced by the full staff of the Geological Survey—P. B. Nye, Government Geologist; K. J. Finucane and F. Blake, Field Geologists—acting together. As soon as the topographic triangulation system was started and uniform methods for the topographic surveys were arranged, the field geologists, Messrs. K. J. Finucane and F. Blake, began the topographical and geological surveys. In February, 1930, Mr. K. M. Harrisson, authorised surveyor, was engaged to carry out the triangulation surveys on the south-east quarter-sheet and levelling on both quarter-sheets.

The time spent in the field (including travelling), and the work performed by the various officers, were as follows:—

K. J. Finucane.—22nd July till 19th December, 1929; 28th January till 2nd May, 1930—making a total of 244 days. Measurement of base line; measurements of angles in triangulation on the north-east quarter-sheet; determination of meridian; theodolite traverses on north-east quarter-sheet; chain and compass surveys for topography and geology on north-east and south-east quarter-sheets.

F. Blake.—22nd July till 20th December, 1929; 28th January till 9th May, 1930; 20th May till 24th July, 1930; 21st October till 19th December, 1930; and 24th January till 21st February, 1931—making a total of 404 days. Measurement of base-line; levelling of base-line and portions of north-east quarter-sheets; chain and compass surveys for topography and geology on the north-east and south-east quarter-sheets, including the greater part of the south-east quarter-sheet.

K. M. Harrisson.—Mr. Harrisson carried out surveying operations during numerous periods between February, 1930, and June, 1931. The surveys included levelling on the north-east, and portion of the south-east quarter-sheet; measurement of angles in triangulation on the south-east quarter-sheet; and theodolite traverses on the same.

P. B. Nye.—29th July till 30th November, 1929; and several short visits during 1930 and 1931. Initiation and general supervision of the survey in its early stages; selection of triangulation stations; and investigation of the economic geology.

O. J. Henderson.—21st October till 29th November, 1929. Initiation of the drafting.

T. D. Hughes.—22nd July till 19th December, 1929. General assistance, chainman, &c.

J. A. Rowland.—22nd July till 30th November, 1929. General assistance, chainman, &c.

In addition to the above, the field parties in 1930 had two temporary field assistants per party. The assistants acted as chainmen, and cleared the survey lines, which process was rendered necessary by the thick undergrowth of shrubs over the greater part of the district.

The drafting work was commenced in the field by Q. J. Henderson in October, 1929, and later continued by him in Hobart until March, 1930. Mr. T. H. Hewitt then continued the drafting of the north-east quarter-sheet until October, 1930, when his position as draftsman was abolished; but he completed the drafting of the quarter-sheet and all the necessary preparation of plates for printing under contract in 1931.

The drafting of the south-east quarter-sheet was commenced by Q. J. Henderson in 1931, and carried on by him for three months before being taken over by F. Blake, in September, 1931.

(3)—Surveying Methods Adopted.

As the Geological Survey had been instructed to carry out topographical as well as geological surveys, and as this work had to be such that it would be available to any State-organised geodetic and topographical survey that might be later formed, it was necessary that the methods used should be designed to meet these requirements.

A topographic triangulation system was therefore initiated and extended over the two quarter-sheets.

Theodolite traverses were made along roads, &c., and connected with the triangulation system. The detailed topography and geology were obtained by chain and compass surveys connected to the above triangulation and theodolite traverses. Levels were measured along the roads, and those of existing railways were also used. The remaining heights were determined by aneroid barometers, a control being maintained by a barograph at the base.

For the triangulation a base line of 11470·33 links was measured on the plains along Smoker's Bank-road. The true meridian was determined at both ends of the base line, and the bearing of the base line established. A system of quadrilaterals was established from the base line, and a few triangles were also established to fix subsidiary points. The length of the sides of the quadrilaterals desired was 1 to 1½ miles. Although the country was not particularly suitable for triangulation, a satisfactory system of quadrilaterals was finally established. Modern five- and six-inch instruments were used, the angles being measured by the method of repetitions (both left and right repetitions being employed), so that the maximum possible error in each angle should not exceed 2 seconds. This accuracy was aimed at in order that the closures of the triangles should have a maximum error not exceeding 12 seconds, and an average error not exceeding 6 seconds.

The theodolite traverses were made along roads, &c., and were arranged so as to provide a regular and well-spaced framework on which to tie the compass traverses. The traverses closed on the triangulation stations, and an accuracy of 1 in 5000 was sought. In traverses independent of triangulation stations an accuracy of 1 in 10,000 was aimed at.

Levelling was carried out along roads, &c., and the levels along the existing railway-lines were also used. The heights of some of the triangulation stations were determined by vertical angles. The datum used was that of the Public Works Department, which has been carried throughout the State by means of the railway surveys, and is based on a Hobart datum.

Permanent marks, consisting of brass tablets set in cement blocks, were established at the triangulation stations, certain theodolite stations, and certain level stations for bench marks.

The compass traverses were carried out with Verschoyle transits, steel bands, and Abney clinometers. Tests of the transits were made and correction tables for the instruments prepared. Fore- and back-sight readings were taken, and local attractions (which were numerous on and near the dolerite and basalt) were allowed for. The traverses were made along streams, divides (ridges), boundaries of swamps, roads, tracks, &c.

(4)—ACKNOWLEDGMENTS.

The staff of the Geological Survey desire to express their appreciation of the assistance rendered them by Mr. M. Brumby, Council Clerk, in providing accommodation for stores, &c., and helping in numerous other ways; and particularly to Mr. L. E. Brooks, for information and assistance given.

They also desire to thank the numerous property-owners of the district for allowing surveys to be conducted through their properties, and especially the following, who permitted the erection of triangulation signals on their land:—Messrs. Marthick, Thorp, O'Halloran, Poke, Young, Fenton, and Brooks.

It is desired to acknowledge the services of the field assistants employed from time to time, including Messrs. H. A. Ling, J. Donohue, T. Onslow, G. Abbott, and A. Stewart.

II.—PREVIOUS LITERATURE.

Owing to the lack of deposits of metallic minerals, the Smithton district had not been geologically surveyed, and no comprehensive departmental reports are therefore in existence concerning it. However, brief references are made to certain rocks, minerals, and geological features in the district and adjacent regions in departmental and other reports. These references are given in the following list:—

Twelvetrees, W. H., and Petterd, W. F.: On the Igneous Rocks of Tasmania, Trans. Aust. Inst. of Min. Engrs., Vol. V., 1898. (Brief reference is made to "an ancient basalt at Smithton, Duck River, carrying native copper.")

Petterd, W. F.: Catalogue of Minerals of Tasmania, 1910. (Reference is made to the occurrence of epidote and native copper. The former is referred to as occurring with quartz as veins in an igneous rock." The latter occurs "as small lumps and filmy scales irregularly dispersed throughout a dark-coloured igneous rock (diabase?).")

Noetling, F., M.A., Ph.D.: The Occurrence of Gigantic Marsupials in Tasmania, Pap. & Proc. Roy. Soc. Tas., 1911. (Dr. Noetling describes Mowbray Swamp, the beds containing the fossil marsupial, and the mounds.)

Scott, H. H.: Natural History and Osteology, Part I., *Nototherium tasmanicum*, Tas. Naturalist, Vol. II., No. 4, 1911.

Ward, L. K., B.A., B.E.: The Mt. Balfour Mining Field, Tas. Geol. Surv. Bull. No. 10, 1911. (The dolerites at Smithton and West Montagu are briefly referred to as varieties of amphibolites.)

T. Stephens: Notes on Mineral Springs of North-West Coast, Pap. & Proc. Roy. Soc. Tas., 1912. (In this report Mr. Stephens describes the springs in the vicinity of Deep Creek.)

Scott, H. H.: A Monograph of *Nototherium tasmanicum*, Tas. Geol. Surv. Record. No. 4, 1915.

Scott, H. H.: A Note on *Palorchestes* as a Tasmanian Genus, Proc. Roy. Soc. Tas., 1915.

Scott, H. H., and Lord, Clive E.: Studies in Tasmanian Mammals, Living and Extinct:

No. I., Pap. & Proc. Roy. Soc. Tas., 1920.
No. II., Pap. & Proc. Roy. Soc. Tas., 1920.
No. III., Pap & Proc. Roy. Soc. Tas., 1920.
No. IV., Pap. & Proc. Roy. Soc. Tas., 1920.
No. XI., Pap. & Proc. Roy. Soc. Tas., 1923.
No. XII., Pap. & Proc. Roy. Soc. Tas., 1924.

III.—GEOGRAPHY AND PHYSIOGRAPHY.

(1)—LOCATION AND EXTENT.

The district described in this report is located near the township of Smithton, in the north-west coastal region. It is included in the Municipality of Circular Head and the County of Wellington.

The district was mapped in two parts, and two separate maps, viz., the Smithton north-east and south-east quarter-sheets are included in this report. The two quarter-sheets, when conjoined, represent the eastern half of the Smithton sheet. The conjoint areas represent a tract of country bounded by 40° 50′ and 41° 00′ parallels of latitude and the 145° 5′ and 145° 10′ meridians of longitude. This tract has an approximate length of 11 miles, and an approximate width of 4½ miles, with an area of 49½ square miles.

The district extends from Smithton in the north to the settlements of Nabageena and Edith Creek in the south. Smithton is the principal township and the headquarters of the municipality. Other townships and settlements include Irishtown, Leesville, Scotchtown, Lileah, Nabageena, and Edith Creek.

(2)—ACCESS.

Access is obtained in an easy manner from any of the main centres of the State. A branch railway-line of three and a half feet gauge leaves the Burnie to Stanley railway system at Wiltshire Junction, and enters the area to the east of Irishtown. It passes through Irishtown, and proceeds in a general south-westerly direction until it leaves the southern sheet in the vicinity of Edith Creek station. From Irishtown another branch line of similar gauge goes north to Smithton, the municipal headquarters. Marrawah, to the west of the district, is linked with Smithton, *via* Leesville, by a tramway of similar gauge. Another short branch unites Leesville with Pelican Point Jetty, in Duck Bay.

Metalled roads suited to motor traffic are numerous, since they serve all settlements, scattered and otherwise. The chief road serving the district is that branching off the Burnie-Stanley road at Wiltshire and running *via* Forest to Smithton, Smithton being 54 miles west of Burnie.

Small steamers and sailing-vessels trade regularly between Melbourne, on the Australian mainland, and Smithton. Shipping accommodation is provided at the township wharf in Duck River and at Pelican Point Jetty.

(3)—Topography.

(*a*) *General Description.*

In no place in the district is the land much elevated, the maximum being only 900 feet above sea-level at O'Connor Hill, in the south-eastern portion. Although parts of the territory, particularly to the west and north, are very low-lying, it is noteworthy that the country to the south and south-east is of comparatively high relief, while the middle portion is moderately so. The area can be conveniently divided into several parts, representing different topographical units, as follows:—

(i) *The Basalt Plateau.*—The south-eastern portion of the area includes part of an extensive plateau, formed by basaltic surface flows, extending easterly beyond the region, and also to the south in a more dissected manner.

(ii) *Tier Hill and Scotchtown Line of Ridge.*—In the middle west of the area is a meridional-trending ridge, which, although of no great height, stands out well above the plains by which it is flanked for the most part.

In the south-western corner of the district it is represented by rough, broken land of high relief, dissected to a marked degree by the streams running to the west.

(iii) *White Hills.*—This is a low ridge near the eastern boundary, continuing northerly from the plateau at a lower altitude and terminating in the vicinity of Smoker's Bank-road.

(iv) *Duck River Plain.*—Along the full extent of the western margin of the area this plain extends in a north and south direction, and is represented by the almost flat floor of the wide Duck River valley.

(v) *Deep Creek Plain.*—This is an undulating plain in the north-east part of the area. It extends from Duck Bay, in the vicinity of the estuary of Deep Creek, in a general southerly direction along Deep Creek to Smoker's Bank-road, and also embraces the plains to the south and west thereof.

The drainage of the district is divided between the Duck River and Deep Creek systems, but belongs mainly to the former. Duck River and its numerous tributaries drain the western, southern, and south-eastern parts of the area, while the north-eastern drainage is effected by Deep Creek and its affluents. The two main streams flow northerly, and enter Duck Bay at separate points.

(*b*) *The Plateau.*

The plateau surface forms a gently undulating plain at an average height above sea-level of about 700 feet. Small prominences, e.g., Spinks Hill (just beyond the eastern boundary) and O'Connor Hill, rise above the general level, the latter being the highest point in the district. The plateau is mainly composed of basalt, but small patches of Tertiary sediments also occur. The portions of the northern and western edges of the tableland in the area generally present steep faces to the adjacent low-lying open valleys.

(*c*) *Hills.*

The most prominent ridge or line of hills is that which, starting in the north near Duck Bay, stretches southerly through Tier Hill (260 feet) at Smithton, the Scotchtown heights in the central portion, and the high country between Edith Creek settlement and Nabageena in the south. The whole of the western face of this ridge inclines steeply to Duck River valley, while the eastern edge is bounded by more gentle slopes to Perkins Creek and Deep Creek Plain towards the north, and to Irishtown valley in the central districts. In the south the ridge broadens out laterally, and grades almost imperceptibly into the plateau to the east. The ridge is broken in several places throughout its length by west-flowing tributaries of Duck River, which in the south have corroded deep and steep-sided valleys, giving the hills an aspect of great relief. Viewed from a distance, this tier presents a fairly even sky-line with no outstanding projections.

To the north and east of Irishtown several hills of an unusual shape occur, e.g., Kay's Hill (326 feet), Connell Hill, (268 feet), and others, on either side of the railway-line in the vicinity of the first east and west straight from Irishtown to Wiltshire Junction. Some of these appear in the form of conical peaks, while others are disposed in the form of successive hills and hollows appearing in or on the sides of open valleys. They represent thin residuals of a differentially eroded basalt flow or flows.

Rising sharply to the east from the southern part of Deep Creek Plain is a low ridge of hard quartzites known as White Hills, which is from 248 feet to 300 feet above sea-level at its highest parts. The eastern fall drops steeply into Deep Creek, while in the north it ends abruptly on plain country at Smoker's Bank-road. The southern extremity is separated from the plateau by the valley along which the Wiltshire-Irishtown railway has been constructed.

Between Tier Hill at Smithton and Deep Creek to the east Bryant Hill rises to a height of 230 feet, and may be taken as a north-westerly continuation of White Hills ridge.

(*d*) *The Plains.*

(i) *The Duck River Plain.*—Several areas of nearly level, but sometimes undulating, country exist in the district. The largest thus defined is that represented by the open valley of Duck River, only the eastern portion of which occurs within the district mapped.

The plain, whose east and west boundaries are well defined by steeply rising hillsides, has a gentle slope from south to north, and terminates in the latter direction at the coast-line.

The river flows near the eastern edge of the plain, which it has dissected to a maximum depth of 20 feet.

This flat area is composed of unconsolidated sands and muds, underlain at various depths by dolomite and, to a less extent, by slates, &c., of the Dundas series. The upper layers consist of both estuarine and fluviatile deposits, since sea sands are distributed alike with rich river alluvium. It would appear that portion, if not all, of the plain within the area had at one time been occupied by an arm of the sea, and during that period large sand accumulations had been brought about. Later, owing to a slow upward movement of the land relative to the sea, the area gradually rose above sea-level, producing a more or less swampy plain. The river which had emptied into the original estuary now took up a meandering course over the flat area, and began to deposit portion of the sediment load over the marshy country. Owing to the level nature of this plain, and accumulation of sediment during flood periods, the river was unable to confine itself to any particular position. It therefore shifted its channel from time to time according to the most favourably existing levels, thus distributing alluvium at different points. To-day it is found that, while some areas have great depths of excellent soil, others are covered with sand of poor quality.

Mowbray Swamp, comprising portion of the plain beyond the west boundary of the district, is an area of partly cleared and drained land noted for its deep and fertile soil.

(ii) *Deep Creek Plain.*—Another plain of estuarine origin is that over which Deep Creek meanders in the lower portion of its course. This plain extends to the east parallel with the coast-line for many miles outside the area defined. An extension of the plain trends inland by way of a narrow tract north of Deep Creek bridge, on the main road to Burnie. From here it widens to the south and east, and to a less extent in the north. The boundaries of the plain in these directions are poorly defined. It would appear to continue almost to Perkins Creek in the west, and to be bounded in the south by a low divide trending east and west, on which the trigonometrical station at the south end of the base line is situated. In a northerly direction it gradually rises and narrows to its termination a little south of the old road to Stanley.

(iii) *Pulbeena Plain.*—A small area of plain country exists in the vicinity of Pulbeena Siding, and consists of flat country, which was, until recent years, in a remarkably swampy condition. It has, however, now been drained artificially to a large extent. Originally this was probably a freshwater lake, afterwards silted up by sediment from inflowing creeks. The sediment is represented by a rich black soil over a large proportion of the plain, the depth in places being over 6 feet.

The lake was destroyed through being tapped by Perkins Creek after the latter had by headward erosion corroded its course through the Smithton-Scotchtown ridge (or by corrosion if it was a superimposed stream already crossing this ridge).

(iv) *Irishtown Plain.*—Another small plain exists around Irishtown and to the south thereof, being an open valley, the floor of which is flat, but is broken in parts by a few small hillocks, chiefly on the eastern side. This plain was also in a very swampy condition before any artificial drainage was carried out, and still is in that portion in which no drains have been cut. The latter is particularly marked in the immediate vicinity of Copper Creek, which has here no defined channel, but spreads out over the plain.

This indeterminate drainage was brought about in the first place by the slow corrosion of Copper Creek on hard dolerite rock, further to the west, as compared with softer slates in the plain area, the consequence being the damming back of the water in the more easily eroded country.

(v) A small open, flat-floored valley also occurs to the north-east of Irishtown along the route of Irishtown-Wiltshire railway. Although this is of small extent, being only half a mile from north to south at its greatest width and a little more than a mile in length, it is thought advisable to place it in the category of a plain.

(*e*) *The Coast-Line.*

The line of coast which stretches from east to west across the north of the area is represented by a medium-sized indent of the sea known as Duck Bay. The bay has a number of subsidiary arms, one of which reaches easterly and forms the estuary of Deep Creek. To the south the bay gradually narrows into the mouth of Duck River, and the other smaller inlets further west. The eastern arm is bounded on the north by a narrow east and west trending spit, on which high sand dunes have developed. The bay generally is of a very shallow nature, portrayed at low water by banks and flats of mud and sand, relieved only by the stream channels, particularly that of Duck River, which has scoured its bed below the general level of the mud flats. Stretching almost across the mouth of Duck Bay is a small sand-covered islet, known as Perkins Island.

Between the south-east angle of this islet and the end of the sandspit is a narrow water-channel, representing the entrance for shipping from Bass Strait into Duck Bay. Further west Perkins Island may be reached from the mainland by foot, over sand and mud flats, during periods of low tides.

(*f*) *Drainage.*

(i) Duck River System.

The greater portion of the district is drained by Duck River and its tributaries, the latter comprising the major part of the drainage system of that stream. Duck River has its source to the south of Trowutta, outside the mapped area. From there it flows westerly for a few miles before turning in a general northerly direction towards Bass Strait, where it has its debouchure in Duck Bay. Within the area the river has a serpentine route, with many small bends, and one large one in particular, over Duck River Plain, a wide, marshy, and sometimes swampy area, where not artificially drained. This stream, which is up to a chain in width, is not deeply entrenched, being generally only a few feet below plain-level, with a maximum of 20 feet. Generally, its course is near the eastern edge of the open valley, and at the most eastern point, viz., near Scotchtown, is cutting into the steep hillside. Duck River presents characteristic features of maturity, but this does not apply to its affluents, which throughout the greater portion of their courses are extremely youthful.

The four main tributaries of Duck River are west-flowing, and, from south to north, comprise Edith Creek, Allen Creek, Copper Creek, and Perkins Creek. The first three of these present much the same features, in that they all have their sources on the basalt plateau, flow in a direction a little north of west, and on reaching Duck River Plain spread out and flow over shallow beds to the river. The latter applied particularly to Copper Creek in its original form, but it has since been confined to an artificial channel. They are not evenly graded throughout their remaining lengths, since in some localities they flow swiftly in steep channels, and at others run slowly over more level country.

Edith Creek, in the form of several branches, takes its rise a little east of the area near the south-east corner, and on entering the region descends rapidly, often in the form of waterfalls, and plunges into a deep and narrow gully. In the vicinity of Nabageena the creek enters an open valley and becomes more devious, but again proceeds in a narrow gorge before reaching Edith Creek settlement, whence it finds its way to the river.

Allen Creek rises by means of two main heads on the plateau top. These course slowly over swampy beds until reaching the plateau edge, and then suddenly drop, by way of waterfalls and rapids, before combining to form the principal stream 200 feet below. From here to Duck River Plain, Allen Creek is entrenched in a deep ravine.

Copper Creek has its head near the top of the western face of the plateau, and grades steeply to the open valley or plain, south of Irishtown, where the drainage becomes indefinite, and wide swampy conditions prevail. On reaching the western side of this flat area the stream-channel is again defined, and it flows more rapidly through a restricted valley before entering the ditch now confining its course over the river flats.

The chief source of Perkins Creek is in the hills to the north-west of Irishtown, where its several branches are restricted to steep and moderately deep valleys. An exception to the latter is that of the branch draining the flat area in the vicinity of Pulbeena. This is limited almost wholly to nearly level country, and is, to a large extent, concentrated in artificial drains. Before the channels were cut the region was a swamp, partly drained by indeterminate watercourses. After the junction of its main upper affluents Perkins Creek has a northerly trend to within a mile of Smithton, where the course changes to the west. At this point the stream has corroded its way through the hard dolerite ridge to reach the level of Duck River, which it joins almost immediately afterwards.

The only creek of any size that flows into Duck River on its west side is Mowbray Creek. This stream is in the form of an artificial ditch along most of its course, and is the main line of drainage in that part of the plain. Other small trenches feed the main one, especially from the direction of Mowbray Swamp.

(ii) Deep Creek System.

Deep Creek drains the north-eastern portion of the district, and takes its rise east of the area in the vicinity of Alcomie and Mengha.

Where it appears in the mapped portion, the creek is flowing in a mature stage of erosion over plain country. Its course is in a general northerly direction, but is extremely devious, and for considerable distances flows east and west respectively. The stream has numerous meanders superimposed upon the main bends, and adjacent meanders often nearly touch one another. The most important feeder of Deep Creek in this vicinage is that of Serpentine Creek, which rises on the northern slopes of the plateau. After falling quickly, by way of deep narrow gullies, in a northerly course to the small plain, along which the Irishtown-Wiltshire railway is constructed, it turns sharply to the east, and combines with Deep Creek outside the map boundary. In its course over the plain, Serpentine Creek is sluggish, and in places is dispersed as small marshy swamps.

(*g*) *Springs.*

Great numbers of springs occur within the district. It is specially noticeable that the greater proportion of these emanate from the igneous rocks, and that the water in these springs proves to be most suitable for domestic purposes. Practically all of the creeks originating on the basalt plateau and from the western meridional ridge commence as clear, vigorous springs of a pure nature.

The clue to the origin of this type of spring may be looked for in numerous joint planes and cracks which exist in the igneous rocks.

An unusual class of springs, of the mineral variety, exists in smaller numbers in the area. They are best developed in five different localities, viz., different parts of Mowbray Swamp, vicinity ot railway crossing of eastern branch of Perkins Creek, near Marthick Siding, Pulbeena, near the mouth of Deep Creek, and beside Copper Creek.

Unlike the springs of the firstmentioned type, these appear at the surface on low-lying plain country, in most cases where there appears to be a fair depth of unconsolidated sediments.

The water in some of the mineral springs is under pressure, and, when the springs are opened out, bursts forth in a forcible manner, the water augmenting swamps, with which they are usually associated. The water is slightly tepid in some instances, as judged by introduction of the hand, and has a distinctive but not altogether pleasant taste. In places it exudes to the surface with an ebullient effect, forming small pools, often covered with an ochreous film, and producing bubbles, which on bursting give off gases. The waters are charged with minerals, which the springs deposit on reaching the surface. In this manner mounds up to 10 feet in height have been formed, while in places the deposit is spread over the surface in an indiscriminate fashion.

The deposits chiefly consist of carbonates of calcium and iron, with the more chalybeate varieties in the minority. In some localities deposits so formed are massive in character, but, on the other hand, tufaceous types with spongy textures are evolved. The latter variety is often represented by casts and replacements of small roots, twigs, and other classes of vegetation, and includes numerous tiny freshwater gasteropod and pelecypod shells of recent origin.

In the following tables analyses are given of water from two different mineral springs, and of samples from deposits at several localities:—

TABLE NO. 1.

Analyses of Mineral Waters.

Constituents.	Mowbray Swamp (Specimen S.146).	Pulbeena (Specimen S.151).
	Parts per Million.	Parts per Million.
Total solids	647·96	1251·93
SiO_2	12·00	8·70
Fe_2O_3 and Al_2O_3	8·00	5·57
Ca	110·80	182·14
Mg	36·60	103·00
Cl	55·02	39·94
Na	43·31	48·27
SO_4	15·94	18·05
CO_3	256·40	526·65
Organic and volatile matter	109·89	319·60

TABLE NO. 2.

Analyses of Spring Deposits.

Constituents.	(1)	(2)	(3)
	S.13.	S.109.	S.147.
	Reg. No. 1578.	Reg. No. 1579.	Reg. No. 1588.
	Per Cent.	Per Cent.	Per Cent.
SiO_2	0·60	0·48	3·46
Fe_2O_3	4·28	0·56	76·00
Al_2O_3	0·52	0·24	4·44
TiO_2	....		Trace
CaO	51·68	53·76	Trace
MgO	1·42	1·72	0·36
P_2O_5	0·08	Trace	....
CO_2 and loss	42·00	43·70	16·84
	99·58	100·46	101·10

(1) S.13 = Carbonate of lime. Near Marthick Siding.
(2) S.109 = Tufaceous carbonate of lime. Vicinity of Pulbeena.
(3) S.147 = Limonite. North of Broadmeadows-road, Mowbray Swamp.

(4)—Climate and Meteorology.

The climate of the Smithton district is moderately cold and wet, but is mild in summer, particularly near the coast. Snow is practically unknown in the less elevated parts, but at higher altitudes it falls occasionally, without accumulating to appreciable depths.

Frosts are often severe in the valleys and low-lying areas, where fogs are frequent occurrences. It is noteworthy that the rainfall increases generally with the altitude.

Figures supplied by Mr. J. G. Foley, Divisional Meteorologist, and shown in Table No. 3, give the average monthly and yearly rainfall for all stations at which it is recorded in the district, and include those for Stanley and Trowutta, north-east and south of the area respectively.

The annual rainfall, which varies from 3492 points to 5739 points, is a fairly high one. It is distributed unevenly throughout the year, but is essentially a winter rainfall. May, June, July, August, September, and October are the months of greatest rainfall, while July is the wettest, and January is the driest, month.

(5)—Timber and Agriculture.

Practically the whole of the land in the district has been alienated from the Crown. The greater part of the region was formerly covered with forests and undergrowth of various kinds, but most of it has now been cleared, or partly so, for agricultural and grazing purposes and by the sawmilling industry.

The only area in which timber of commercial value now exists is the high broken country to the east of Edith Creek settlement. Here the predominating trees are stringy-bark *(Eucalyptus obliqua)*, and they extend in a narrow belt as far north as Copper Creek.

White Hills ridge, particularly in the south, has not been cleared, although quantities of milling timber have been felled in the past. Stringy-bark is here, again, the outstanding tree, with prickly wattle *(Acacia verticilata)* and ti-tree *(Leptospermum lanigerum)* undergrowth, but small peppermints *(E. amygdalina)* are frequent features on the north of the ridge.

The vegetation on Bryant Hill is similar to that on White Hills ridge.

Most of the undulating country in the north-east is not timbered, but supports a growth of button-grass *(Mesomelœna sphœrocephela)* and associated shrubs, with ti-tree lining the watercourses.

Duck River Plain to the west is cleared in parts, but swamp-gum *(E. regnans)* and ti-tree still exist, together with a little peppermint and blackwood *(Acacia melanoxylon)*.

The basalt country in the neighbourhood of Myrtle Hill and Lileah formerly supported a heavy growth of myrtle *(Fagus cunninghami)*, with subordinate amounts of such associated trees as blackwood, leatherwood *(Eucryphia billardieri)*, sassafras *(Atherosperma maschatum)*, tree-ferns *(Dicksonia)*, &c., but this has been cleared with the exception of the deeper gullies. Where this land has been neglected after clearing, bracken-fern, fire-weed, and dolly-bush have spread over the surface.

The main ridge extending south from Smithton has been cleared and grassed, for the most part, with the exception of the extreme southern portion, but formerly stringy-bark trees covered the whole of this ridge, and concealed an undergrowth of musk *(Olearia argophylla)* and dogwood or pearwood *(Pomaderris apetala)*.

Timber-felling and sawmilling constituted a considerable industry until recent years, but it is now declining, and many of the mills are at present idle.

The main industry of the district is that of dairying, while cattle-raising, together with potato and turnip culture, are important adjuncts to the former. An ideal butter factory is situated at Smithton for the purpose of treating the cream supplied by the dairies.

Table No. 3.

Rainfall Data of the Smithton District.

Station.	No. of Years of Records.	Elevation.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
		Feet.													
Stanley	47	14	166	160	195	281	350	430	420	367	329	328	226	240	3492
Smithton	18	37	179	191	195	328	403	486	513	489	438	438	335	265	4260
Irishtown	23	159	200	216	244	410	519	602	594	598	512	505	371	347	5118
Edith Creek	5	116	235	294	175	549	475	512	686	683	544	606	345	360	5464
Trowutta	6	800	316	323	254	531	472	584	683	645	601	601	398	331	5739

IV.—GEOLOGY.

(1)—INTRODUCTION.

A.—*Summary.*

The oldest rocks occurring within the district are the sedimentary ones of the Cambro-Ordovician system. These are intruded by dolerite which is probably of Devonian age, and the chief occurrence of which is in the form of a long continuous dyke.

Tertiary basalt and interbedded freshwater sediments cover the bedrock in the eastern part of the district. There are four distinct flows of basalt, and three interbedded series of sediments which include quartzites, sandstones, fine conglomerates, clays, and lignites.

Pleistocene sediments occur in Duck River, Deep Creek, and Pulbeena Plains, and include marine (sands) and freshwater (peats, marls, clays, &c.) facies.

Recent river alluvium and gravel have been formed along the courses of the existing streams.

B.—*Geological Maps and Sections.*

Two geological maps of the district—the Smithton north-east and south-east quarter-sheets—are appended.

On them are marked the topographical and geographical features, and, in addition, contours at 25 feet vertical intervals. The geological formations which outcrop at the surface are shown in distinguishing colours, and the boundaries thereof are indicated.

The observed strikes and dips of the sedimentary rocks are designated on the maps by conventional signs.

A geological section is given on each of the above quarter-sheets.

(2)—THE SEDIMENTARY ROCKS.

A.—*The Cambro-Ordovician System.*

The rocks of this system do not occupy a large proportion of the surface, but they constitute the bedrock of the whole of the district, and extend far beyond the boundaries of the surveyed areas. Except in a few instances, the areas in which these rocks occur are covered with soil, so that good natural exposures were not common. Most of the strikes and dips were observed in artificial exposures, such as quarries, road and railway cuttings, &c., but quite a number were also obtained from natural creek and river channels.

From the mapping it would appear that the general strike of the system is north and south, but the strike varies to some extent throughout the different stages. The strata are folded in places into a series of anticlines and synclines, while in at least one instance a dome was distinguished. Faulting has also taken place, and this is particularly noticeable about the periphery of the dolerite intrusion.

The mapping enabled the rocks to be divided into five stages, which will be described separately below, the order being from oldest to youngest.

(i) White Quartzite Stage.

There is only one rock type in this stage, and its characteristics are remarkably uniform throughout. The rock is an extremely siliceous white quartzite, consisting of rounded quartz sand of fine-grain size, cemented together by silica. In places, particularly along joint-planes, the silica has crystallised, and small clear quartz crystals have developed. The rock is dense and brittle, being much broken by irregular joint-planes, while here and there a slight shearing has taken place. Owing to the general broken nature of the quartzite, bedding-planes are most difficult to distingunish.

The outcrops of the white quartzite are confined to the north-eastern portion of the district. It is exposed on the south of Bryant Hill, and is here bounded on the north by grey-green quartzites, and on the west by cherts. To the south and east of the outcrops the rocks are masked by the sand deposits of Deep Creek Plain. The northern end of White Hills also consists of white quartzite, bounded on the south by grey-green quartzites and on the other sides by sands. Some 20 chains south-east, on the same ridge, white quartzite is again in evidence in the vicinity of White Hills Trigonometrical Station. This gives place in the south to grey-green quartzite for about 8 chains before white quartzite beds are once more exposed. Southerly and easterly the white quartzite is bounded by grey-green quartzite, while along the west the sand deposits of the plain cover the rocks. A small patch of white quartzite, of only a few feet in extent, is exposed within an area of grey-green quartzite south of Fahey's Lane, at about 50 chains south of Amos Trigonometrical Station.

The best exposure of the white quartzite is on the north-east fall of White Hills into Deep Creek, where a small cliff of the rock has been formed, and here it strikes west 37 degrees north, and dips 80 degrees to the north-east. A few other observations of strike and dip are obtainable, and from these it would appear that the rock is striking north-west and south-east, with dips ranging between 20 and 80 degrees to the north-east.

The thickness of this series as exposed on the northern part of White Hills is at least 1500 feet.

No traces of organic remains have been found in this stage. No definite relationship to other rocks in the district has been established. In every instance the white quartzites are associated with grey-green quartzites, but no contact is visible. The grey-green quartzites have a northerly trend, which would appear to correspond to the general strike of these rocks, while the dips are towards the west. On the other hand, the white quartzites strike north-west and south-east, with the dips towards the north-east, the inference being that the two series are not conformable.

At Sisters Hills, some 15 miles due east of the area, there are beds of similar white quartzites, but they are there interbedded with slates, dark quartzites, and schistose argillaceous rocks. This suite of rocks has been ascribed by Loftus Hills (1) to the Upper Proterozoic, but they may represent transition beds between the Upper Proterozoic and Lower Palæozoic, or even be Lower Cambrian.

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(1) Hills, Loftus: The Preolenna Coalfield and the Geology of the Wynyard District. (Geol. Surv. Tas., Bulletin No. 13, 1913, p. 63.

If evidence of lithological character alone can be taken as a criterion, then it is possible that the Smithton white quartzite belongs to the Sisters Hills series. If this view is a correct one, the former would represent older rocks in faulted relationship with the grey-green quartzites. However, through lack of concrete evidence to the contrary, it is thought advisable to tentatively place the White Quartzite Stage with the other stages, in the Cambro-Ordovician system. By virtue of its association with the Grey-green Quartzite Stage, the White Quartzite Stage may possibly represent part of the former. It has, however, been mapped and described as a separate stage.

(ii) Grey-Green Quartzite Stage.

This stage is composed of two different types of quartzites. The predominating rock is a fine-grained quartzite, which has evidently been derived, by a metamorphic process, from a finely compact argillaceous sandstone. Examination under the lens shows the rock to be composed chiefly of small, rounded grains of quartz sand, together with lesser quantities of argillaceous material and a little white mica. When fresh the rock is hard and tough, and has a light grey-green colour. On weathering the original colour changes first to a heliotrope tint, and then, at a further stage, to a buff shade. As the process of weathering continues the rock becomes softer, until it resembles a fine-grained sandstone, and at times almost a mudstone. This quartzite appears to be even in texture and uniform in composition throughout its extent. In places reef quartz occurs as bunches and small veins across the strata, while occasionally crystals of pyrite are distributed sporadically through the rock.

The other rock type is a more indefinite one, being intermediate between a quartzite and a slate. In colour the rock is dark-grey to black, and it is made up of fine siliceous sand, with quantities of a light-coloured mica. Some bands appear to be more siliceous than others. Generally, the structure of the rock has more resemblance to a slate, while the hand specimen simulates a quartzite. The bedding-planes are closely spaced, and slight cleavage parallel to these has been introduced. The rock does not occur *in situ* within the mapped area, but appears, apparently interbedded with grey-green quartzite, 10 chains to the east thereof.

The Grey-green Quartzite Stage is confined to the eastern margin of the area, and is quite distinct from the Dundas series as developed further westward.

Commencing in the north, it occurs as scattered boulders on the south side of Deep Creek, 40 chains east of Duck Bay. At the northern foot of Bryant Hill the rock outcrops on the old disused road to Stanley. Southerly along Bryant Hill weathered types are traceable for about 1 mile, then giving place to cherts on the west and to white quartzites on the eastern slope of the hill. On White Hills ridge, a little more than half a mile south of Smoker's Bank-road, grey-green quartzites are again in evidence. They are here in contact with white quartzites, being generally south-east of the latter. The rock continues in a wider belt until, in the vicinity of Amos Trigonometrical Station, it is covered by a patch of basalt.

The quartzite again outcrops from beneath the basalt cover 12 chains south of Fahey's-lane, but is overlain by a smaller area of basalt immediately north of the Irishtown-Wiltshire railway. South of the railway dolomite succeeds the quartzite beneath this basalt flow. From Fahey's-lane south, to the railway, dolomite bounds the quartzite on the west. On the east side, at Fahey's-lane, the quartzite is bounded by cherts. The only other outcrop of grey-green quartzite is that in the upper part of Edith Creek valley, where a small area is exposed in the creek-bed below the main plateau basalt.

The rock exposures throughout are poor, and few strike and dip observations were possible. The most constant strikes, at the best exposures in the main northern mass of the quartzites, vary from 20 degrees to 83 degrees east of north, and the dips from 30 to 80 degrees towards the north-west. The general trend of the rocks is from north to south, and this suggests that the true strike is in that direction.

It seems probable that the thickness of the strata in this stage is in the vicinity of 3000 feet.

From the evidence provided it is only possible to give an elementary idea of the relations existing between the quartzites and the rocks below and above them. It is established, however, that the Tertiary basalts and interbedded sediments are much younger rocks. Further, a small dyke of basic igneous rock, generally similar to the main dolerite dyke intruding the Dundas series, and evidently an offshoot from that mass, traverses the grey-green quartzite.

The Dundas series has a general westerly dip, as also has the Grey-green Quartzite Stage, and as both trend in the same direction, in adjacent parallel belts, the inference is that the latter underlies the former, and that the relation is conformable. This stage is, therefore, regarded as conformably underlying the Chert Stage, to be described below.

The relations between the Grey-Green and the White Quartzite Stages have been discussed above. (2)

(iii) — (*a*) Dolomite Sub-Stage.

This stage consists of dolomite of two types. The predominant type is a fine-grained one of light-grey to yellowish-grey colour. It contains small areas of the other type, which is a white crystalline one, with crystals up to one-thirty-second of an inch in size. The dolomite is generally thickly bedded, but the fine-grained type is apparently thinly bedded in places. Generally, the dolomite is identical with that of the Dolomite Stage, to be described below. (3)

In the Irishtown district the dolomite is traversed in places by numerous veins of reef quartz. In many cases the rock is partly or wholly silicified, the complete silicification producing a chert. At Nabageena irregular areas are replaced by chert, while the dolomite also appears to be interbedded with cherts which may represent complete replacements of dolomite beds.

(2) See p. 25. (3) See p. 45.

The composition of the dolomite is indicated in the following analyses in Table No. 4:—

TABLE No. 4.

Analyses of Irishtown Dolomite—Expressed as Percentages.

Constituent.	(1) S.113. Reg. No. 1808/30.	(2) — Reg. No. 1141/29.	(3) — Reg. No. 1832/31.
SiO_2	6·20	15·00	3·28
Fe_2O_3	0·70 (Fe₂O₃ and FeO)	2·29	0·15
FeO		....	0·38
Al_2O_3	0·90	0·91	0·42
TiO_2	Trace	....	....
CaO	28·77	26·00	30·40
MgO	20·66	18·01	21·56
P_2O_5	0·057	....	0·06
S	0·068	....	....
CO_2 and I.L.	43·40	38·00	44·83
C	....	....	0·05
	100·155	100·21	101·13

(1) Dolomite. Between Fahey's-lane and Ray's-road, vicinity of Irishtown. Typical sample of fine-grained type.

(2) Dolomite. Between Fahey's-lane and Ray's-road, vicinity of Irishtown. Grab sample.

(3) Dolomite. Railway cutting on Wiltshire-Irishtown railway, 20 chains east of Smithton-Irishtown road. Representative sample across 200 feet. Chiefly fine-grained type.

The above analyses indicate that the molecular ratio CaO : MgO is approximately 1 : 1, so that the rock is a dolomite, and the dolomitisation of the original limestone was complete. In general, this dolomite is considered to have a similar origin to that of the Duck River plain, which is discussed below, [4] as the unsilicified material is generally very similar to that of the latter locality. (It is, of

[4] See p. 45.

course, incorrect to attempt to discuss the origin when using the analyses with high silica contents, as these are due, in most cases, if not in all, to secondary silicification.)

This sub-stage occurs chiefly in the vicinity of Irishtown, the principal outcrops being along and south of Fahey's-lane, and from Irishtown north as far as the Wiltshire railway. The dolomite forms a long, narrow belt, with a general north and south trend, from which an arm extends easterly along the Wiltshire railway. The total length from north to south is 1½ miles, and the maximum width (along the railway) is three-quarters of a mile. The other area in which this sub-stage occurs is near the Nabageena school, just south of the southern boundary of the south-east quarter-sheet, where dolomite is interbedded with and replaced by cherts, both these rocks being interbedded with slates.

Owing to general lack of good exposures and the obscurity of the bedding-planes, very few reliable observations of strike and dip could be made. The apparent strike ranged from 300 degrees to 70 degrees, with the dip in a general northerly direction. In the most reliable exposures near Irishtown the strike is 62 degrees, and the dip 40 to 80 degrees to the north. At Nabageena the strike is 49 degrees and the dip to the north-west at 23 degrees.

The thickness at Irishtown cannot be accurately determined, but it is probably in the region of 500 feet, and may reach a maximum of 1000 feet or more. Unless undetected faulting is present, the mapping suggests that the dolomite is in the form of a large lenticular body, thinning out rapidly to the north, and probably less rapidly to the south, where its continuation is covered by basalt. The thickness at Nabageena is much less, the dolomite forming thin beds up to 20 feet in thickness.

The dolomite in both areas appears to be intimately associated with the Chert Sub-stage, and the structure, as deduced from the mapping, suggests that it underlies or forms the base of the Chert Sub-stage. The relationship with the Grey-green Quartzite Stage is not clear, but the mapping suggests that the Dolomite Sub-stage and the Chert Sub-stage overlie the Grey-green Quartzite Stage.

No fossils were obtained, but at one outcrop a concentric structure was present which either represents a large, but not very distinct, cone-in-cone structure or a fossil such as a large algal growth.

(iii)—(*b*) Cherts, Slates, &c., Sub-stage.

(This will be referred to as the Chert Stage.)

The stage is made up of dense cherts, siliceous breccias, breccia-conglomerate, and fine-grained conglomerates, with some grey and purplish-grey slates. The cherts are black, white, grey, or brown in colour. The siliceous breccia is made up of angular fragments, set in a dense cherty groundmass. The fragments are always cherty; they vary from one-half to two inches in section and may be black, white, or banded. The cherty groundmass is usually black or white. The breccia-conglomerate contains both angular and rounded pieces; the angular fragments are similar to those of the breccia; the groundmass is also similar, but the true waterworn and rounded pebbles consist of pieces of pink or white quartzite, which vary in diameter from 1 to 3 inches. The majority of the rounded pebbles are waterworn forms of an original quartzite, and offer a direct contrast to the angular cherty pieces. The widespread silicification and brecciation were probably secondary processes.

In the Irishtown-road gravel pits, about a mile south of Smoker's Bank-road, a fine-grained silicified conglomerate is interbedded with dense black cherts and grey and purplish-grey slates. The rock is composed of rounded, with some angular, quartzose pebbles, set in a siliceous matrix. The pebbles are black or white in colour, and are remarkably uniform in size; their diameter is one-eighth to three-sixteenths of an inch. The rock sometimes has the appearance of a silicified grit, but, as the bulk of the pebbles are rounded, it corresponds more to a fine-grained conglomerate. Grey and purplish-grey slates are interbedded with the above members.

It seems probable that the series was originally composed of coarse and fine-grained conglomerates, with beds of finer siliceous and calcareous material. These have since been silicified, and in part brecciated, thus giving rise to the present forms. In the dolomite near Irishtown and at Fahey's-lane it is quite common to get the rock replaced, either wholly or partly, by silica. The same thing is true of certain localised areas along the Duck River. Therefore the cherts may, in part, be silicified limestones. Some of the cherts to the west of the series are doubtless silicified forms of the Dundas slates.

The exposures of these rocks are somewhat limited. The most northerly outcrop is on Duck Bay, and forms a small rocky headland, about 10 chains west of the mouth of Deep Creek; here it is represented by the siliceous breccias. Cherts occur in the vicinity of the Smithton Rifle-range. In the Irishtown-road gravel pits black cherts and fine-grained conglomerates are interbedded with grey and purplish-grey slates. On the Smithton-Irishtown railway in the gravel pits, immediately to the north and south of Fahey's-lane, fine-grained siliceous conglomerates, coarse siliceous breccias, and conglomerates are all interbedded; true cherts outcrop in the fields immediately to the east. South from Fahey's-lane the cherts and siliceous breccias can be traced through Groom's cross-road to Sharman's-road (E. L. Smith's-road). The stage outcrops on Sharman's-road about 20 chains from Young's-road, and from there can be traced in a westerly direction for about 70 chains. On the low ridges to the north of Sharman's-road, and to the east of McLachlan Creek, there are a number of scattered outcrops of siliceous breccia and chert. The stage is here closely associated with the true slates and breccias of the Dundas series.

Cherts outcrop on Scantlebury's-road and in small creeks to the east. For a distance of some 2½ miles to the south the stage is covered by Tertiary basalts, but reappears in the Edith Creek valley on the south boundary of the area. In a quarry on the Nabageena-Lileah road, immediately north of Edith Creek, black cherts and conglomerates are interbedded with dark-grey slates; some of the conglomerate is much coarser than that of the Irishtown gravel pits, and consists of white cherty pebbles, varying from half an inch to an inch in diameter, set in a dark cherty matrix. Similar rocks extend some 40 chains to the west of the quarry.

Outcrops of the stage extend, at intervals, for a total distance of 1½ miles west of the abovementioned quarry, and, in many places, are intimately associated with the Dundas slates and breccias. The most westerly exposure of the chert is interbedded with weathered rocks similar to those of the Dundas slates and breccias. To the south of this belt, outside the mapped area and at a point a few chains to the north-east of the Nabageena School, dolomitic limestone, partially replaced by dark chert, is exposed in some small quarries; in addition to the replacement small cherty bands and thin beds of fine-grained conglomerate appear to be interbedded with the dolomite.

Few strikes and dips could be obtained. In the Irishtown-road gravel pits the rocks are in the form of a flat dome; on the western side of the pits the rocks are striking 10 to 20 degrees west of north (true bearing), and dip west at 20 to 30 degrees; within a few chains they flatten, and on the eastern side of the road appear to dip to the east. In the gravel reserve near the corner of Scantlebury's and Sharman's roads, the cherts strike 65 degrees east of north, and dip to the north-west at 35-40 degrees. Immediately south of Fahey's-lane, on the Smithton-Irishtown railway, chert and fine-grained conglomerate strike 51 degrees east of south, and dip to the north-west at 45 degrees. An excellent section in the roadside quarry, north and adjacent to Edith Creek at Nabageena, shows the rocks folded in the form of an asymmetrical anticline, accompanied by slight faulting on each side of the arch apex. One limb has an even westerly dip of 18 degrees and strike of 24 degrees west of north, while the other dips at 63 degrees to the west and strikes 38 degrees west of north.

The mapping of the two quarter-sheets proves that this stage occupies the surface along a narrow tract extending from Duck Bay in the north to Nabageena in the south. The trend of this tract is east of north and west of south, and this may be taken to represent the general strike of the stage. The general dip is probably westerly, but this is masked by the shallow open folds occurring in this stage and the overlying one.

It is difficult to form an idea of the thickness of the stage or of the individual beds comprising it. In the Irishtown-road gravel reserve grey and purplish slates are overlain by 6 feet of dense black cherts; this, in turn, is overlain by 12 feet of fine-grained siliceous conglomerate. Twelve feet probably represents the approximate thickness of the bed of fine conglomerate. No idea of the thickness of the coarse breccia-conglomerate could be formed. The maximum width of the stage on Sharman's-road is approximately a mile, but the structural features are so obscure that any attempt to estimate the thickness of the stage is somewhat hazardous. It seems probable that the maximum thickness would be in the vicinity of 2000 feet.

This stage contains slates generally resembling those of the Slate Stage, to be described below. Moreover, it passes up into interbedded slates and cherts which have no definite division from the slates to the west. It is, therefore, regarded as conformably underlying the Slate Stage to the west, the latter having a general westerly dip.

The base of this stage is not well defined, but it is generally succeeded to the east by the Grey-green Quartzite Stage. The latter has a similar trend from north to south, and is assumed, on general grounds, to underlie the Slates, Cherts, &c., Stage. In the vicinity of Irishtown, however, the Dolomite Sub-stage occurs to the east of this stage. It appears to be related to the Chert Stage, and forms or underlies the base of the Chert Stage.

(iv) The Slate, Breccia, and Limestone Stage.

(This will be referred to as the Slate Stage.)

Lithologically this stage contains a considerable variety of rock types. They range from slates and cherts to breccias and tuffs, and also include limestones. The slates and breccias predominate, and constitute probably more than ninety per cent. of the stage.

Slates.—These are purple, green, grey, greenish-grey, and black. Generally speaking, they are thinly bedded. In cases where the bedding-planes are quite distinct the slates are usually grey and black, or greenish-grey and black; the purple slates are generally massive. Massive forms of other types are not uncommon.

Cherts.—These range in colour from black, to green, to grey, and are interbedded with the slates, and doubtless represent silicified forms of them. Many of the slates are, in all probability, exceedingly fine-grained forms of breccias described below.

Breccias.—The breccias are similar to those of the Waratah district, where they have been studied in detail by Nye, (5) and have been divided by him into two main types, called felspathic and micaceous respectively, according to the dominance of felspar or mica in the hand specimen. Although the micaceous and felspathic breccias do occur as distinct types in this district, it is only rarely that the distinction can be made, as all gradations exist between the two, and the most common type appears to be a transition phase which closely resembles the felspathic breccia type in general appearance.

The typical breccia of this district is a fine-grained blue-grey or purplish rock, in which felspar, calcite, and perhaps a little mica, are the only minerals recognisable in hand specimens. Included in the rock are small lenses of grey, purple, or reddish slate. These occur in the form of short bands varying in length from a few inches up to 3 or 4 feet, and in width from a quarter of an inch to 2 inches.

Under the microscope the type rock is seen to consist of angular fragments of quartz, felspar, augite, calcite, hornblende, chlorite, and oxides of iron, set in a fine-grained groundmass of the same material. Quartz is fairly abundant, and is of the

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(5) Nye, P. B.: The Silver-Lead Deposits of the Waratah District. (Tas. Geol. Surv. Bull. No. 33, pp. 24-31.)

usual clear variety; it contains numerous inclusions of apatite. The felspars are fairly fresh; plagioclase appears to predominate, but pieces of an acid felspar, probably anorthoclase, appear in the section. Calcite occurs as irregular patches and as a replacement after felspar. The augite appears as fragments of simple crystals, and is generally colourless or very pale green; some of the augite is titaniferous, and is readily recognised by its faint pink colour and pleochroism. A few fragmentary crystals of hornblende showing the typical cleavage were observed in the section; these are usually colourless, but some have a faint green tinge. Chlorite is fairly common, and occurs both as flakes and as irregular grains; in the former case it is probably an alteration product of the biotite, and in the latter it may represent original augite or hornblende. Only a few flakes of biotite were observed. The oxides of iron include magnetite, ilmenite, and hematite, all of which are fairly common. Some of the ilmenite is partially altered to leucoxene.

A rather unusual type of fine-grained breccia occurs along the shores of Duck Bay, on the eastern side of the dolerite dyke. In this section it is seen to be composed of an aggregate of angular mineral fragments of remarkably uniform size. The principal minerals present are quartz, a little felspar, chlorite, hematite, magnetite, and ilmenite, and these are evenly distributed through the section. A good deal of the quartz is ironstained, and in places the rock is traversed by thin seams of chlorite.

The chemical composition of the typical breccia described above is shown by Analysis (1) in Table No. 5. For purposes of comparison the analyses of the micaceous and felspathic breccias of the Waratah district have been inserted.

TABLE NO. 5.

Analyses of Dundas Breccias.

Constituent.	(1) S.30. Reg. No. 1804.	(2) — —	(3) — —
SiO_2	49·28	46·60	48·08
FeO	5·93	0·26	0·49
Fe_2O_3	7·12	19·16	21·61
FeS_2	....	....	0·33
Al_2O_3	13·78	19·23	18·91
TiO_2	2·20	....	....
CaO	5·81	2·95	2·35
MgO	7·24	4·49	5·07
MnO	Trace	0·222	....
P_2O_5	0·254	....	....
S	Trace	....	....
K_2O	1·10	0·54	1·20
Na_2O	2·44	3·29	0·67
Ignition loss	4·90	4·06	1·70
	100·054	100·80	100·41

S.30.

(1) Dundas breccia. Quarry near head of a branch of Perkins Creek. Lot 4652, Smithton.

(2) Felspathic breccia. Magnet Creek, near north-east corner of Section 5137. Waratah District.

(3) Micaceous breccia. No. 14 Plat, Magnet Mine, Waratah District.

A comparison of Analysis (1) with Analyses (2) and (3) supports the main points of distinction between the Smithton and Waratah rocks, as revealed by microscopic examination of thin sections. Thus, under the microscope, quartz is fairly common in the Smithton breccia, and is also common in the micaceous breccia of the Waratah district, but is somewhat less common in the felspathic breccia. The higher percentage of ferrous oxide in Analysis (1) corresponds with the presence of augite and hornblende in the Smithton rock and its absence in the Waratah specimens. Likewise, the titanium corresponds with the presence of ilmenite and leucoxene; some of the titanium is, of course, present in the augite. Ferric oxide is much lower, and this agrees with a considerably smaller amount of hematite. The higher calcium and magnesium percentages are explained by the presence of augite and hornblende, both of these minerals being rare in the Waratah specimens. The alkalis occupy a curious position, the potassium corresponding to that of the micaceous breccia, and the soda to that of the felspathic; as there is but little mica in the Smithton specimen, the potash must be present in an acid felspar—probably anorthoclase. This comparison supports the view, already stated, that the typical Smithton breccia corresponds generally to a transition phase between the micaceous and felspathic types as developed at Waratah. It, perhaps, approaches more nearly to the felspathic type than to the micaceous, but differs from both, inasmuch as it contains augite and hornblende.

Like those from Waratah, the Smithton breccias are similar to specimens from the Dundas series as developed near Dundas. The field evidence shows that they are interbedded with the slate members of this stage, and that they are sedimentary rocks deposited under water along with the associated slates. The analysis shown above corresponds roughly to that of a basic igneous rock. Furthermore the minerals are all remarkably fresh, and are such as one would expect to see in a thin section of an igneous rock, but the angular nature of the minerals, the microscopic structure of the rock, and its close association with slates prove that it is of sedimentary origin. The rock may be described briefly as a fine-grained sedimentary breccia, made up of angular fragments of minerals derived from an igneous rock.

Tuffs.—These are coarse-grained greenish rocks composed of angular and subangular fragments of scoriaceous material, with some angular pieces of grey or green slate, set in a fine-grained greyish matrix. The component fragments vary in size from one-eighth of an inch to an inch, the average size being about a quarter of an inch. Some of the smaller fragments are rounded.

Under the microscope the scoriaceous material is seen to consist of rounded pieces of glass, partly devitrified glass, spherulites, and small subhedral crystals of felspar and quartz, set in a dense brownish groundmass, in which small felspar laths are the only resolvable minerals. Some of the smaller subangular and rounded fragments of the rock contain relatively large crystals of felspar, probably sanidine, set in a glassy groundmass containing numerous small felspar laths. Some of the fragments consist entirely of glass or devitrified glass. These rock particles, along with small pieces of slate, are set in fine-groundmass consisting of glassy material, felspar, a little quartz, and oxides of iron.

The general character of these rocks indicates that they are true tuffs. Their occurrence is restricted to a single outcrop on Duck Bay, where they occur interbedded with normal greenish slates of this stage.

Limestones.—A dark-blue crystalline variety of limestone occurs towards the top of the Slate Stage. This rock is usually massively bedded, with bedding-planes 4 to 5 feet apart.

The outcropping rock has a somewhat fine, cellular appearance, due to the weathering out of small circular grains. When the rock is broken and fresh surfaces obtained, the circular grains are visible in the rock, and strongly suggest the oolitic texture. On examining a specimen under the microscope, the rock is found to consist of crystalline calcite, with a few small grains of pyrite and limonite. The apparent oolitic grains are visible as circular sections, and are composed of calcite crystals. There is no sign of concentric or radiating structure, nor can any definite nuclei be recognised. The general character of the rock suggests that the grains are of detrital origin, and represent rounded pieces of calcitic material. This view is confirmed by Mr. F. Chapman (Commonwealth Palæontologist), to whom a specimen was submitted. Mr. Chapman (correspondence 21.5.31) reports as follows:

> " The rock is a crinoidal limestone, in which rounded and waterworn ossicles of crinoids are embedded in a calcitic matrix—a rather unusual occurrence."

Further support is given in the occurrence of beds resembling fine conglomerates in the quarry at

Lower Scotchtown. These beds consist of rounded grains and rod-like pieces of limestone up to one-quarter of an inch in size, set in a finer matrix, with some of the finer grains also present. These larger grains probably represent large pieces of crinoids. Thus the fine grains are not true oolites, though it is convenient to retain the word to describe the texture.

The " oolitic " texture is most pronounced on weathered surfaces, while it is not so apparent on fresh surfaces. However, there generally appears to be some of the fine grains present even in dense fine-grained limestone, so that it is probable that all the beds have more or less of the " oolitic " texture.

Analyses of the limestone are tabulated below:—

TABLE No. 6.

Analyses of Limestone.

	(1)	(2)	(3)
		S.120.	S.32.
	Reg. No. 1300.	Reg. No. 1996/30.	Reg. No. 1805.
SiO_2	0·76	0·52	1·08
FeO, Fe_2O_3	0·31	0·56	1·38
Al_2O_3	0·38	0·36	0·22
MgO	0·29	0·50	7·53
CaO	53·85	54·23	46·40
TiO_2		Trace	Trace
S		0·068	0·11
P_2O_5	....	0·068	0·077
CO_2 and loss	44·11	43·30	44·12
	99·70	99·606	100·917

(1) Representative sample across 12 feet in quarry (western side). Lower Scotchtown-road. (Fine-grained type, with little, if any, oolitic texture.)

(2) " Oolitic " limestone from quarry. Lower Scotchtown-road.

(3) " Oolitic " limestone. South bank of the Duck River, 30 chains upstream from the bridge at Smithton.

These analyses show that the rock is practically a pure limestone. The third analysis indicates some replacement of calcium by magnesium.

The limestone outcrops only in two localities, viz., to the east of the Lower Scotchtown-road, some 3 miles south of Smithton, and on the south bank of the Duck River, at a point about 30 chains upstream from the bridge at Smithton. In the former locality it is exposed in a small quarry, where the beds are at least 40 feet thick, and dip to the west at an angle of 45 degrees; here the limestone is overlain and underlain by purple and grey slates, the greatest possible width of the limestone being 5 chains. The exposures on the Duck River bank near Smithton are limited to a few small outcrops, and the relationships of the limestone to other members of the Slate Stage are obscure. Slates and breccias outcrop about 5 chains to the east, while dolomites occur about 10 chains to the west. However, in view of the fact that dolomites also occur about 10 chains to the west of the limestone bed near the Lower Scotchtown-road, it is not unreasonable to assume that those two occurrences of limestone form portions of a single bed in the slates.

The Slate Stage occupies a fairly broad strip, extending in a southerly direction from the eastern side of Duck Bay. The surface area occupied is modified by an intrusive dolerite dyke and by large areas of recent deposits and swamp country. Most of the typical rocks of this stage may be seen by following the south-eastern shore-line of Duck Bay from the wharves at Smithton around to Deep Creek; from the wharves for a distance of 70 chains north there are excellent exposures of purple, grey, and green slates and fine-grained breccias, and to the east of the dolerite dyke, i.e., about half a mile beyond Park Point, there are numerous outcrops of purple, green, greenish-grey, black, and banded slates, along with fine-grained micaceous and felspathic breccias; the tuffs occur near the eastern edge of these exposures, at a point about 30 chains from Deep Creek.

On their western margin the slates, &c., are in contact with dolomite. In the northern portion of the mapped areas the contact has been picked up at a point about 40 chains west of the Duck River Bridge at Smithton; from this point southwards it probably passes a few chains to the west of Stewart's Bridge, and again crosses the Duck River near Mowbray Creek. To the south of Mowbray Creek the contact lies between the Duck River and the hills which flank the eastern edge of the Duck River flats; slates and breccias are exposed along the western margin of these hills, and the dolomite outcrops in the Duck River, but it is impossible to map the boundary without a large margin of error, as most of the country is swampy, and there are few exposures. Further to the south, however, and a little more than half a mile north of Edith Creek Station, the contact is again picked up; it runs southwards from this point, and crosses Edith Creek about 20 chains to the east of the Trowutta-road.

From Edith Creek the contact apparently trends to the south-west, but is obscured by the superficial deposits.

The eastern boundary of this stage (it junctions with the Chert Stage) cannot everywhere be accurately defined. Between Duck Bay and Fahey's-lane the contact is ill defined on account of the large areas of button-grass and swamp country. South from Duck Bay, in the vicinity of Smithton, the slates and breccias occupy the eastern slopes of Tier Hill. The stage can be traced across the Main-road, along the eastern slopes of Harrisson's Hill, and across the Smithton-Irishtown railway. Some good exposures may be seen in the railway-cuttings, where the line runs close to, and parallel with, Perkins Creek. Southwards from here the stage is well exposed both east and west of Perkins Creek. Near Fahey's-lane the contact is a little to the west of the railway-line. South of Fahey's-lane the contact is ill-defined, but probably crosses Groom's cross-road about 30 chains from Irishtown; here, also, the geology is obscured by recent deposits. Judging by the scattered outcrops of the cherts, siliceous breccias, &c., between Groom's cross-road and Sharman's-road, the contact in this vicinity is rather irregular. The contact probably crosses Sharman's-road near the big bend in the road, about one and a half miles from Young's-road (measuring along the road). From Sharman's-road south, to Edith Creek, the eastern boundary of the slates and breccias is represented by the irregular western edges of basalt flows, under which they pass. In the vicinity of Edith Creek the slates and breccias are once more in contact with the chert series, but here the dividing-line is very irregular.

Good exposures of the slates and breccias may be seen in the railway-cuttings where the Irishtown-Trowutta railway crosses through the hilly country between Irishtown and the Duck River flats, and in the cuttings on Groom's cross-road. Fresh exposures of the breccias may be seen in a small quarry north of O'Halloran's farm on Groom's cross-road, and in a quarry at the head of a branch of Perkins Creek, on Lot 4652. Probably the most continuous exposure of the slates and breccias, other than Duck Bay, is that in the valley of Allen Creek.

This extends for 2½ miles up the creek, from the eastern periphery of the dolerite dyke to the contact with overlying basalt, a little west of Young's-road. In Edith Creek Valley, where the basalt cover has been removed, several good exposures of the rocks are disclosed.

The normal strike of the slates and breccias varies between 10 degrees west and 20 degrees east of north. The dip is to the west, and varies from 25 degrees to 50 degrees west, approximating more often to 50 degrees west. On Duck Bay, on the western edge of the dolerite dyke, the strike varies between very wide limits; near the wharves at Smithton the strike is north 30 to 50 degrees east, and the dip is to the north-west at 50 to 55 degrees; further north the strike changes and varies between north 7 degrees east and north 35 degrees west, the dips being westerly from 30 to 40 degrees, but some easterly dips are observed. The slates on the eastern side of the dyke on Duck Bay are somewhat folded and contorted; the strikes appear to be a little to the north of west, and the dips are generally to the south at a fairly flat angle, approximating to 25 degrees; some of the dips are to the north at the same angle. As the influence of the dyke wanes, i.e., as we get further to the east from its contact, the slates and breccias begin to resume their normal strike, but the dips are at a somewhat flatter angle to the west, and lie between 10 degrees and 25 degrees west. There is still some folding of the series, however, and in one place a small anticline was observed in which the strike was approximately 110 degrees, the dip of the southern limb was 25 degrees, and that of the northern limb was about 20 degrees. About half a mile to the east of the contract all signs of folding have died out, and the series resumes its more normal strike, and the dips are to the west at 50 degrees.

Elsewhere than on Duck Bay the rocks show signs of folding. In a cutting on Connell's cross-road there is an excellent section where the rocks are thrown into a number of gentle folds; on the extreme west they are dipping to the west at 2 degrees, and on the eastern side of the section the dip is to the east at 20 degrees, the strike being roughly north-south. On Sharman's-road, a little over a mile and a half from Young's-road, the slates and breccias are more sharply folded into a double syncline; the strike is 10 degrees west of north and the folds are pitching sharply to the south. The observed folding is probably due to the influence of the dolerite dyke, or it may be partly due to faulting.

In spite of the fact that the series is folded in many places, the bulk of the evidence points to a strike approximating to north-south and a dip of about 40 to 50 degrees west; the normal strikes and dips will, of course, vary within the limits as stated above. A number of open folds (anticlines, synclines, and domes) are superimposed upon the general west-dipping structure.

The thickness of the series would probably be some thousands of feet, but it is difficult to give a figure owing to the variation in the structural features. A thickness of about 4000 feet is shown on the section across the north-east quarter-sheet.

This stage conformably overlies the Chert Stage, as already discussed above. (6) The latter appears to pass up into the Slate Stage by a decrease in the

(6) See p. 34.

amount of the chert beds, as both contain slates more or less indistinguishable from one another. Moreover the mapping shows the two stages as parallel north-south tracts, and, as the dips are westerly, the Slate Stage overlies the Chert Stage.

The mapping indicates that the stage is conformably overlain by the dolomite stage of the Duck River valley which occurs to the west. Both stages occupy parallel tracts, and the dips are westerly, so that the above relationship exists.

The slates and breccias are intruded by the dolerite dyke, and are covered in the south-east by basalt flows.

Type specimens of the Dundas slates and breccias are—

Slates: S7, S16, S17, S25, S26, S50, S51.
Breccias: S1, S3, S4, S14, S30.
Cherts: S5.
Coarse Tuff: S27.

(v) Dolomite Stage.

This stage consists entirely of dolomite, which occurs as two types, viz., a fine-grained and a crystalline type. The fine-grained type is light-grey to yellowish-grey in colour, but weathers white at the surface. It is generally thickly bedded, but thin bedding appears to be represented at a few localities, e.g., near Edith Creek Settlement. Two other sets of joint-planes exist, and the rock in such places breaks into small rectangular blocks (in some cases the third set of planes may be joint and not bedding planes). The crystalline dolomite is generally white, with a grey or yellow tinge. It is massive or thickly bedded, and jointing is not prominent. This type is well-developed at Blackwood Bridge, Watson's Bend, and is generally confined to the northern part of the district.

The dolomite is traversed in a few localities by narrow white veins, which are sometimes composed of calcite, and other times of dolomite. Quartz veins traverse the dolomite in one place, viz., Watson's Bend.

The field relations between the two types are not clear beyond the fact that the crystalline dolomite appears to form the western or upper part of the stage, but whether it constitutes the whole of this part, or occurs rather as irregular areas throughout this part, cannot be stated.

Under the microscope, the distinction between the two types is very evident. A section (No. 950) of a crystalline type from Watson's Bend (S.44) consists wholly of a colourless, crystalline carbonate, showing the typical cleavage, distinct change of absorption with rotation of the crystal, and third to fourth order polarisation colours, suggesting calcite or dolomite. The analyses below ([7]) suggest that the rock consists of dolomite or a mixture of calcite and magnesite.

The crystals all appeared alike under the microscope, and, on treatment with Lemberg's solution, did not produce a stain, so that the rock is composed of dolomite. The grains range in size up to one-thirtysecond of an inch, and do not exhibit any crystal outlines. No other minerals are present, thus testifying to the purity of the rock.

A section of another crystalline specimen (S.127) from Mowbray Creek was examined by Professor E. W. Skeats, who, after a preliminary examination, reported that it was "dolomite, in which coarse dolomite and interstitial quartz are recognisable."

A section (No. 949) of a fine-grained type (S.37) from Allen Creek shows a very fine-grained rock, with a yellowish-brown colour. A number of very fine colourless grains of carbonate occur throughout the section, as well as a few larger ones, but the greater part of the section consists of the yellowish-brown material.

Professor E. W. Skeats examined another section of a specimen from the same locality, and reported, after a preliminary examination, that it was "fine-grained dolomite, with small rhombohedra of dolomite visible. No interstitial quartz."

The quarries immediately south of Mowbray Creek contain impure bands of dolomite and bands showing a pock-marked or oolitic texture. A section (No. 855) of a weathered specimen (S.119)

([7]) See Tables 7 and 13.

did not show any structure, but an opaque, fine-grained rock, with areas of a clear, crystalline carbonate.

The association is strongly suggestive of incipient crystallisation, as stated by F. Chapman (correspondence, 21.5.31). Staining with Lemberg's solution proves that some of the crystalline carbonate is calcite. As the rock is an impure dolomite or dolomite limestone the matrix is probably dolomitic.

The chemical composition of the dolomite is represented by the following analyses of typical pieces of the rock:—

TABLE No. 7.

Analyses of Dolomite.

Constituents	(1)	(2)	(3)	(4)	(5)
	Spec. No. S.33.	Spec. No. S.128.	—	—	Spec. No. S.53A.
	Reg. No. 1806.	Reg. No. 1581.	Reg. No. 1380/31.	Reg. No. 1272/31.	Reg. No. 78/32.
SiO_2	4·32	0·44	0·08	0·28	....
Fe_2O_3	1·26	1·14	....	0·50 (})	
FeO	0·75				
Al_2O_3	1·50	0·54	....		....
TiO_2	Trace	....	....	....	....
CaO	28·73	31·62	31·10	30·78	19·17
MgO	20·28	20·85	21·45	21·93	15·37
P_2O_5	Trace	....	....	....	....
S	0·11	....	....	....	....
CO_2 & I.L.	44·08	46·85	....	46·98	....
	101·03	101·44	....	100·47	....

(1) S.33. Fine-grained dolomite. Quarry near bridge (Blackwood) on Broadmeadows-road, over Duck River.

(2) S.128. Crystalline dolomite. Quarry north of Broadmeadows-road, at Blackwood Bridge.

(3) Crystalline dolomite. Quarry north of Broadmeadows-road, at Blackwood Bridge.

(4) Crystalline dolomite. Quarry north of Broadmeadows-road, at Blackwood Bridge.

(5) Bluish-grey impure dolomite. Lower Scotchtown-road.

Further analyses of samples taken by systematic sampling are given in Table No. 13. [8]

The analyses indicate that the molecular ratio of CaO: MgO is very close to 1 : 1, so that the rock is a dolomite, and that dolomitisation was complete. The dolomite has, in common with others throughout the world, been formed by the alteration (dolomitisation) of a limestone, magnesium replacing part of the calcium.

The analyses in Tables 7 and 13 show that there is an appreciable difference in the purity of the two types. The crystalline type is the purer, and contains (except for one sample) under 2 per cent. of impurities (silica, oxides of iron, and alumina), and often under 1 per cent. The fine-grained type contains 4 to 10 per cent. of impurities, while a few narrow beds, e.g., those represented by analyses (5) in Table No. 7, and analyses (11) in Table 13, represent a gradation to impure or argillaceous dolomite. This difference in composition renders it unlikely that the crystalline type was derived from the fine-grained type by recrystallisation, unless this process included the removal of silica, iron oxides, and alumina. It would appear more likely that it is due to some original difference in composition of the limestone related to the mode of origin. This is supported to some extent by the fact that the two types occur in two more or less distinct belts; but this is not apparently always the case, as in the cutting on the Wiltshire-Irishtown railway the two types appear to be intimately associated.

The crystalline dolomite (if impurities have not been removed during recrystallisation) with the very low content of impurities suggests that the original limestone was formed under coral reef conditions. The higher content of impurities in the fine-grained type indicates that, if formed under coral reef conditions, the zone of deposition was invaded by detrital or volcanic material. [9] (The

(8) See p. 103.

(9) Skeats, Prof. E. W.: Dolomites of Southern Tyrol, Vol. LXI., Part 1. (Q.J.G.S., 1905.)

formation under deep-sea conditions is precluded by the large thickness of the beds.)

The nature and composition of the impurities in the dolomite are discussed later. ([10])

The dolomite forms a wide belt, extending in a north and south direction along the western part of the district. It is, for the most part, overlain by the sand and other superficial deposits of Duck River plain. It is exposed at many places along the banks of the Duck River; in the drains and creeks flowing into the Duck River from the plain to the west; in the lower part of Allen Creek; in the bed of Edith Creek on both sides of the Trowutta-road, and the railway-cutting half a mile to the north; and in the surface of the Duck River plain at a number of places near Watson's Bend, Blackwood Bridge, and Lower Scotchtown-road, which are, however, not very far distant from the Duck River.

The contact of the eastern boundary of the dolomite with Slate Stage has already been described. ([11])

Immediately west of the Duck River Bridge, the dolomite is striking north 40 degrees east, and is dipping to the north-west at 30 to 35 degrees. The strike of the oolitic limestone in this vicinity is also north 40 degrees east, but its dip is 80 degrees north-west. Further to the west the strike of the dolomite is north 10 degrees east, and the measured dip was 30 degrees west.

Along the Duck River, between the Broadmeadows-road Bridge and Ollington's Bridge on the Lower Scotchtown-road, the strike of the series is north 15 degrees west, and the dip is from 30 to 40 degrees west. In the vicinity of Ollington's Bridge there is a change in strike; from there south the strike is very nearly true north and south, varying in places to north 10 degrees east, and the dip is from 40 to 50 degrees west. In a quarry on the banks of the Duck River, about 6 chains upstream from Lobster Creek, there is an anticlinal fold in the series; the strike is north 10 degrees east, the dip of the western limb is 45 degrees, and that of the eastern limb is 28 degrees. As far as

([10]) See p. 104. ([11]) See p. 45.

could be seen this fold is purely a local occurrence. In the neighbourhood of Edith Creek these rocks assume an average strike of north 33 degrees west, and recorded dips vary from 15 to 46 degrees to the south-west.

The minimum thickness of the Dolomite Stage is approximately 3500 feet. The most westerly exposure is on the elbow of Watson's Bend, on the Duck River. A general reconnaissance of the low-lying country immediately to the west of the Duck River revealed no outcrops of any kind. It seems probable that the true thickness of the series is considerably greater than the figure given above. This question will be further discussed below. (12)

Although the contact of the Dolomite Stage with the underlying slates and breccias is nowhere exposed, the mapping and structural features indicate that the two are conformable. The normal strikes of the two stages are more or less in accord. The average dip of the dolomites along the Duck River certainly appears to be a little flatter than the more normal dips of the slates and breccias further to the east, but there are very few places, where the slates and breccias are in juxtaposition to the dolomite, where their dips can be measured. The mapping at these places indicates conformability.

Type specimens of the dolomites are:—

Dolomites, S.33, S.34, S.35, S.36, S.37, S.38, S.119.

Crystalline Dolomite, S.44.

(vi) Post-Dolomite Stages.

As stated above, (13) the dolomite forms the bedrock of the Duck River plain, and outcrops are not numerous, except in the vicinity of rivers, creeks, &c., where the sand, &c., have been removed by erosion.

The top of the Dolomite Stage had not been reached within the district mapped, as it outcropped at Watson's Bend, just off the north-east quarter-

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(12) See p. 51. (13) See p. 50.

sheet. Outcrops were not found immediately west of this locality, but reconnaissance trips still further west gave valuable information worthy of being recorded.

The most westerly outcrop of dolomite was found in drains 2 miles west of the south-west corner of the north-east quarter-sheet. This must be somewhere near the western boundary of the dolomite, because—

(*a*) Slates are exposed along the Marrawah Tram 2½ miles west of the quarter-sheet, in the latitude of Blackwood Bridge.

(*b*) Breccias (fine and coarse) are exposed along the Smithton-Montagu-road, half a mile west of Muddy Creek, and 2 miles west of the north-west corner of the north-east quarter-sheet.

Accepting the above locality as the western boundary, the dolomite is 220 chains wide across the outcrop. Assuming an average dip of 40 degrees, the thickness is 140 chains, or 9240 feet (no allowance being possible for strike faults or for folding, as such were not detected).

The continuance of the reconnaissance west along the Montagu-road revealed quartzites (argillaceous) 2 miles north-west of Muddy Creek, with a strike of 20 degrees, and a dip of 20 degrees to the west; fine and coarse breccias half a mile further west; fine breccias and slates still further west, the strikes and dips of which are indefinite, but which may be a north and south strike and an easterly dip; and white crystalline dolomite at the Montagu River Bridge.

At the old Montagu Jetty, 2½ miles north of the road, and about half-way between the last two outcrops, slates and breccias (both fine and coarse types) outcrop along the shore for about a mile. The strike of these rocks is north and south, and the dip to the east at 20 to 30 degrees. The above outcrops are strongly suggestive of a large syncline, the slates and breccias being the centre of the fold, and the Duck River dolomite appearing again at the Montagu River on the western limb of the fold.

A sketch section drawn in accordance with this view presents no difficulties. The slates and breccias represent another stage (Coarse Breccia Stage), separated from the Slate Stage by the Duck River dolomite.

(vii) Age.

The above descriptions show that the rocks of this system are divisible into five stages. Of these, all, excepting possibly the White Quartzite Stage, form a conformable series, the order from oldest to youngest being Grey-green Quartzite Stage, Chert Stage, Slate Stage, and Dolomite Stage. The White Quartzite Stage is associated with the Grey-green Quartzite Stage, but the relations of the two have not been definitely established. Though described as separate stages, the former may represent portions of the latter.

There is no direct evidence of the age of these rocks within the district, beyond the fact that they are probably pre-Devonian, because they are intruded by the dolerite dyke, which probably belongs to the Devonian igneous intrusions. Fossils have not been found, excepting the crinoid ossicles in the limestone and the doubtful fossil in the Irishtown dolomite, both of which are useless for age-determination. From general lithological considerations, however, the rocks can be referred to the Cambro-Ordovician system.

Further, the rocks can be referred to particular rock series occurring in the west and north-western districts of the State.

The slates and breccias of the Slate Stage, and the cherts of this stage and the Chert Stage, are analogous with those of the Dundas series, with which they can be correlated with certainty. As regards the dolomite, however, this is the first district in which it has been found, so that it introduces a new feature into the Dundas series.

Reconnaissance surveys east of the district, i.e., where beds lower than those mapped should occur, proved the absence of typical Dundas rock types, so that it is assumed that in the district it is the lower stages of this series that occur. This represents a considerable advance in the knowledge of the Cambro-Ordovician stratigraphy, as the base of the Dundas series had not previously been recognised.

It is not quite definite as to where the base of the Dundas series within the district should be placed, nor as to whether there is an unconformity between it and the underlying series. On the accompanying maps the base has been taken as the Dolomite Sub-stage (or, when absent, the Chert Sub-stage). However, the Grey-green Quartzite Stage appears to conformably underlie the other stages. It might appear, therefore, that a conformable series exists, and that the base of the Dundas series is merely an arbitrary one indicating the base of the typical rock-types (purple and green slates, breccias, and cherts).

Even the correlation with the Dundas series does not help greatly in the exact determination of the age of the rocks, as the latter is referred to the dual Cambro-Ordovician system, being younger than the Proterozoic rocks and older than the Silurian system, the basal conglomerates of which overlie it unconformably. However, in a forthcoming report ([14]) a more exact determination is made, because the graptolite beds on the North-East Dundas Tramway are interbedded with Dundas strata about the middle of the series. The graptolites are described by Keble ([15]) as indicating an age either at the summit of the Lower Ordovician or the base of the Upper Ordovician, so that the Dundas series may be considered as of Ordovician age.

B.—Tertiary System.

Of the various rocks comprising the Tertiary period in the Smithton district two groups may be recognised: (i) The rocks laid down between basalt flows. (ii) Post-basaltic sediments.

(i) The Rocks Laid Down Between Basalt Flows.

The rocks of this group are most numerous and widespread, and consist of quartzites, sandstones,

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([14]) Forthcoming report on the Rosebery district.
([15]) Keble, R. A.: Tasmanian Graptolite Record. (Pap. and Proc. Roy. Soc. Tas., 1928, pp. 69-71.)

conglomerates, grits, clays, and lignites. The quartzites are fine-grained, light-grey to white coloured rocks composed of small, rounded grains of quartz sand.

Scattered here and there among the sand grains are specks of black iron oxides, which are probably magnetite and ilmenite. The whole is cemented together by silica into a hard, compact quartzite. It seems reasonable to assume that originally the quartzites were sandstones, and that heat emanating from a succeeding flow of basalt had the effect of indurating the sandstones to the hard quartzites as they are found at present. The sandstones represent weathered derivatives of the quartzites. They are light to dark-brown in colour, and consist of all gradations between hard quartzites and soft, loosely compact sandstones. The brown colour is derived from the iron oxides, which have been altered to limonite. In places concretionary boulders may be seen in which the sandstones have given place almost wholly to limonite.

The conglomerate is really a breccia conglomerate, since it is made up of rounded and angular pebbles. The rock is of fine to medium coarseness, with pebbles of 1 inch maximum size. The latter are composed of reef quartz, while the cementing material is silica and limonite.

The grits consist of small angular pieces of quartz, cemented together by limonite.

Clays are present as typical sedimentary types of both blue and white colours.

Lignites of the series are described under the heading of " Economic Geology."

The group is represented by freshwater sediments appearing as scattered outcrops and remnants, at different levels, on and at the edges of the basalt plateau in the south-east of the district. From field evidence it seems conclusive that the rocks were laid down between separate flows of basalt. From heights taken it has been found possible to correlate certain of the occurrences, and to divide the whole into three series of slightly different ages, which occur at three distinct elevations.

The series are here described separately from the oldest to the youngest:—

(*a*) *Lower Series*.—The outcrop of the rock under this heading has been much denuded, and is now only seen *in situ* as a small patch of quartzite overlying weathered basalt. It occurs about the south boundary of Smithton south-east quarter-sheet, on the west side of the subsidiary road going south from the ballast reserve, at the foot of Beattie Hill. Blocks of weathered quartzite in the form of sandstone are at surface 20 chains to the north-west, at a slightly higher level. The thickness of this series is in the vicinity of 40 feet.

(*b*) *Lignite Series*.—The best exposure is in the bed of the main upper branch of Edith Creek, near the south-east corner of the southern sheet. At this place the series, from top to bottom, consists of horizontal beds of quartzite, lignite, breccia conglomerate (maximum thickness 10 feet), lignite (3 feet), clay (6 feet), and quartzite (40 feet). The upper quartzite is not seen directly overlying the other rocks, but it outcrops on the sides of the valley up to 60 feet above the upper lignite bed. The original thickness of the top bed of lignite could not be ascertained, since it is exposed over the creek-bed, where it has evidently been eroded by the stream, but 1 foot would represent the maximum thickness of the remnant at this point.

The minimum thickness of the series is therefore 60 feet, while the maximum may reach 120 feet.

On the steep northern slope of Myrtle Hill, in a block of 34 acres 34 perches of land purchased from the Crown by A. Wood, a level bed of lignite outcrops. Boulders of sandstone are scattered about on the surface, and, although it cannot be seen *in situ*, the rock is evidently interbedded with the brown coal.

In the valley of a small tributary of Allen Creek, situate on a block of 44 acres 1 rood 3 perches purchased by A. B. John, a patch of quartzite is found to be directly overlying basalt. No associated lignite is to be seen, but the occurrence lies within the height range of the more definite of the series.

About 25 chains east of Spinks Hill, in 101 acres 1 rood 3 perches of land purchased by A. A. Spinks, just beyond the east boundary of the south sheet.

a small patch of sandstone appears associated with basalt, and this occurrence can be correlated with the Lignite Series.

At several other places about the basalt plateau, at approximately the same height as the rest of the series, pieces of grit and sandstone on the surface indicate the presence of these rocks.

In a road-cutting on Beattie Hill, north-east of Nabageena, a white plastic clay, with iron oxide stains, is exposed for several chains along the road. The thickness of the clay is about 30 feet in this vicinity.

(*c*) *Upper Series.*—Several areas of quartzites and sandstones appear near the top of the plateau at greater elevations than the rocks of the other series.

Along that portion of the cross-road from O'Connor Hill to Edith Creek settlement, generally known as McPherson's-road, in the 148 acres 1 rood 34 perches block purchased by C. J. Hills, numerous scattered boulders of limonitic sandstone occur at surface. The rock is *in situ* 10 chains from the road along the sides of a small creek, which heads 2 chains to the south of the road and flows southerly to Edith Creek.

The rock is again exposed 40 chains north-east of O'Connor Trigonometrical Station, in the head of a small creek rising 3½ chains west of Young's-road, near the south boundary of 88 acres 1 rood 6 perches of land purchased by G. Acheson. The exposed thickness of sandstone at this place is 10 feet, and basalt outcrops above and below, but the contact of the two rock types cannot be seen. In road-cuttings, half a mile south of Young Trigonometrical Station, are remnants of sandstone; but here the exposure is poor.

Forty feet would represent the approximate thickness of the Upper Series.

(ii) Post-Basaltic.

Post-basaltic gravels are known to occur only in three localities, viz., near the intersection of the Scotchtown-road and Connell's cross-road, in the flat country to the south-east of Connell's Hill, and about half a mile to the north of Edith Creek station.

The gravels on the Scotchtown-road occur at an elevation of 200 feet. They are well consolidated, and consist of waterworn quartz pebbles ranging in diameter from one-quarter of an inch up to 3 inches. The cementing material consists of fine quartzose particles and kaolin; in places there is a certain amount of ferruginous cement, possibly leached from the underlying slates and breccias. The total thickness of these gravels is approximately 15 feet.

The second bed of gravels has been cut in a drain to the south-east of Connell's Hill, their height above sea-level being 125 feet. These are generally similar to those described above, but contain larger pebbles, and are somewhat less consolidated. Their total width is approximately 150 feet, and they appear to mark the course of a former east-flowing creek. They are overlain by Pleistocene clays.

About half a mile to the north of Edith Creek station there are numerous waterworn quartz pebbles in the soil. These indicate the existence of a bed of gravels in this locality, and, from their general lithological character, they have been correlated with those described above. They occur at an elevation of 125 feet above sea-level.

The quartz pebbles of the post-basaltic gravels have been derived either from pre-basaltic gravel beds, or from the Cambro-Ordovician cherts. If the latter view is correct, then the gravels on the Scotchtown-road and those near Edith Creek station indicate the existence of former creeks which flowed westwards into the Duck River, and the gravels near Connell's Hill would be associated with a former east-flowing creek, which was possibly a tributary of Deep Creek. The divide between these two drainage systems would be formed by the resistant beds of chert.

C.—Pleistocene System.

The Pleistocene rocks of the district occur in two separate areas, viz., Duck River plain, and the Deep Creek and Pulbeena plains, and for the purpose of description they will be treated separately below.

(i) Duck River Plain.

The superficial deposits forming this plain consist of two different types, viz., sand and peat. These apparently correspond to marine and freshwater deposits, and will be described separately as such.

(*a*) *Marine Series.*—The greater part of the surface of the plain is occupied by unconsolidated sand. The sand is generally white in colour, and resembles sea-sand, but in the transition areas between the sand and the peaty regions the sand is brown, due to discolouration by peat.

The sand is not of uniform thickness, due to differences in the original thickness through being deposited over an uneven bedrock, and also to subsequent erosion. Generally, along the eastern part of the plain the present thickness is small, being only a few feet. To the west of the district, however, drains have exposed the sand to a depth of 12 feet. Still further west, on the flanks of the Christmas Hills ridge, sand occurs up to heights of over 100 feet above the plain. While some of this may be wind-blown, it rather suggests that the sand deposits were much thicker than they appear at present.

In a drain towards the northern end of R. H. Smith's farm, some 2½ miles south-west of Smithton, a drain has exposed the sand to a depth of 10 feet. Two feet lower there is a layer of greyish-green sand containing numerous shells, representing, however, only a few species. The shells were submitted to Mr. F. Chapman, Commonwealth Palæontologist, who identified the following: *Ostrea* sp., *Ostrea virescens* (Angas), *Spisula trigonella* (Lam.), *Pecten medius* (Lam.), and *Cardium tenuicostatum* (Lam.)—and stated that the beds were of Pleistocene age. Other shells have been collected by local residents, but are not available for examination. *Mactra ovalina* has also been collected in addition to the above.

In general, the sand containing the shells is similar to sands on Flinders Island, which have yielded numerous shells, by virtue of which Mr. F. Chapman and Mr. F. Singleton have identified the beds as of Werrikooian age.

For the present, therefore, the marine sands of the Duck River plain are being regarded as not older than Pleistocene, and probably of Pleistocene age. Further evidence will be discussed in connection with the Freshwater Series. ([16])

(*b*) *Freshwater Series.*—This series is represented at the surface by a black peaty soil, which forms the rich parts of the plains, such as Mowbray Swamp, &c. This peat apparently consists of fine sand and mud, containing a large proportion of decomposed vegetable matter.

Drains have exposed the peat to a depth of 10 feet, while poles can be pushed down into it for greater depths.

This series is interesting, as it was from the peat that the specimens of *Nototherium* were obtained. The first specimen was found by Mr. E. C. Lovell in July, 1910, and described by Mr. H. H. Scott ([17]) ([18]) as *Nototherium tasmanicum* (Scott). The second specimen was found by Mr. E. C. Lovell in 1920, and was described by Messrs. H. H. Scott and Clive E. Lord ([19]) as *Nototherium mitchelli.* Other discoveries include those of—

(1) Mr. K. M. Harrisson: Nototherian teeth. Described by H. H. Scott. ([20])

(2) Mr. T. Edwards, 1915: Upper jaw of *Palorchestes.* Described by H. H. Scott. ([21])

(3) Mr. Burnley, 1923: Mutilated *Nototherium* femur. Described by Messrs. Scott and Lord. ([22])

([16]) See p. 60.

([17]) Scott, H. H.: Tasmanian Naturalist, Vol. II., No. 4, 1911, p. 64.

([18]) Scott, H. H.: A Monograph of *Nototherium tasmanicum.* (Tas. Geol. Surv. Rec. No. 4, 1915.)

([19]) Scott, H. H., and Lord, Clive E.: Studies in Tasmanian Mammals, Living and Extinct—No. 1, *Nototherium mitchelli.* (Proc. Roy. Soc. Tas., 1920, pp. 13-15; also pp. 17-32, 76-96, and 97-113.)

([20]) Scott, H. H.: A Note on *Palorchestes*, as a Tasmanian Genus. (Proc. Roy. Soc. Tas., 1915, pp. 100-1.)

([21]) Scott, H. H.: A Note on *Palorchestes*, as a Tasmanian Genus. (Proc. Roy. Soc. Tas., 1915, pp. 100-1.)

([22]) Scott, H. H., and Lord, Clive: Studies in Tasmanian Mammals, Living and Extinct—No. XI. (Proc. Roy. Soc. Tas., 1923, pp. 56-57.)

(4) Mr. and Mrs. K. M. Harrisson, 1924: Mandible and cheek teeth of *Palorchestes azael?* (Owens) and *Parous?* (De Vis); mutilated femur of *Phascolonus* (Owen); and parts of lower jaw of *Nototherium tasmanicum* (Scott). [23]

(5) Mr. E. W. Reeman, 1924: Teeth of *Nototherium mitchelli* (Owen). Described by Messrs. H. H. Scott and Clive E. Lord. [24]

The above mammals are referred by Messrs. Scott and Lord to the Pleistocene, and are regarded as having died out in the late Pleistocene.

The peat contains soft calcareous layers, described by Noetling [25] as "Imbedded in the peat are irregular streaks and layers of a soft calcareous mud, full of the shells of freshwater molluscs." Noetling made a collection of the shells, and determined the following:—*Vitrina (Paryphanta) milligani* (Pfeiff); *Helix (Flammulina) Hamiltoni* (Cox); *Bulimus (Caryodes) Dufresnii* (Leach), eggs only; *Succinea australis* (Fer); *Physa tasmanica* (Ten. Woods); *Bithynella nigra* (Quoy and Gaimard sp.); *Cyclas tasmanica* (Ten. Woods); *Pisidium tasmanicum* (Ten. Woods); and *Ostracodum*, gen. and spec. indet.

Chapman [26] also examined some of the material, and reports the following mollusca:—*Sphærium tasmanicum* (T. Woods sp.); *Pisidium tasmanicum* (T. Woods); *Bythinella nigra* (Quoy and Gaimard sp.); *Assiminea tasmanica* (T. Woods); *Bulinus tasmanicus* (T. Woods sp.); *Amphipeplea subaquatilis* (Tate sp., var. *neglecta*, Petterd); and *Vitrina milligani* (Pfeiffer).

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(23) Scott, H. H., and Lord, Clive: Studies in Tasmanian Mammals, Living and Extinct—No. XII. (Proc. Roy. Soc. Tas., 1924, pp. 53-58.)

(24) Scott, H. H., and Lord, Clive: Studies in Tasmanian Mammals, Living and Extinct—No. XII. (Proc. Roy. Soc. Tas., 1924, pp. 53-58.)

(25) Noetling, Fritz, M.A., Ph.D.: The Occurrence of Gigantic Marsupials in Tasmania. (Proc. Roy. Soc. Tas., 1911, pp. 124-133.)

(26) Chapman, F., A.L.S., F.R.M.S.: Notes on Testacea from the Pleistocene Marl of Mowbray Swamp, North-West Tasmania. (Memoirs of the Nat. Mus. Melbourne, No. 5, 1914, pp. 55-61.)

The two following ostracoda were also reported:—*Candona lutea* (King) and *Limnicythere mowbrayensis* (sp. nov.).

Chapman states that the genera *Assiminea* and *Bythinella* are strong indications of the presence of tidal influence in this swamp. His conclusion as to the age is: "The conclusion as to the age of the Mowbray Swamp deposit is significant, for it shows that the first marsupial associated with these remains cannot date very far back in Pleistocene times, as seen in the comparatively fresh condition of some of the mollusca and the ostracoda, many of which have their original colour markings still preserved."

It would appear from the above description that the mammals, mollusca, and ostracoda were deposited in swamps perhaps subject at times to tidal influences, and that the age of the sediments is Pleistocene and possibly Upper Pleistocene.

This freshwater series is regarded as being slightly later than the Marine series, the general relationships being expressed as follows:—The sea in Lower or Middle Pleistocene occupied the estuary now represented by the Duck River Plain, and the Marine series were deposited. A small uplift of the land relative to the sea caused the sea to recede from most, if not the whole, of the estuary. Swampy conditions were established over those parts now represented by the freshwater series, possibly associated at times with tidal conditions.

(ii) Deep Creek Plain.

This area includes the flat country around Pulbeena, as well as Deep Creek plain. Two types of rocks, viz., sand and peat, occupy the surface, and these are to be correlated with the two series of the Duck River plain. This area is different from the Duck River, in that the surface is not so level and it attains a height of 100 to 125 feet above sea-level, while that of Duck River plain is 25 to 50 feet above sea-level. These differences are due to a smaller amount of denudation in the case of the area under review.

(*a*) *Marine Series*.—The surface of the plain is occupied by white sand similar to that of the Duck River plain. This supports a vegetation of heath, ti-tree, &c., as does that of Duck River, but a large proportion is covered with button-grass, &c., which builds up a peaty soil, totally different, however, from the peat of the Freshwater Series. On the old Stanley road, one mile and a half east of Smithton, coarse gravels occur just below the sandy surface. The gravels consist of well-rounded pebbles of quartzite up to 3 inches in diameter, and appear to be of marine origin, representing an old shore. The gravels overlie a hard, dark-brown to black peaty sand.

Only a few feet of sand are exposed at any one place, but seeing that it outcrops from sea-level up to 125 feet above, the total thickness probably exceeded this figure.

The sands are similar to those of Duck River plain, and, although no fossils were obtained from them, they are therefore referred to the Marine Series.

(*b*) *Freshwater Series.*—The rocks of this series include peat or black silt, limestone, clays, and gravels. The peat is a dark material, composed of clay and silt, with much vegetable matter, but not nearly as much as that at Mowbray Swamp. The limestones are of two types, viz., hard and soft. The hard limestones are not plentiful, the best exposure being at Fenton's quarry, north-west of Pulbeena. They consist chiefly of casts and replacements of moss, grass, &c., and contain freshwater gasteropod shells. The soft limestones or marls are more plentiful, and occur, interbedded with the peat, in layers up to 3 feet thick. They contain numerous freshwater gasteropod and pelecypod shells. The peat and the limestone are restricted to the rich land around and north of Pulbeena. The marls are probably similar to the calcareous muds of Mowbray Swamp.

The clays are soft, bluish types, and are exposed in the drains east and south-east of Pulbeena.

The gravels occur at several localities, including east side of Matthews-road, 20 chains north-west of Amos Trigonometrical Station; railway ballast reserve, north of Fahey's-lane; in the swamp, north-east of the reserve; and near Pulbeena Siding. At Matthews-road the gravels consist of rounded quartzite pebbles up to 2 inches diameter, in a matrix of sand and clay. The ballast reserve and swamp gravels are composed of pebbles of quartzite and chert (some of which may be shed from the adjacent conglomerates) which range up to 3 inches in diameter. The gravels at Pulbeena are much finer, the pebbles ranging up to half an inch.

Only small thicknesses of these rocks are exposed, 10 feet being exposed in drains, &c., but the maximum thickness is not known.

Fossils occur in the peat, marl, and limestone, and, while numerous, they represent only a few species. The fossils are more readily obtainable from the marl and peat, and a collection of them was submitted to Mr. F. Chapman, Commonwealth Palæontologist, who identified—

Pelecypoda—*Pisidium tasmanicum* (T. Woods):
Gasteropoda—*Bulinus tasmanicus* (T. Woods); *Bythinella nigra* (Q. & G.); *Vitrina* [26a] *milligani* (Pfeiffer)—

and stated that the beds were of Pleistocene age.

The beds are similar in age and in lithological characters to those of Mowbray Swamp, and are therefore correlated with them.

D.—Recent.

Duck River and Deep Creek are at present depositing the suspended mud and sand over the lower portion of their courses and their estuaries in Duck Bay. Alluvium and gravels are being formed along the courses of the present streams where they have widened their valleys to any appreciable extent. The silt and soil deposited over the swampy plain from Irishtown south to Copper Creek are of a slightly different character from the deposits at present forming along creeks, and are probably a little older than the latter. They have been mapped as Recent, but might be more correctly termed Pleistocene.

(26a) In a recent paper, entitled "Systematic Notes on Australian Land Shells," by T. Iredale, in Records of the Australian Museum, Vol. XIX., No. 1, some of the living Tasmanian land shells have been studied and new genera suggested, including the following:—

Vitrina or *Paryplanta milligani*
= *Melavitrina milligani.*

Adjacent to the mapped area, immediately to the north, sand dunes are forming on a narrow spit, partly across the entrance to Duck Bay.

In several places in the district there are mounds and flat deposits composed chiefly of calcium, magnesium, and iron carbonates. This material is forming at present by deposition from springs, but it is probable that the deposition has been continuous from the Pleistocene up till the present day. The flat deposits, evidently formed in pools from the overflow of springs, are developed to their greatest extent in the valley of Perkins Creek, to the north-west of Marthick Siding, where the derived material is represented by a dense, light-brown coloured limestone or travertine. This occurrence appears to be older than the mounds, and may date back to the Pleistocene.

North of Marthick Siding, and near the mouth of Deep Creek, there are mounds and other flat deposits associated with active springs.

In the former locality the deposits are of a chalybeate nature, while in the latter, although the mound is composed of ironstone, the flat deposits around the periphery of the mound are made up of tufaceous calcareous material, intermixed with a peaty soil.

Springs are also active in the vicinity of Pulbeena, and were evidently connected with the deposition of the calcareous deposits of that locality as described under the heading of "Pleistocene." [27]

The springs, although now tapped by drains, may still be depositing to a small extent.

(3)—The Igneous Rocks.

A.—Devonian.

A fairly broad dolerite dyke, having a general meridional trend, intrudes the Dundas slates and breccias. The dolerite is typically a dense, dark-green, fine-grained rock. It is generally massive, with irregular joints, and breaks with a semi-conchoidal fracture. Local variations in lithological character and composition occur. Its appearance is sometimes rendered coarse by numerous amygdaloidal inclusions. Some loose gabbroid boulders

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([27]) See p. 62.

indicate a coarse state of crystallisation, but, as these rocks have not been seen *in situ*, the extent of this phase of the dolerite is unknown. Some marginal types of the dyke and certain marginal tongues and subsidiary dykes vary both in chemical composition and in lithological character from the parent magma.

Excepting the local variations cited above, the greater portion of the dyke does not show much noticeable differentiation. The rock may be even-grained or porphyritic; when it is porphyritic the phenocrysts consist of augite, largely replaced by chlorite, with occasional felspar phenocrysts.

Under the microscope the non-porphyritic dolerite is seen to consist essentially of a fine-grained aggregate of augite, chlorite, and plagioclase felspar, with abundant oxides of iron. The augite is in the form of rounded grains of varying size; some of the larger grains are hypidiomorphic. The felspars are not uniform in size, but are usually small and lath-shaped; they exhibit multiple twinning, and hence belong to the plagioclases. Owing to their size, and the resultant difficulty in determining their extinction angles, it is impossible to determine the member of the plagioclase group to which they belong. The oxides of iron are chiefly magnetite and ilmenite; they are generally in the form of irregular grains, but the magnetite is sometimes idiomorphic. Small areas consisting mainly of partially decomposed felspar enclosing small grains of augite and chlorite, and other smaller areas consisting of chlorite and quartz, occasionally stand out from the remainder of the rock.

The porphyritic dolerite consists of phenocrysts of augite and plagioclase felspar, set in an extremely fine-grained groundmass of augite and plagioclase felspar, with ilmenite and magnetite, and a good deal of cloudy irresolvable base; small grains of native copper appear in some sections. The augite phenocrysts have been largely altered to chlorite, and are usually hypidiomorphic. The felspar phenocrysts are intermediate in composition between labradorite and anorthite; they are irregular in shape, and have undergone some alteration around their margins. In the groundmass augite is the most abundant mineral; it is finely granular, the individual grains showing different orientation. The felspar of the groundmass occurs as lath-shaped crystals or as small irregular grains; it is not as abundant in the porphyritic dolerite as it is in the non-porphyritic type. Some portions of the groundmass of the porphyritic dolerite show a fair amount of felspar, while others show comparatively none; some of the cloudy base probably represents decomposed felspar. The magnetite and ilmenite are generally hypidiomorphic, but a good deal of the magnetite is idiomorphic. In the absence of crystals it is difficult to separate the magnetite and ilmenite, and there appears to have been no alteration of the ilmenite to leucoxene; the presence of ilmenite is inferred from the percentage of TiO_2 in the analysis.

In the hand specimen the porphyritic and non-porphyritic types of the dolerite are difficult to separate, and there appear to be gradations between the two types. The distinction becomes apparent under the microscope, and such sections as have been examined show generally the characteristics of either one or the other of the two types.

Both the porphyritic and the non-porphyritic types sometimes contain amygdules. These are rounded or irregular, and may be white or green in colour. The while amygdules consist mainly of aggregates of quartz and calcite, which may contain augite or chlorite. The green amygdules consist of a central nucleus of quartz, surrounded by fibres of the same material, with a thin outer layer of chlorite; the fibrous quartz between the nucleus and the outer chlorite layer radiates in fan-shaped fashion from a number of points on the inside of the chlorite layer.

In a small outcrop of the dolerite on the northern spur of Tier Hill the white amygdaloidal inclusions are so numerous that the rock has quite a coarse appearance. Under the microscope the amygdules of this rock are identical with the white amygdules already described; the remainder of the rock is made up of dense chlorite, with an occasional patch of augite.

Although the coarse gabbroid form of the dolerite has not been seen *in situ*, it may be as well to give a brief description of it. The rock is composed mainly of augite, chlorite, felspar, magnetite, and ilmenite. The augite is in large hypidiomorphic crystals; it is often twinned, and exhibits hourglass structure. In addition to the usual prismatic cleavage, diallage and salite structures are developed. The felspars are rather turbid, but the twinning into broad lamellæ is distinguishable; it is probably labradorite. Magnetite and ilmenite occur as skeletons of larger crystals; the former is sometimes idiomorphic, in which case the crystals are small; the ilmenite shows some alteration to leucoxene. The augite sometimes has inclusions in the form of small quartz crystals. Needles of apatite are common in the felspars. Chlorite occurs in irregular grains and as a replacement after augite; it also occurs in the form of large irregular fibrous patches. The order of crystallisation of the constituent minerals is probably magnetite, ilmenite, felspar, and augite. There is some difficulty in determining the relative order of crystallisation of the felspar and the augite. Both minerals show crystalline outlines, but the felspar appears to be idiomorphic with respect to the augite; furthermore, augite is present as wedge-shaped pieces penetrating cracks in the felspar. The evidence is not altogether clear on this point, as in one part of the section a crystal of augite was seen to be entirely enclosed by felspar.

Veins and irregular patches of reef quartz occur in various places throughout the dyke, and often contain considerable amounts of epidote. A typical occurrence is that on the north-western slope of Harrison's Hill, just outside the south boundary of the Smithton township reserve. Veins consisting chiefly of epidote occur in the mugearite dykes on the east side of Duck Bay.

The chemical composition of the dolerite is illustrated by the following analyses:—

TABLE No. 8.

Analyses of Dolerite.

Constituents.	(1) Spec. No. S.15. Reg. No 1801.	(2) Spec. No. S.137. Reg. No. 2267.	(3) Spec No. S.108. Reg. No 1807.
SiO_2	46·88	44·20	48·20
Fe_2O_3	5·15	9·98	9·22
FeO	9·03	5·84	7·82
Al_2O_3	19·04	20·80	14·74
TiO_2	1·48	1·44	2·36
CaO	10·67	10·40	5·91
MgO	3·62	3·18	5·00
MnO	Trace	1·06	0·74
P_2O_5	0·13	0·15	0·385
S	0·04		0·068
K_2O	0·55	0·36	0·44
Na_2O	2·00	1·71	2·89
Ignition loss	2·00	1·44	2·50
	100·59	100·56	100·273

(1) Fine-grained non-porphyritic dolerite. Duck Bay, east of Park Point.
(2) Fine-grained porphyritic dolerite.
(3) Coarse gabbro. Coward's-road, ¾-mile from Smithton.

Subsidiary tongues and dykes are to be found around the margin of the dolerite dyke, and fall naturally into two main groups:

(i) The western group—Mugearites.
(ii) The eastern group—Augite-Porphyrites.

(i) The western tongues and dykes may be seen along the shores of Duck Bay, from the Smithton wharves northward. There are two main types, one being a fine-grained, reddish-brown basaltic rock, the other a fine-grained, greenish basaltic rock; both are amygdaloidal.

Under the microscope the reddish-brown type is seen to be made up of a plexus of felspar laths, probably oligoclase or albite, with some chlorite, a little interstitial biotite, and abundant oxides of iron. In addition to the lath-shaped felspars there are occasional aggregates of slightly larger felspar crystals; these resemble phenocrysts, but as a rule the rock is not porphyritic. The oxides of iron are ilmenite altering to leucoxene, magnetite, and hematite; hematite is the most abundant, and is scattered through the rock, imparting to it the reddish-brown colour. Chlorite and biotite occur as interstitial grains; the latter is not common. The amygdules consist of quartz and chlorite; in some cases the chlorite occupies the centre of the amygdule, and is surrounded by quartz; in others the amygdule is of quartz surrounded by a thin film of chlorite.

The greenish basaltic rocks are closely associated with the reddish-brown types, and both may occur in the same dyke; they, too, consist mainly of a mass of felspar laths, with abundant oxides of iron, but are characterised by a greater amount of felspar, much more chlorite, and less oxide of iron. The chlorite occurs as large irregular grains and as small interstitial pieces; some of the larger grains are surrounded by a border of felspar. Hematite, magnetite, and ilmenite constitute the iron oxides; the hematite is much less abundant. The amygdules are small vesicular cavities lined with quartz.

The chemical composition of these rocks is illustrated by the following analyses:—

TABLE NO. 9.

Analyses of Mugearites.

Constituents.	Spec. No. S.8. Reg. No. 1799.	Spec. No. S 12. Reg. No. 1800.
SiO_2	50·16	53·20
Fe_2O_3	13·98	7·72
FeO	4·15	3·87
Al_2O_3	18·01	19·15
TiO_2	2·00	1·74
CaO	1·40	1·24
MgO	1·84	2·89
MnO	Trace	Trace
P_2O_5	0·253	0·298
S	Trace	0·05
K_2O	0·83	0·58
Na_2O	4·43	5·17
I.L.	2·10	4·00
	99·153	99·908

The higher percentages of Na_2O, Al_2O_3, and SiO_2 in the greenish type correspond with the greater amount of felspar, likewise the higher MgO agrees with an increase in the amount of chlorite. The greater percentage of Fe_2O_3 in the reddish-brown type corresponds with the greater abundance of hematite.

In addition to these two rock types there are certain other marginal tongues which, though they are very similar in their general characteristics, contain a good deal of augite occurring as interstitial grains.

The mineralogical and chemical composition of these rocks is rather unusual; in some respects they correspond to the mugearites, with which type they have been classed, but contain no olivine. They are similar in some respects to certain trachyitic rocks, but contain a much lower silica percentage. The analyses show that they are generally low in silica, high in soda, and low in Ca and Mg.

These rocks occur as small dykes separated from the main dyke, or as irregular tongues protruding from it.

(ii) The dykes and tongues occurring on the eastern margin of the doleritic dyke occur in proximity to the north-eastern corner of the main dyke, at a distance of some 30 to 35 chains east of Park Point. These rocks differ, both chemically and mineralogically, from the western group of tongues and dykes described above. Some of them occur as small independent dykes; others are joined to the main mass.

In hand specimen, the small subsidiary dykes are fine-grained, greenish, porphyritic rocks, resembling a basic porphyrite. Microscopically, the phenocrysts are seen to consist of augite, now largely altered to chlorite, zoisite, and epidote, set in an extremely fine-grained groundmass. Some of the augite phenocrysts are idiomorphic, some hypidiomorphic; most of them have been corroded by the magma. The groundmass is made up of finely granular epidote, augite, and felspar, the latter resolvable only under high power. The rock is comparatively free from iron oxides. This rock may be described as an altered basic augite-porphyrite; it must not be confused with the porphyritic dolerite of the main dyke, from which it differs both in structure and chemical composition, and, in hand specimens, the two rocks are readily distinguishable.

Another type of rock, which resembles the basic augite porphyrite in chemical composition, but which differs from it in appearance, occurs as a tongue which extends a few chains eastwards from the main dyke. In hand specimen, it resembles some types of the normal fine-grained dolerite, but is specked with numerous small reddish patches, which, under the microscope, appear as small areas of zoisite and/or chlorite, surrounded by a border of hematite or limonite; these areas may contain fragments of augite, of which they are probably the alteration products; some resemble altered phenocrysts. The remainder of the rock is made up of large and small grains of augite, which is generally more abundant in this rock than it is in the basic porphyrite, epidote, and small laths of felspar. Like the basic dyke described above, it is (if we except the limonite and hematite surrounding the zoisite and chlorite) comparatively free from oxides of iron.

The composition of these rocks is shown by the following analyses:—

TABLE No. 10.

Analyses of Augite Porphyrites.

Constituents.	Spec. No. S.24. Reg. No. 1803.	Spec. No. S.18. Reg. No. 1802.
SiO_2	46·64	45·00
Fe_2O_3	9·00	7·58
FeO	1·80	3·48
Al_2O_3	23·45	24·64
TiO_2	0·54	0·32
CaO	10·91	9·07
MgO	3·26	6·30
MnO	...	...
P_2O_5	0·09	0·05
S	0·27	Trace
K_2O	0·50	0·46
Na_2O	2·09	1·06
I.L.	3·00	3·20

S.24. Altered basic augite porphyrite dyke. 28 chains east of Park Point.

S.18. Altered dolerite porphyrite. 25 chains east of Park Point.

The analyses show that the two rocks are similar in chemical composition; the higher percentage of MgO in S.18 agrees with the greater amount of augite in that rock. In general, the chemical composition of both rocks approaches closely to that of the normal dolerites, but the alumina is approximately 4 per cent. higher, and the total of the ferric and ferrous oxides is about 4 per cent. lower.

The intrusive nature of the dolerite dyke can be seen at many places around its margin, particularly around the shores of Duck Bay, where the contact with the intruded slates is often exposed at low tide. In some places the slates have been baked to a hard, brick-like consistency, the effect being most noticeable in the purple slates.

The contact is not always a clean one; a fairly common effect is the occurrence, between the intruded and intrusive rocks, of a thin selvage of brecciated rocks composed of baked irregular fragments of purple slate and small irregular patches of dolerite. The slate appeared to be undergoing digestion by the dolerite, the process resembling magmatic stoping on a minute scale. Another curious effect is that in some of the baked slates there occur small zenolith-like patches of dolerite, which vary from half an inch to an inch in section. The exact processes by which these zenolith-like pieces attained their present positions is not clear, but it seems probable that in places the dyke magma was exceedingly mobile, and that tiny veinlets of the fluid magma penetrated the slates along cracks or joint planes; during the baking of the slates these cracks were closed, and then, the source of supply being cut off, there would be left isolated patches of fluid dolerite, which, when consolidated, would be completely surrounded by slate. These marginal effects may best be studied on Duck Bay, at a distance of 25 to 30 chains east of Park Point.

The dyke extends southwards from Duck Bay for a distance of many miles. Being more resistant to the processes of weathering than the intruded slates, the dyke is marked along its length by a chain of hills, of which it forms the core. These from north to south are Tier Hill, Harrison's Hill, Marthick's Hill, Poke's Hill, Ollington's Hill, Groom's Hill, &c. In the vicinity of Ollington's it attains a maximum width of 60 chains. To the south of Groom's Cross-road, the dyke begins to narrow considerably, but it can be traced with little difficulty along the line of hills which run parallel to the Balfour-road. Where the Balfour-road crosses Copper Creek it is only 7 chains wide, but going south it widens again until, in the vicinity of Allen Creek, the width has increased to 45 chains. South of Allen Creek the dyke narrows, and to the east of Cooper's Trigonometrical Station becomes extremely difficult to follow; it widens again to the south of McPherson's-road, and on passing out of the area has regained its maximum width of 60 chains.

Ten miles to the south-west of this area there are exposures of dolerite rocks similar to those described above; they outcrop in the bed of the Arthur River at the Balfour Track crossing. It is possible that these rocks may be connected with the Smithton dolerites.

Type specimens of the dolerite and its associates are—

Porphyritic dolerite: S.137, S.138.
Non-porphyritic dolerite: S.15, S.43.
Gabbro: S.31, S.108.
Amygdaloidal dolerite: S.101.
Augite porphyrite: S.22, S.23, S.24.
Altered dolerite porphyrite: S.18, S.19.
Mugearites: S.2, S.6, S.8, S.9, S.10, S.12.
Rocks from brecciated zone on Duck Bay: S.20, S.21.

In addition to the above dyke and its marginal tongues, small areas of basic rock occur at the following two localities:—

(i) Sixty chains north-east of Amos Trigonometrical Station. Boulders of dolerite are found along a timber track (connecting with Fahey's-lane to the south) in the valley of a small tributary of Deep Creek, but the rock was not found *in situ*. The rock is a fine to medium grained type, similar to the typical dolerite of the Smithton-Edith Creek dyke.

(ii) Forty chains north-east of Amos Trigonometrical Station. At the head of the northern branch of the above creek boulders of a completely weathered basic rock occur in the soil, which also has the appearance of having been derived from a basic rock.

The above outcrops suggest the occurrence of one or more dykes of dolerite in the vicinity.

Similar dolerites occur in adjacent regions. On the old road from Smithton to Stanley dolerite occurs at the site of the bridge over Deep Creek. The dolerite rocks on the Arthur River have already been mentioned above. Dolerite identical with that at Smithton occurs at West Montagu, and the similarity extends even to the occurrence of native copper and patches of quartz and epidote. This rock has already been referred to by Ward, (28) as have the amphibolites of the Mt. Balfour district.

Similar dolerite rocks occur at other localities in the north-west, e.g., east of Penguin, and west coast districts, e.g., between Zeehan and Queenstown.

The dolerite intrudes the Slate Stage of the Dundas series, and is therefore post-Ordovician. It is overlain by gravels of probably Upper Tertiary age, and is therefore pre-Upper Tertiary. No more precise age-determination can be made from the evidence within the district, but, in conformity with other similar intrusions throughout the State, the dolerite is regarded as belonging to the Devonian intrusions. This view is supported by the occurrence of similar dolerites intrusive into Silurian rocks between Zeehan and Queenstown. (29)

B.—Tertiary.

Surface flows of olivine basalt are developed over approximately fifteen per cent. of the surface area.

Very slight variations occur, but these graduate one into the other throughout the same flow. The rock is slightly amygdaloidal at some localities, but the amygdules are small, and although apparently consisting of zeolites, these could not be satisfactorily determined.

In hand specimens the basalt is found to be a dark-grey coloured, compact, fine to medium grained type. The chief constituent minerals cannot be distinguished, except in some cases by their light and dark colours. Olivine is at times seen as porphyritic areas, made conspicuous by its olive-green colour and glassy lustre.

Under the microscope the typical rock type was proved to be an olivine basalt. It is a holocrystalline, even, medium-grained type, with hypidiomorphic texture. The minerals, in order of decreasing abundance, consist of plagioclase felspar, augite, olivine,

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(28) Ward, L. K.: The Mt. Balfour Mining Field, Tasmania. (Geol. Surv. Bull. No. 10, 1911, pp. 21-25.

(29) Blake, F.: Departmental Report—Geological Reconnaissance of the South Dundas District, 1928.

and iron oxides. Plagioclase felspar fills the interstitial spaces between the other minerals, and appears as long and narrow, lath-shaped forms showing lamellæ twinning. The augite and olivine occur in equidimensional grains, with some crystal outlines. The olivine shows slight alteration to serpentine along irregular cracks. The oxides of iron are magnetite and ilmenite, the latter being indicated in the analyses by the presence of TiO_2.

The chemical composition of the basalt is exemplified by the following analyses:—

TABLE No. 11.

Analyses of Basalt.

Constituents.	(1) Spec. No. S.129. Reg. No. 582.	(2) Spec. No. S.142. Reg. No. 1586.
	Per Cent.	Per Cent.
SiO_2	44·48	43·68
Fe_2O_3	5·98	1·42
FeO	7·38	11·45
Al_2O_3	20·60	21·18
TiO_2	1·80	1·80
CaO	8·10	8·85
MnO	0·91	2·04
MgO	3·76	3·90
P_2O_5	0·51	0·44
K_2O	2·01	1·71
Na_2O	2·67	2·51
Ignition loss	1·56	1·70
	99·76	100·68

(1) S.129: Olivine basalt. Myrtle Hill. Probably from bottom of third flow.

(2) S.142: Olivine basalt. Lileah. Probably from top of third flow.

The silica content is low for basalts, and if this was alone taken into account the rock should be placed in the ultrabasic division, but from a hand specimen the rock type is essentially an olivine basalt.

Many fine instances of columnar jointing occur in the basalt of this district, and may be best observed on the faces of some of the numerous waterfalls on the plateau edge. The structures are almost perfect hexagons in form, and the columns stand straight and vertical. Horizontal jointing, giving a distinct platy structure, is another characteristic feature.

Soil derived from the rock is very rich, being renowned for its fertility, and is much sought after by agriculturalists for root and cereal cropping and for grazing purposes.

The first stage of weathering in the basalt is that of the formation of a light to dark brown crust on the surface of unaltered rock. This is followed in gradual stages by complete disintegration and the production of, in most cases, a dark-red or chocolate coloured soil of good depth. Spheroidal weathering is characteristic of the rock, and blocks are often seen to decay in a concentric fashion, with successive shells of differentially altered rock about a core of unaltered basalt. In some instances where weathering has not proceeded so rapidly, and for other reasons, a light-brown soil is produced which has not the same growing qualities as the darker chocolate soil; but this is exceptional.

The basalt attains its greatest development on the tableland in the vicinity of Lileah and Myrtle Hill, where it composes the plateau to the south-east of Irishtown. Dissection to the north of the latter has caused the formation of several isolated patches. This is instanced by the occurrences of basalt at Connell Hill, Amos Hill, and those on each side of Irishtown-Wiltshire railway. In the middle west of the plateau the rock is dissected by Allen Creek, thereby exposing the underlying strata and effecting the isolation of a small basalt area on Greene Hill.

To the south-east of the district Edith Creek has cut through basalt, and there discloses older series.

The rock extends easterly and southerly outside the mapped area.

From the field evidence it is evident that more than one basalt flow exists. At numbers of places, at different heights on and around the plateau, Tertiary sediments are exposed, and these are bedded between distinct flows of basalt. From data, based on heights taken at the separate occurrences of the Tertiary rocks, it is possible to distinguish three horizons, each representing sediments at approximately the same height. Basalt was seen underlying the lowest of the Tertiary rocks, and it also occurs above the highest, although not directly in contact. It would appear, therefore, that four flows of basalt are here represented. The first basalt flow, resting on Lower Palæozoic rocks, was laid down on a more uneven surface than were the succeeding flows, and varies greatly in thickness throughout its area, but the maximum thickness is in the vicinity of 120 feet.

The second flow, that between the Lower and Lignite Series of sediments, is apparently the thickest, and attains 140 feet in thickness.

The third flow, between the Lignite and Upper Series of rocks, is only 40 feet, and therefore the thinnest sheet. The uppermost flow now has a thickness of 50 feet, but before being denuded was much thicker.

The basalt, together with the sedimentaries, has a thickness of several hundreds of feet. At Kay's Trigonometrical Station, on Myrtle Hill, they effect a thickness of 450 feet. The greatest thickness attained is probably at O'Connor Hill, towards the south of the flows, where they are found to be 520 feet.

The source or sources of the basaltic lava cannot be determined.

There is no trace of craters or cones, and the lava was probably extruded as quiet fissure eruptions, such fissures being still covered by the basalt.

Towards the east the basalt is seen to be directly overlying the Grey-green Quartzite Series. The latter is exposed both in the northern and southern extremities of the flows.

The western portion of the basalt was extruded over a land surface of Dundas slates and breccias, cherts, and associated dolomite.

Since Tertiary sediments are found interbedded between separate flows of basalt, the age of the basalt is clearly established in the Tertiary Period. The rock types are similar in every essential to other basalts in Tasmania, which are regarded as having closed the Lower Tertiary sedimentation. The basalt of the Smithton area is therefore correlated with similar formations in other parts of the State, and regarded as being of the Tertiary era.

It is possible that the basalt near Connell Hill is of different age from that on the plateau. If this is so, the Connell Hill basalt would be the older.

(4)—Structure.

A.—General.

It will be realised from the above descriptions that the bedrock of the district consists of a thick series of Cambro-Ordovician sedimentary rocks. These are intruded by dykes of Devonian dolerite. Thin flows of basalt, with interbedded Tertiary freshwater sedimentary rocks, form the plateau in the south-eastern part of the district. Pleistocene marine and freshwater sediments, and Recent fluviatile sediments, occur in the northern parts.

B.—Folding.

Folding is restricted to the Cambro-Ordovician rocks. As is clearly shown by the two geological sections, these rocks have a general north and south strike, and dip westerly at an average angle of 40°. On the east the lowest beds exposed are the Grey-green and the White Quartzite Stages. The relations of these to one another and to the Dundas series are not very clear, but from the general occurrence of the Grey-green Quartzite Stage it appears that they underlie the Dundas series. The remaining stages are conformable with one another, and, from oldest to youngest, are: the Dolomite Substage, the Chert Substage, the Slate Stage, and the Dolomite Stage. In the Slate Stage, the strikes and dips are irregular, due partly to the beds being incompetent ones, and also to the fact that open folds (anticlines, synclines, and domes) are superimposed on the general westerly dip.

When the rocks to the west of the district are considered, it appears that a large synclinal structure is represented, the beds in the district forming the eastern limb of the syncline. The axis of the syncline is approximately 4 miles west of Smithton, and the western limb occurs at the old Montagu jetty, Montagu, &c.

C.—Faulting.

Very few faults were detected, but it is probable that many others occur. The faulting was most common in the Dundas slates, particularly near the margins of the dolerite dyke.

D.—Igneous Intrusions and Extrusions.

The largest igneous intrusion is represented by the dolerite dyke, which extends in a general north and south direction from Park Point in the north to Edith Creek in the south. It is in the form of a long, narrow dyke, with a considerable range in width, and is transgressive with regard to the slates and breccias.

The extrusions are represented by the Tertiary basalt flows. These are four in number, and contained three series of freshwater Tertiary sedimentary rocks, the flows and interbedded rocks being practically horizontal.

(5)—The Relation of Topography to Geology.

The topographical features of the district have been influenced by two main elements, viz.:—

(*a*) The rock types.
(*b*) The geological structure.

These factors are so thoroughly connected that no attempt will be made to separate them.

It is a noticeable feature that the main drainage valley, viz., that of Duck River, which is broad and flat, is in an area of easily eroded sedimentary bedrock, consisting of dolomite. On the other hand, the most outstanding hills and ridges of the district and the plateau coincide with areas of harder rock, mainly of igneous origin. For instance, the main longitudinal ridge on the west is composed of a central core of dolerite, in the form of a dyke, trending in a like direction. The dolerite is a medium-grained resistant rock, able to withstand the agents of weathering and denudation to a marked degree. Where the dyke-rock has become exposed by the removal of softer slates and breccias on the western side, the dolerite stands out in relief with almost perpendicular slopes. On the eastern side of the dyke, where the sedimentaries have not been eroded to the same extent, flatter slopes are the rule. Generally, it may be said that the most elevated parts of the ridge are represented by the igneous rock, and that its superior compactness and resistant qualities have influenced the moulding of this physiographical unit.

The extrusions of basalt in the south-east have played a large part in fashioning the topography in that direction. The basalt, formed as surface flows, has been the main contributing feature in constructing the plateau. The more easily eroded rocks about the north and north-western edges of the flows have been removed, and the plateau now stands out conspicuously when viewed from those directions.

The two ridges in the north-east of the district, namely, White Hills and Bryant Hill, are made up of hard white and grey-green quartzites, and the formation of the hills has been largely due to the resistant character of these rocks.

(6)—Evolution of the Topography.

Little is known of the topography of the district in the Lower Tertiary era, i.e., before the extensive basalt flows were extruded. The land was probably at much the same height above sea-level as at present, allowing, of course, for the thickness of basalt and interbedded sediments. It may have formed portion of any extension of the coastal plain from the Mt. Balfour district, but this was probably not the case, although it may apply to the country west of the district. It appears, however, that the district was occupied by a river valley trending east-north-easterly from the vicinity of the Arthur River, through Trowutta, towards the Stanley peninsula. This valley was filled with basalt and freshwater sediments to a depth of 520 feet. Following the last basalt flow, the main stream apparently established itself on the western side of its basalt-filled valley, and corroded its course in the less resistant slates, breccias, &c. During its development the stream apparently had its course forced to the west of the western side of its former valley, which effect was apparently influenced by the dolerite dyke in that vicinity. At the same time its main tributaries developed as west-flowing streams, draining and dissecting the basalt-filling of the valley. The erosion by the main and tributary streams of the western side of the old valley has formed the steep western face of the basalt plateau. The undissected portion of the basalt-filling now stands out as a slightly elevated plateau.

The presence of the resistant dolerite dyke in the western side of the old valley had a large influence in the resultant topography. This is readily seen in the Tier Hill-Scotchtown ridge, which has a central core of the dolerite. At the same time it greatly affected the development of certain of the tributary streams (Perkins, Copper, and Allen Creeks), and retarded their corrosion, with the formation of swamps, if not lakes, along Perkins and Copper Creeks.

The western side of the valley was eroded further north by the development of the Deep Creek drainage system, which caused the formation of the northern scarp of the plateau.

The erosion by the main stream caused it eventually to become established in the tract occupied by the thick dolomite beds. These rocks, being readily eroded, resulted in the establishment of the wide and open valley the floor of which is now represented by the Duck River plain. Up till this time, and probably later, the main stream referred to above was probably the Arthur River, which in its lower course flowed through what is now the valley of the Duck River. There is direct evidence of this in—

(*a*) The extension of the Duck River plain south to the Arthur River, whereas the present drainage of the Duck River does not extend that far, the southern part being drained by the headwaters of the

Montagu River. Also it is stated that the nearest waters of the Duck River are only 30 feet above those of the Arthur River.

(*b*) Blackfish (*Gadopsis marmoratus*) were, with one exception, only found in the southern rivers of Victoria and the northern ones of Tasmania, or, in other words, in those streams entering Bass Strait. The one exception was the Arthur River, which now enters the sea on the west coast.

The above alteration of drainage was brought about by the headward erosion of a stream now forming the lower part of the Arthur River, which eventually resulted in the capture of the upper part of the Arthur River, and left the lower part of the Arthur River to form the present Duck River.

A small subsidence of the land caused the sea to enter the lower portions of the valleys of Duck River and Deep Creek. Sands were deposited in these estuaries, and later the conditions were altered, and freshwater clays, peats, and marls were formed. This was probably accompanied by rising of the land, and the Duck River established itself on the eastern side of the broad valley. The sands, peats, &c., thus became drained, and formed the Duck River plain, in which the river is entrenched to a maximum depth of 20 feet.

V.—ECONOMIC GEOLOGY.

(1)—Introduction.

The Smithton district is not generally regarded as a mining district, because no deposits of metallic minerals of commercial importance have so far been discovered. The recent survey has, however, revealed the presence of extensive deposits of high-grade dolomite, and also deposits of limestone, so that the district has possibilities of becoming a non-metallic mining district.

(2)—Metallic Minerals.

The metallic mineral deposits of Tasmania are generally present in regions in which granites and porphyries of Devonian age intrude Lower Palæozoic (Cambro-Ordovician and Silurian) rocks. The Lower Palæozoic rocks occur in the district, but granite and/or porphyry do not outcrop nearer than the North Pieman (Balfour) district (45 miles), Waratah district (45 miles), and Hunter Island (35 miles). Thus the general absence of ore-deposits is explainable by the lack of outcropping granites or porphyries and the distance from such rocks. This does not, however, preclude the possibility of the granite existing at depth without actually outcropping. If the granite occurs at reasonable depth, there should be some evidence of mineralisation within the district. The only evidence of mineralisation is that of the few quartz veins that occur. These veins generally contain epidote, or chlorite, and occur in the dolerite or the intruded slates, &c., in close proximity thereto, and the association indicates that these veins are related to the dolerite intrusion. On Meaney's Hill one vein occurs at the junction of the dolerite and intruded slates.

Small flakes of native copper occur in the dolerite at Smithton, and also in the similar rock which occurs at West Montagu. The flakes are small in size, and do not exceed one-sixteenth of an inch. They do not occur on joint planes, but in the body of the rock, and may therefore be one of the original mineral constituents of the rock. Specimens of dolerite containing the copper are comparatively rare, and the copper-bearing rock is not in sufficient quantity to render it important. Further, when copper-bearing, the grade is too low to make the rock such that it could be profitably treated. This deposit is connected with the dolerite, and is therefore not indicative of mineralisation associated with the granitic intrusions.

It is only to be expected that as the granite areas are approached, evidence of mineralisation will be found. Thus in the vicinity of Gorgey Creek and Gibson Plains, some 12 miles south-south-east of Smithton, veins of quartz, with (in some cases) pyrite, occur at a number of places. In Gorgey Creek another vein consists of siderite, galena, pyrite, and sphalerite, being typical of the silver-lead deposits of Tasmania. The prospects of finding metallic mineral deposits are therefore better to the south of the Smithton district rather than in the district itself.

(3)—Non-Metallic Mineral Deposits.

The non-metallic mineral deposits include lignite, limestone, and dolomite. The lignite has little or no commercial importance. The limestone has been quarried for agricultural purposes, and also burned for lime on a small scale. The dolomite was not generally recognised as such before the recent geological survey, nor was its importance realised.

A.—Brown Coal, or Lignite.

Brown coal, or lignite, exists in two localities in the district, and these are described below under separate headings.

(i) Myrtle Hill.

This occurrence is situated on Myrtle Hill, 50 chains south-east of Irishtown, in 194 acres 3 roods 1 perch of land purchased by R. W. John, and a block of 30 acres and 34 perches alienated to A. Wood.

A motor-road is constructed from the railway at Irishtown, and passes through the area at a point 10 chains south of the coal outcrops. An unmetalled road connects with the former, and runs north to within a few chains of the occurrence.

Brown coal of Tertiary age is here exposed in the steep heads of two small creeks running northerly to join Serpentine Creek.

The coal or lignite is brittle, and bright and shining in appearance, with a nearly black colour. In places wood structure is discernible, and after breaking the coal disintegrates rapidly.

The following is an analysis of a sample of the best-looking material:—

Constituents.	Reg. No. 1585. Samp. No. S.140.
	Per Cent.
Moisture	9·90
Volatile combustible matter	51·00
Fixed carbon	29·90
Ash	9·20
Sulphur	3·61

Only one seam is visible, and the coal, which is level bedded, appears to be about 3 feet in thickness. Loose blocks of quartzite are at surface in the vicinity of the seam, and it seems probable that the coal is interbedded with the quartzite. On the hillside, above and below the outcrop of lignite, basalt appears, and this suggests that the coal and quartzite were laid down between two flows of basalt. The overlying basalt constitutes an overburden of 100 feet or more.

A little prospecting work has been carried out on the lignite, and the remains of three small adits are visible. These could not be examined owing to the headings having caved in.

The quality of the deposit, from a brown coal standpoint, is good, but it is of little or no commercial importance. To be of economic value such a brown coal should be of great thickness and have no overburden. These two conditions are not fulfilled in the present instance. Moreover, it is probable that the above analysis represents a composition that would not be approached if an average sample of the seam could be taken.

(ii) Edith Creek.

Brown coal is again exposed in the upper portion of Edith Creek valley, on 138 acres and 29 perches of land purchased by B. L. Leech.

Access is gained by means of the Lileah-road from Irishtown as far as Lileah School, a distance of 4½ miles. From the latter a by-road, metalled for the most part, leads in a south-easterly direction to Edith Creek, a quarter of a mile above the outcrop.

Two level seams of coal are outcropping in the creek-bed, with 10 feet of fine conglomerate separating them. The upper seam, where exposed, has probably been denuded by the stream, and now a thickness of not more than 1 foot can be seen. The lower seam is from 2 to 3 feet thick, and is underlain by blue clay and quartzite. The whole of the sediments associated with the coal are bedded between two flows of basalt. The coal is very similar in character to that at Myrtle Hill. In places it has a lignitic structure, while altered leaves, sticks, and tree-trunks can be recognised.

Similar economic factors deprive this coal from being of importance as those applied to the Myrtle Hill coal.

B.—Limestone.

Limestone occurs at several places within the Smithton district. Three types are also present which differ considerably from each other in appearance, nature, and origin. The types are:—

(i) The tufaceous and marly deposits of Pulbeena.

(ii) The dense bluish-grey limestone of Lower Scotchtown-road and the Duck River, near Smithton.

(iii) The brownish limestone from the mound deposits near Marthick Siding.

These deposits will be described separately below.

(i) Pulbeena.

The Pulbeena deposit occurs on the 198-acre soldier settler's block leased to A. B. Fenton, immediately north of Pulbeena Station. The limestone occurs at and immediately beneath the surface to a depth of at least 5 feet. It has been exposed in a shallow excavation, from which a quantity was removed for agricultural purposes, and in many of the drains in the vicinity.

Part of the deposit, especially that within 2 feet of the surface, is of a cellular nature, and represents replacements and casts of leaves, twigs, moss, grass, &c. The material at a greater depth is more friable and of a marly nature. Both types, and particularly the marl, contain numerous small freshwater shells.

Recent drains have given good exposures of the limestone, and also show that it occurs in thin layers, interbedded with a black peat or peaty soil. In general, the layers do not exceed 1 foot in thickness. In Fenton's excavation the limestone is apparently 3 to 4 feet in thickness, but at a distance of less than 2 chains it is found to be interbedded with peat.

From the occurrence it is obvious that the limestone and peat were formed in freshwater ponds, lagoons, swamps, &c., which may have been partly fed from the warm springs of the neighbourhood.

These conditions probably existed over several hundred acres in the vicinity of Pulbeena, but the limestone does not appear to have been formed throughout this area. So far as the excavations, drains, &c., show, the limestone occurs along a length of some 15 chains on the eastern side of the railway. The width is not known.

The quality of the limestone is shown by the analyses of Samples I., II., and III. in Table No. 12. It is to be observed that the limestone is of fairly high grade, and contains approximately 94 per cent. calcium carbonate and 3 per cent. magnesium carbonate.

The quantity available could not be estimated without a considerable amount of shaft-sinking or boring. The thin beds of limestone and peat, of which individual beds would probably not continue over any great distance, would render this testing necessary. Generally speaking, there is probably sufficient to supply a small, but not a large, demand.

As regards working facilities, the material is soft and near the surface, and could therefore be easily and cheaply obtained. Much would depend, however, as to whether the peat would have to be rejected. If it contains any desirable properties from the agricultural viewpoint, it could possibly be left with the limestone for treating the land.

The deposit is alongside the railway and close to a road, so that there would be no transport difficulties.

(ii) Lower Scotchtown.

This deposit is situated on the land blocks charted in the name of Peter Smith (315 acres) and James Lawrie (53 acres 3 roods), which are situated on the east side of Duck River, some 3 miles south of Smithton. Access is gained by the Lower Scotchtown-road, which branches off the Scotchtown (or Trowutta) road, 1½ miles south of Smithton.

The limestone is a hard, dense, dark-blue type. The strata have a general northerly strike, and dip westerly at 45 degrees. It occurs as a bed in the Dundas series of slates, &c. The width of the bed is not definitely known, but the quarry proves it to be a chain at least. The overlying slates on the western side are exposed in the excavation for the kiln. Slates underlie the limestone on the eastern side, but the junction cannot be definitely determined. The limestone may be anything up to 5 chains in width.

The limestone has been opened by a quarry some 5 or 6 chains east of the road. The quarry is at the foot of the south side of a low hill, and the limestone can be traced by outcrops across the summit of the hill for a distance of 5 to 10 chains. The only other locality where this bed has been exposed is in the Duck River, immediately west of Smithton.

The quantity can, in view of the above, be regarded as sufficient to supply the requirements of the Smithton district for many years.

The quality of the limestone is shown by the analyses of Samples IV. and VI. in Table No. 12, the former being of a small typical piece, and the latter a representative sample across 12 feet. The latter proves the limestone to be of very high grade, with 96 per cent. calcium carbonate and 0·6 per cent. of magnesium carbonate. Sample V., from Duck River, near Smithton, represents the northern extension.

The facilities for working are good, and quarries could be opened up on the hill. The present quarry is at the same level as the kiln, and for economical working it would be advisable to open a quarry at a higher level, so that the floor is slightly above the level of the top of the kiln.

As regards transport, the deposit is close to the Lower Scotchtown-road, which connects with the township and railway-station of Smithton in a distance of 3 miles.

The same bed outcrops on the south bank of the Duck River, about 20 chains west of the bridge. There are only two small outcrops, and the conditions are generally unsuitable for easy working, so that it need not be further considered.

(iii) Marthick Siding.

This deposit occurs along the eastern side of Perkins Creek, to the north-west of Marthick Siding. This siding is 2 miles south-east of Smithton, and can also be reached by a cross-road off the Irishtown-road.

The limestone is a hard, slightly cellular, brownish type, the colour being due to oxide of iron. The deposit has been formed chiefly as mounds built up by springs, and now represents a deposit with an undulating surface. This thickness is 10 to 12 feet, and the area approximately 5 acres. The quantity is therefore small, but would be sufficient to supply the requirements of the Smithton district for a number of years.

The quality is shown by the analyses of Sample VII. in Table No. 12. It is not of high grade, the calcium carbonate content being approximately 92 per cent., the magnesium carbonate being approximately 3 per cent., and ferric oxide 4·28 per cent.

The deposit is immediately below the surface, and so could be broken in open quarries, probably without any water trouble.

It is well situated as regards transport, being alongside the railway and near Marthick's-road, which, however, is not a first-class one.

(iv) Conclusions.

The three limestone deposits differ in many respects. From the point of view of quality, the Scotchtown is the best deposit, followed by the Pulbeena and Marthick deposits in that order (in the Pulbeena deposit the fact that the peaty layers would have to be sorted out rather detracts from its quality).

As regards quantity, the Scotchtown is the best, and the others are, to all intents, equal.

From the viewpoint of transport, the three are well situated as regards proximity to roads, but the Scotchtown deposit is 3 miles from a railway, while the others are alongside the railway and close to sidings.

In considering working facilities, it will be observed from the above descriptions that the Pulbeena and Marthick deposits would have to be excavated by shallow quarries below the surface of generally flat land (with possible troubles from water draining into the excavations), while the Scotchtown deposit could be quarried by faces carried into the hill, with a maximum height of 100 feet.

From the point of view of the material, the Pulbeena is the softest and the easiest to work, while the Scotchtown is the hardest, and would be the most costly to break.

If desired, the Scotchtown and Marthick limestones could be " burnt " in kilns, but the nature of the material would not permit of this being done with the marly limestone at Pulbeena. On the other hand, the Pulbeena limestone would be more easily crushed (the marly portion would probably be sufficiently fine after being broken in the quarry) than the harder Scotchtown and Marthick material. The possible use of the peaty material mixed with the limestone is a point that the Agricultural Department might investigate if deemed advisable.

Viewing the deposits generally, it would appear that it would probably be preferable to develop the Scotchtown deposits, in spite of the slightly higher cost of quarrying and (possibly) of transport of the material. The limestone would be suitable for agricultural purposes, burning for lime, or for manufacture of cement, carbide, &c. For agricultural purposes it would either have to be crushed or burned.

Small quantities have been burnt in a small kiln adjacent to the quarry. The lime produced has probably been used both for agricultural and structural purposes.

The Pulbeena deposit could be used only for agricultural purposes. The marly part could probably be quarried and spread on the land without further crushing. The harder parts would either have to be crushed or burned. Small quantities of the marl have already been used for putting on the land.

Table No. 12.

Analyses of Smithton Limestone.

(Expressed as Percentages.)

Constituents.	I.	II.	III.	IV.	V.	VI.	VII.
	S.109.	S.109.	S 109	S.120.	S.32.	S.32.	S.13.
	1579.	1269.	1270.	1996.	1805.	1300.	1578.
Silica	0·48	0·88	0·84	0·52	1·08	0·76	0·60
Ferrous oxide / Ferric oxide	0·56	0·44	0·52	0·56	1·38	0·31	4·28
Alumina	0·24	....	....	0·36	0·22	0·38	0·52
Magnesia	1·72	1·35	1·51	0·50	7·53	0·29	1·42
Lime	53·76	52·59	52·39	54·23	46·40	53·85	51·68
Carbon dioxide and loss	43·70	44·90	44·72	43·30	44·12	44·11	42·00
Titanium dioxide	....	....	....	Trace	Trace	....	....
Sulphur	....	....	....	0·068	0·11	....	....
Phosphorus pentoxide	Trace	....	....	0·068	0·077	....	0·08
		100·16	99·88	99·606	100·917	99·70	100·58

Sample.

I. Typical sample: tufaceous limestone. Pulbeena.
II. Representative sample: tufaceous limestone. Fenton's quarry, Pulbeena.
III. Representative sample: marly limestone. Fenton's quarry, Pulbeena.
IV. Typical sample: limestone. Lower Scotchtown-road.
V. Typical sample: limestone. Duck River, Smithton. (Partly dolomitised.)
VI. Representative sample across 12 feet in quarry. Lower Scotchtown-road.
VII. Typical sample: brown limestone. Near Marthick Siding.

C.—Dolomite.

(i) Introduction.

The systematic geological survey of the Smithton district during 1929 and 1930 resulted in the discovery of extensive areas of dolomite or dolomitic limestone. Except for the mixed deposit of dolomite and magnesite at the Victory Mine, Arthur River, this discovery represented the first one of dolomite deposits of commercial importance within the State.

In addition to the above survey, reconnaissance trips were made to the west and east of Smithton. These revealed other deposits of dolomite at Montagu River to the west and Black River to the east, which were not, however, examined in detail. The dolomite therefore appears to occur at a number of localities in the far north-west coastal districts. Reference will be made to all the known occurrences in the following descriptions.

(ii) Composition and Uses of Dolomite.

Dolomite is a mineral composed of carbonates of calcium and magnesium in equal molecular proportions, the formula being $CaCO_3 \, . \, MgCO_3$, and the theoretical composition being $CaCO_3$, 54·35 per cent., and $MgCO_3$, 45·65 per cent. Varieties occur in which the ratio of the carbonates differs from the 1 : 1 ratio.

It is used for a number of purposes mainly for its magnesium content, and has in recent years largely replaced magnesite for such purposes. It is also used for its carbonate content.

The principal uses are—

(1) Manufacture of carbon dioxide.

(2) Flux in the iron-smelting industry.

(3) Refractory. It is used in the dead burned form for refractory purposes, for which it is made into furnace linings and hearths, refractory brick, shapes, and crucibles.

(4) In the sulphite process for the manufacture of paper.

(5) Production of basic or technical carbonate. This product is a crude carbonate used for a filler for rubber, paint, and paper, and mixed with asbestos for pipe and boiler coverings.

(6) Magnesium salts. These include precipitated carbonate, epsom salt, &c. They are used as chemical reagents and for medicinal and toilet preparations, &c.

(7) Manufacture of metallic magnesium. Dolomite has been used for this purpose, but the present tendency appears to be to use other raw material.

(iii) Geology of the Dolomite.

The dolomites of the north-western districts occur as sedimentary beds interbedded with the Dundas series of Cambro-Ordovician rocks. They were originally formed as beds of limestones, which were later converted into dolomitic limestones or dolomites by replacement of part of the calcium by magnesium. The analyses given in Tables Nos. 7 and 13 prove that the conversion into dolomite was practically complete.

The analyses also prove that the limestone and the dolomite were nearly free of impurities, the percentages of silica, ferric oxide, and alumina being very small.

The dolomite occurs in two main types, viz. :—

(*a*) Fine-grained type. This type is light-grey to dirty-white in colour and very fine-grained. It is usually thinly bedded, with numerous joints at right angles to the bedding-planes, which causes it to break in rectangular pieces.

(*b*) Coarse-grained type. This type is usually white in colour, with sometimes a greyish tinge. It is more thickly bedded than the fine-grained type. The crystals range up to one-sixteenth of an inch in size. This type has evidently been produced by recrystallisation, and has probably been derived from the fine-grained type.

The dolomite is in places traversed by narrow white veins of calcite and dolomite. When the veins are of calcite, and are included in samples, they increase the calcium content, and thus cause the sample to depart from the theoretical composition of dolomite.

At Nabageena the dolomite contains irregular veins and patches of cherty quartz, while at Irishtown quartz veins and impregnations are common in parts of the dolomite. The Duck River dolomite is free from silification, except an occasional large quartz vein.

(iv) Geological Relations Between the Dolomite in the Different Districts.

The dolomite in the Smithton or Duck River district represents a very thick series of beds, with a westerly dip of 40 degrees. The width across the outcrop is 220 chains, and the thickness is therefore 140 chains, or 9000 feet.

The Irishtown dolomite represents another bed, some 5000 feet lower stratigraphically than the Duck River beds.

The Nabageena dolomite consists of thin beds only, and may possibly represent the southerly continuation of the Irishtown, with a thinning out in the direction of Nabageena.

The Montagu River dolomite occurs in flat, sandy country, and very little information could be obtained about it during a reconnaissance survey. However, in view of the knowledge of the geology of the country between Smithton and the Montagu River, it would appear that the two dolomites are parts of the one series of beds, being, in fact, on opposite limbs of a synclinal fold (the Smithton dolomite being on the eastern limb, which dips to the west, and that at Montagu being on the western limb, which probably dips to the east).

The Black River dolomite occurs under similar conditions to the Montagu River rock, and little is known of its geological relationships. However, it is similar to the rock at Smithton and Montagu River, and may be part of the same bed, being exposed on, perhaps, the opposite limb of an anticlinal fold to that at Smithton, or more likely as a result of faulting. It is also possible that it is a different bed, situated much lower stratigraphically than the other beds.

(v) Relative Importance of the Districts.

The relative importance of the dolomite in the different districts, from the viewpoint of its commercial exploitation, depends upon a number of factors, including size of deposit, quality, proximity to transport facilities, suitability for easy and cheap means of extraction, &c.

(*a*) *Size of Deposit.*—As far as is known, the Smithton deposit occupies the largest area, while the Montagu River and Black River deposits might prove to be of similar dimensions if detailed surveys were made of them. The Irishtown deposit is smaller than the Smithton, but sufficiently large to be exploited. The Nabageena one is too small to be considered of importance.

(*b*) *Quality.*—This is a factor to be determined in the favourable deposits after the other factors have eliminated the unfavourable deposits. It will therefore be considered later in the case of the more favourable deposits.

(*c*) *Transport Facilities.*—The railways (Smithton-Irishtown, and Irishtown-Trowutta) traverse, or are in close proximity to, the Smithton deposits, while numerous roads also serve the district. The Irishtown-Wiltshire line traverses the Irishtown deposit.

The Montagu River deposit is connected by road (16 miles in length) with Smithton, which is the nearest railway-station.

The Wiltshire-Burnie railway and the main-road to Burnie traverse the Black River deposit.

Of the above, it will be realised that the Montagu River deposit is the least favourably situated as regards transport facilities. The remainder are well served by rail and road.

(*d*) *Working Facilities.*—The deposits at Duck River, Montagu River, and Black River occur under similar conditions, viz., in plain-like tracts of country forming parts of the valleys of the respective streams after which they are named. This similarity is not accidental, but is the result of geological processes, in that these streams have formed their valleys in the dolomite, which is more easily corroded than the adjacent rocks (slates, breccias, &c.). The similarity extends further, in that the plains are, for the most part, covered by small thicknesses of sands (representing sand deposited by the sea during recent flooding of the valleys).

The outcrops of dolomite are not numerous, and it is exceptional to find it occurring in low hills rising above the level of the plains.

In the Irishtown deposits the conditions are somewhat different, and the dolomite does form low hills, and there is alluvium instead of sand on the plains.

Thus the conditions for quarrying are generally not very suitable, and sub-surface quarries would have to be opened up.

(*e*) *Development.*—In the Montagu River and Black River districts the dolomite is represented by outcrops only. This applies also to the Irishtown deposit, except that rail and road cuttings have further exposed it.

In the Duck River deposit, rail and road cuttings have exposed it, but it has also opened up in numerous quarries for road-metal. These afforded opportunities for sampling the dolomite, and also represent suitable places for opening up sub-surface quarries. The locations are shown in the geological maps at the end of this report.

(*f*) *Conclusions.*—From the above considerations of size, transport, and working facilities, and development, it is evident that the Duck River deposit is the most suitable deposit, while the Irishtown deposit, though smaller, is also worthy of being considered. These deposits were sampled, and their quality and other factors will be discussed below.

(vi) Sampling and Results Thereof.

The Duck River dolomite has been opened up in numerous small quarries from which the rock was taken for roadmaking. These are restricted chiefly to the vicinity of the Duck River, where the denudation of the sand has exposed the underlying dolomite. The one exception is at Edith Creek, where the dolomite forms a low hill, and has been opened up by a quarry and railway-cuttings. The quarries offer good facilities for sampling, except where filled with water or overgrown with vegetation.

Representative samples were taken at Blackwood Bridge (Nos. 1 to 5), near junction of Duck River and Mowbray Creek (Nos. 11 and 12), half a mile south of latter (No. 13 sample), and near Edith Creek Quarry (Nos. 9 and 10) and railway-cutting (Nos. 6 to 8). One grab sample (No. 15) was taken from the quarry at Watson's Bend.

In the Irishtown district the only place suitable for sampling was the railway-cutting from which No. 14 sample was taken.

The representative samples will give the composition of the dolomite as closely as it can be obtained. It must be remembered, however, that all quarries and cuttings are shallow, and so samples are taken near the surface. Under such conditions the joints in the rocks contain more soil which has moved downwards from the surface, and more oxides of iron, than would be the case at greater depths. In most samples the joints were therefore avoided as far as possible, and in such cases the analyses will reveal a rock slightly better in quality than will be obtained by actual quarrying. On the other hand, when jointed material has been included, the analyses will more truly represent the quality at shallow depths, but will indicate a rock slightly more impure than will be obtained at greater depths. The actual conditions will be indicated in the following list:—

Sample No.

1. Across 20 feet of the north-west face in western quarry, west of Blackwood Bridge. Sample of clean dolomite only. Crystalline type.
2. Across 30 feet over total width of 60 feet. North face of northern quarry, west of Blackwood Bridge. Sample of clean dolomite only. Crystalline type, partly weathered in places.

Sample
No.

3. Picked from 10 feet x 10 feet x 3 feet heap of dolomite obtained from shallow pits, West of Blackwood Bridge. Clean material only. Crystalline type (some soft, due to weathering).
4. Picked from 10 feet x 25 feet x 3 feet heap of dolomite obtained from shallow pits, west of Blackwood Bridge. Clean material only. Crystalline type (some soft, due to weathering).
5. Picked from 10 feet x 25 feet x 3 feet heap of dolomite obtained from shallow pits, west of Blackwood Bridge. Clean material only. Crystalline type (some soft, due to weathering).
6. Railway-cutting, north of Edith Creek, 10 feet vertical sample. Iron stains on joint-planes. Fine-grained type.
7. Three chains north of No. 6. Across 10 to 12 feet. Iron-stained on joint-planes. Fine-grained type.
8. Half a chain north of No. 7. Across 6 feet. Iron stains on joint-planes. Fine-grained type.
9. Quarry at intersection of road and railway, north of Edith Creek. Across 12 feet at west side. Jointed, weathered, and stained material. Fine-grained type.
10. Quarry at intersection of road and railway, north of Edith Creek. Across 8 feet at east side. Jointed, weathered, and stained material. Fine-grained type.
11. Quarry near Junction of Duck River and Mowbray Creek. Across 12 feet on east side. Fine-grained type, with oolitic band. Clean material.
12. Quarry near Junction of Duck River and Mowbray Creek. Across 10 feet on west side. Fine-grained type, with oolitic band. Clean material.
13. Quarry 30 chains south-west of Nos. 11 and 12. Across 10 feet. Fine-grained. Fairly clean material.

Sample No.

14. Cutting, Wiltshire-Irishtown railway, 20 chains east of Smithton-Irishtown road. Across 200 feet. Chiefly fine-grained type. Jointed and stained.
15. Grab sample. Watson's Bend. Crystalline type.

The positions and lengths of samples, the nature of the dolomite (crystallised or fine-grained), and the nature of the sample (clean, iron-stained, &c.) are given. It will be noted that Nos. 1 to 5 and No. 15 are of crystalline dolomite, and the remainder fine-grained dolomite.

Total analyses were carried out on the samples, and the results are given in Table No. 13. In addition each sample was calcined, the percentage of calcine being determined and a partial analysis made of same.

It will be noted that the best samples, i.e., those which give the highest contents of lime and magnesia and the lowest content of impurities (such as silica, alumina, and oxides of iron), are Nos. 1 to 5 and No. 15. These are all of the crystalline type, which, therefore, apparently form the purest material. Further, Nos. 1 to 5 are all from the quarries west of Blackwood Bridge.

The lime ranges from 28·00 to 31·60 per cent., and the magnesia (excepting No. 11) from 19·20 to 22·22 per cent. The silica ranges up to 6·64 per cent., the ferric oxide up to 0·76 per cent., the ferrous oxide up to 1·26 per cent., and the alumina (excepting No. 11, the content of which is 8·24) from 0·36 to 3·86 per cent. Arsenic is absent or present as a minute trace only. Phosphate (P_2O_5) ranges from a trace up to 0·10 per cent., and is soluble in hydrochloric acid. Carbon, i.e., carbon apart from that in the carbonate, ranges up to 0·65 per cent. In the samples determined, the sulphate was present to the extent of a trace only.

On testing the percentages of lime, magnesia, and carbon dioxide in the analyses it is found that there is a deficiency of carbon dioxide compared with that necessary to satisfy the lime and magnesia, or, conversely, an excess of lime and magnesia. This is due, at least partly, to the difficulty of analyses of high-grade dolomite, as far as obtaining a correct balance of the above constituents is concerned, when the carbon dioxide is determined by heating of the dolomite because a small proportion of the carbon dioxide remains in the calcined material. It is possible, but not likely, that some of the magnesium may be present as silicates.

Table No. 13.

Analyses of Dolomite Samples.
(Expressed as Percentages.)

Sample No.	Reg. No.	Raw Dolomite.											Calcined Dolomite.			
		SiO_2	FeO and Fe_2O_3		Al_2O_3	CaO	MgO	As	P_2O_5	C	CO_2 By Ign. Loss.	SO_3	Cal-cines.	SiO_2	CaO	MgO
1	1819	0.08	0.24*		0.36	31.12	21.48	M.T.	T.	0.02	46.73	T.T.	52.74	0.16	58.50	40.44
2	1820	0.20	0.24*		0.48	31.22	21.64	M.T.	T.	0.156	46.14	T.	52.72	0.06	58.34	41.53
3	1821	0.12	0.12*		0.36	31.32	21.50	M.T.	T.	0.032	46.68	T.	52.73	0.06	58.34	41.06
4	1822	0.08	0.12*		0.48	31.22	21.56	T.	T.	0.028	46.64	T.	52.78	0.06	58.21	41.52
			Fe_2O_3	FeO												
5	1823	0.08	0.08	N.D.	0.40	31.60	22.22	M.T.	T.	0.03	46.84	N.D.	52.85	‡0.04	58.03	40.74
6	1824	4.60	0.37	0.84	3.18	28.70	19.72	Nil	0.029	0.20	43.60	N.D.	56.37	‡9.63	49.80	36.13
7	1825	4.88	0.44	0.78	3.06	28.30	19.76	Nil	0.03	0.25	43.31	N.D.	56.36	‡10.16	51.00	34.84
8	1826	4.80	0.47	0.87	3.56	28.64	19.32	Nil	0.03	0.25	43.35	N.D.	56.40	‡9.22	49.60	36.09
9	1827	3.80	0.29	0.74	3.38	28.40	20.36	Nil	0.028	0.35	43.73	N.D.	56.31	‡9.10	48.99	37.05
10	1828	5.08	0.35	0.71	3.86	28.00	19.20	Nil	0.035	0.25	43.63	N.D.	57.13	‡11.26	48.18	35.92
11	1829†	6.64	0.76	1.26	8.24	28.20	14.62	Nil	0.054	0.65	40.75	N.D.	58.61	‡14.86	46.33	29.79
12	1830	2.12	0.71	1.03	3.54	29.80	19.40	Nil	0.04	0.35	44.73	N.D.	54.93	‡5.86	52.96	36.34
13	1831	5.52	0.40	0.94	3.68	28.00	19.98	Nil	0.03	0.40	42.48	N.D.	57.16	‡12.12	47.54	35.50
14	1832	3.28	0.15	0.38	0.42	30.40	21.56	Nil	0.06	0.05	44.83	N.D.§	54.79	‡7.28	54.00	37.33
15	1833	0.52	0.65	0.71	0.56	31.20	21.36	Nil	0.10	0.14	46.46	N.D.	53.35	‡1.02	57.42	38.77

Phosphate is soluble in hydrochloric acid. Oxides of iron in Nos. 1 to 5 soluble in hydrochloric acid, and in Nos. 6 to 15 probably a small proportion is insoluble in hydrochloric acid.

* Estimated that the oxides of iron contain approximately 65 per cent. Fe_2O_3

† TiO_2 — 0.20.

‡ Insoluble.

§ Contains a trace of iron pyrite.

(vii) Insoluble Portion of Dolomite.

It will be noted from the analyses of the raw dolomite in Table No. 13 that the dolomite contains insolubles such as silica and alumina (in part). It will also be noted that, when a comparison is made between the figure obtained by calculating the silica in the calcined dolomite from that in the raw, and the insoluble determined by analysis of the calcined, the silica makes up practically all of the insoluble. The remainder of the insoluble will be alumina; but it is to be noted that the greater part of the alumina is acid soluble. These points are illustrated by the following figures, derived by calculation from the analyses in Table No. 13:—

Sample Number.	Calculated Silica in Calcines.	Reported Insolubles.	Difference between Columns 2 and 3.	Calculated Alumina in Calcines.
6	8·61	9·63	1·02	5·65
7	8·61	10·16	1·55	5·43
8	8·47	9·22	0·75	6·31
9	6·75	9·10	2·35	6·00
10	9·01	11·26	2·25	6·76
11	11·20	14·86	3·66	14·06
12	3·83	5·86	2·02	6·44
13	9·52	12·12	2·60	6·46
14	5·94	7·28	1·34	0·77

It is to be observed that in all samples, except No. 14, the alumina in the insolubles from the calcines is only a fraction (ranging from 0·12 to 0·40) of the total alumina in the calcines. It is apparent, therefore, that the proportion of soluble alumina ranges from 88 to 60 per cent. of the whole. In the case of No. 14 it will be noted that the difference is greater than the alumina present, so that apparently all the alumina enters the insoluble.

In order to obtain further information about the insolubles, a composite sample was made from Nos. 6 to 13 samples, and a complete analysis made in the Mines Department laboratory, the results of which are given in Table No. 14 below.

TABLE No. 14.

Analysis of Insolubles from Composite Sample of Dolomite.

Constituents.	Per Cent.
SiO_2	82·60
Fe_2O_3	0·21
Al_2O_3	11·92
TiO_2	0·81
CaO	Trace
MgO	0·25
K_2O	4·59
Na_2O	0·26
	100·64

Thus the insolubles consist almost entirely of silica (82·6 per cent.), alumina (11·92 per cent.), and potash (4·59 per cent.). The percentage of insoluble was not determined, but, calculating from the average content (10·32 per cent.) of insoluble in the calcines and the average yield (56·66 per cent.) of calcines, the figure is 5·84 per cent. The average contents of silica and alumina in the composite sample are 4·68 and 4·06 per cent. respectively. Thus silica (4·68 per cent.) forms the greater part of the insoluble, and of the total alumina in the composite sample (4·06 per cent.) not more than 1·16 per cent. is insoluble, which represents 28·6 per cent. of the total alumina.

It is noteworthy that the analysis in Table No. 14 proves that the dolomite does not contain any insoluble calcium silicates.

A microscopic examination of the insoluble material does not give much information, as it is in the form of extremely fine powder. A few small grains of quartz stand out from the powder, and are easily recognised. The powder, for the most part, resembles quartz, but it was impossible to determine if any other mineral was present.

The analysis suggests a mixture of quartz and probably a potassium aluminium silicate. The ratio of $K_2O : Al_2O_3$ is 1 : 2·4, but with soda included the ratio $(K, Na)_2O : Al_2O_3$ is 1 : 2·2. If there is only one potassium mineral or one aluminium silicate present, it is difficult to suggest what it might be. The ratio is somewhat low for muscovite, and, further, no micaceous mineral was detected under the microscope, although it might be of the nature of pinite. The ratio is too small for the felspars, leucite, &c. It would therefore appear that the potassium and aluminium are present in more than one mineral, or possibly in fragments of potassium-bearing igneous rocks of acid to intermediate composition.

When it is considered that some alumina dissolves when most silicates are treated with acid, it will be realised that the above ratio will be decreased to 1 : 3, or even less. This would exclude the possibility of the potassium and aluminium occurring in one mineral, and tend to prove a mixture of two or more minerals or fragments of rocks.

(viii) Conclusions.

The geological surveys and reconnaissance trips have shown the existence of dolomite in several districts on the far north-west coasts. From a consideration of extent, transport facilities, development of the deposists, &c., it is recommended that the deposists of Duck River plain and of Irishtown at present offer the best opportunities for exploitation of same. These deposits were sampled in order to determine the quality of the dolomite in them. The main result of the sampling is that the crystalline type of dolomite is the purest material, in that it contains less impurities. It is the impurities that really determine the quality, as all the samples (except No. 11) contain the lime and magnesia in the approximately correct proportions for dolomite, and the material therefore consists of dolomite, with more or less impurities.

The area of crystalline dolomite sampled was that including the small quarries west of the Blackwood Bridge, over the Duck River, on the Broadmeadows-road. There are no other areas of crystalline dolomite as well opened up as this one, nor are there any in the Smithton district with better transport facilities. This area is adjacent to the Broadmeadows-road, and is 1¾ miles from the Smithton railway-station, or 2 miles from the township. The dolomite outcrops over approximately 7 acres, and beyond this it is covered with several feet of sand. Sub-surface quarrying would have to be resorted to.

Of the other areas the sampling indicates that the Irishtown deposit is of fairly good grade, with magnesia content of 21·56 per cent. and silica 3·28 per cent. The sampling was carried out in the railway-cutting, and no outcrops occur in the immediate vicinity, the dolomite being covered by soil, alluvium, &c. Sub-surface quarrying would have to be carried out.

The Edith Creek area has a magnesia content of 19·20 to 20·36 per cent., while the silica ranges from 3·80 to 5·08 per cent., and the alumina from 3·06 to 3·86 per cent. The conditions here are suitable for quarrying, and approximately 15 acres would be the maximum that could be so quarried.

The poor quality of No. 11 sample is against the exploitation of the Lower Scotchtown-road area, though better grade material exists, as is evident from sample No. 12. Sample No. 13 is high in silica, but also comparatively high in magnesia. The transport facilities are not so good as in the other areas.

Generally, therefore, it would appear that the Blackwood Bridge area is the one which should be investigated first with a view to exploitation. The dolomite is of good quality; the extent is sufficient for all purposes; it is within 2 miles of a railway-station, with which it is connected by a good motor-road; it is close to the Duck River, from which a supply of water is obtainable (it would, however, have to be treated if being used in preparation of chemicals, &c.); it is close to a settlement (Smithton) where labour is available; and it is within 2 miles of the electric power connected to Smithton.

(ix) Quantities

The selection of the Blackwood Bridge area, and, to a less extent, the Irishtown area, as suitable localities in which the dolomite could be exploited necessitates that information should be given as to the quantities.

(*a*) *Smithton or Duck River Deposit.*—As far as the evidence shows, this deposit forms the bedrock of the whole of Duck River plain. The most continuous outcrops are along the Duck River, and these prove its existence over a length of approximately 5 miles, from near Smithton in the north to Edith Creek in the south. The northern continuation is obscured by the sand, alluvium, &c., while no attempt was made to trace the continuation to the south.

The eastern boundary of the dolomite is formed by the slates, breccias, and limestone which underlie it, this boundary being approximately along or east of the general line of the Duck River.

To the west the dolomite occurs on the Duck River plain, but outcrops are not numerous, due to the thin covering of sand and, on the Mowbray Swamp, of peat, marls, &c. The outcrops, exposures in drains, &c., however, prove that the dolomite occurs over a width of 220 chains. Taking into consideration the westerly dip of 40 degrees, the total thickness of the beds is 140 chains, or approximately 9000 feet.

Thus the dolomite occupies a tract of country at least 5 miles long and $2\frac{3}{4}$ miles wide. The depth to which the dolomite extends increases from east to west to a depth of many thousands of feet (no allowance can be made for undetected faulting). The quantity is therefore, for all practical purposes, inexhaustible.

Turning from the general area to that (viz., in the vicinity of Blackwood Bridge) recommended as the one worthy of investigation, as the most suitable for exploitation, the following remarks apply:—The dolomite here outcrops at intervals over an area of about 7 acres, and numerous shallow quarries have been opened up in it. From this locality the dolomite should extent for 60 chains to the east and north, and greater distances to the west and north. However, unless separate quarries were started on both sides of the Duck River, this stream would limit the extension of quarrying operations. Moreover, as the crystalline dolomite (of better quality) occurs west of the river, it would be better to commence quarrying operations on that side. Operations could then be carried to the north for 30 chains, north-west for 60 chains, and west as far as desired. The area available would be at least 200 acres, below which the dolomite should extend to depths of 2000 to 3000 feet. It must be realised that the greater part of this area is covered by a superficial layer of sand, ranging in depth up to a maximum of about 12 feet, while in the vicinity of the existing quarries it would be much less than this figure.

At Edith Creek it has already been indicated that quarrying operations could probably be carried out over 15 acres. In addition there would be a considerable extent under the plain country to the south-west, west, and north sufficient for all practical purposes, but in which sub-surface quarrying would have to be employed.

(*b*) *Irishtown Deposit.*—This deposit is shown on the plan as extending over about 200 acres, but actually it outcrops over only one-half of this area. This deposit would not extend beyond the area shown, except under the basalt to the south.

From the railway south to Irishtown a portion could probably be extracted by ordinary quarrying, but the greater part could only be extracted by sub-surface methods. In the northern half, sub-surface quarrying only could be applied.

The surface covering is soil and stream alluvial. The depth to which the dolomite extends would not be as great as in the case of the Smithton deposit, but would be sufficient for all practical purposes.

(*c*) *Conclusion.*—From the above descriptions it will be realised that the extent and depth of the dolomite of the Smithton deposit are so large that the quantities available may be considered practically inexhaustible.

In the Blackwood Bridge area the extent is at least 200 acres, and the depth is much greater than any likely to be reached by sub-surface quarrying methods.

It is hardly necessary to express the quantities in figures, and it need only be pointed out that every 10 acres worked to a depth of 50 feet in dolomite should yield 1,700,000 tons approximately.

(x) Markets and Possible Establishment of Industries.

At present there is probably no market in Tasmania for the dolomite in its raw state. If, however, the paper-pulp industry commences, especially if located near Burnie, there would probably be a market for the dolomite. For fluxing or refractory purposes markets might be found in New South Wales, but this would mean displacing the dolomite already produced in that State, and the marketing would be in face of opposition and competition from that State.

There appears to be possibilities of establishing an industry to manufacture magnesium compounds to supply Australian and other nearby markets. This would include the manufacture of basic or technical carbonate, precipitated carbonate, epsom salts, magnesia, &c. These are not produced in Australia (apart from a small quantity of epsom salts), but are imported from England.

The above compounds are used in many industries and in the preparation of medicinal and toilet preparations. It is probable that there is a sufficient consumption in Australia, New Zealand, &c., to warrant the establishment of such an industry, as can be seen from the following tables showing imports into Australia and New Zealand:—

Australia.

(Imports in long tons.)

Year.	Magnesia.	Magnesium Carbonate.	Magnesium Chloride.	Magnesium Sulphate.
1920	8	67	43	141
1921	12	86	110	176
1922	4	57	49	267
1923	11	65	205	320
1924	56	114	170	367
1925	415	209	286	430
1926	190	74	375	549
1927	190	196	310	790
1928	184	232	229	1413
1929	244	182	387	1452
1930	137	153	332	1369
1931	43	94	37	626

New Zealand.

(Imports in long tons.)

	Magnesium Sulphate.
1928	201
1929	187
1930	242
1931	235

The total value of imports of all magnesium compounds into Australia was at a maximum of £25,497 in 1929, dropping to £14,700 in 1932.

The possibilities are not so good as regards the manufacture of metallic magnesium, as there is only a small demand for it in Australia at present. It might, however, be possible to establish it in a small way in association with the above chemical industry.

The possibilities of a marble industry will depend upon the colour and jointing of the dolomite when opened up by quarries.

D.—Road Materials.

Rocks suitable for road-construction are plentiful throughout this district. The best rocks for making water-bound macadam roads are the hard, fine-textured, igneous varieties. Of these, two types, viz., dolerite and basalt, are well developed in the area, and the rocks, together with their distribution, have already been discussed in this issue. These basic rocks have been extensively used in the building of the better-class roads. Practically no quarries have been opened up in the basalt, as, up to the present, adequate supplies have been obtained from road-cuttings and loose boulders in the vicinity of the roads.

Dolerite has been supplied principally from the steep western slopes of the ridge along which it outcrops. Conditions here are ideal for quarrying, and several quarries have been in operation for breaking out road-metal. Two such quarries are situated in Smithton: one in Goldie-street and the other along Coward's-road.

To the east of the railway-line, half a mile south of Smithton, are two small quarries 10 chains from each other. On the east side of the road to Trowutta from Smithton, near its southern junction with Lower Scotchtown-road, another small quarry has been excavated in dolerite.

Chert is another rock that has been successful as road material, and quantities of this rock are obtained from three main road-side quarries, viz., half a mile north of Pulbeena on Smithton-Irishtown road, at the junction of the Scantlebury and Sharman roads three-quarters of a mile south of Irishtown, and alongside Edith Creek on the Nabageena-Lileah road. The gravel formed on the disintegration of the chert produces an excellent binding material, which sets very hard.

The local dolomite is used to a limited extent on some of the secondary roads, and has proved suitable where traffic is not heavy. Where the dolomite is developed the topography has generally not proved applicable for quarrying, and large pits have sometimes been resorted to. The main openings from which dolomite has been procured are—

(i) West bank of Duck River, at Watson's Bend.
(ii) South of Duck River, 40 to 60 chains east of Watson's Bend.
(iii) East side of Duck River, at Blackwood Bridge, on Christmas Hills-road.
(iv) West side of Duck River, at Blackwood Bridge.
(v) Several quarries on west side of Duck River, south of Mowbray Creek and in the vicinity of the Lower Scotchtown-road.
(vi) Large quarry at intersection of road and railway, half a mile north of Edith Creek siding.
(vii) First bend in Fahey's-lane, east of Smithton-Irishtown road.

E.—Paint Materials.

A deposit of oxide of iron (limonite) occurs on the property of Mr. G. Davis, on the west bank of Deep Creek, one and a half miles north of Fahey's-lane station.

The deposit is accessible by cart-track from Smoker's Bank-road, the track branching off the road a short distance west of the bridge over Deep Creek.

The deposit forms a small mound rising above the level of Deep Creek flood plain. The bottom of the deposit and its relation to the bedrock cannot be seen, as no development work has been performed. It appears certain, however, that the deposit represents a secondary one, due either to formation under swampy conditions (bog iron ore) or from a spring.

A sample was crushed and used as a paint material. The colour was a dark-brown, and not a very satisfactory one for paint purposes. On calcining a sample, it gave a dark-red colour, somewhat darker than that usually sought in such paints.

A sample of the raw material was analysed, with the following result:—

Registered No.	Constituents.	Per Cent.
1271	Iron	52·83

Mr. Davis calcines and crushes small quantities of the material, and sells small amounts in the Smithton district.

F.—Peat.

A peculiar cork-like substance was reported to occur on the basalt plateau to the east of the district, and it was decided to investigate the occurrence. The locality was a small pond to the south-east of Alcomie. A low island occurs in the centre of the pond, and by digging to depths of 1 to 2 feet in the soil and subsoil along its edge, small hard lumps were obtained. After drying in the atmosphere for a period of weeks, these assume a dirty yellowish-brown colour. The dried material has a very low specific gravity, and resembles cork as much as any other product. It is traversed by rootlets, and, from its occurrence in the peaty soil, has apparently formed in a manner similar to peat. It is possible that some particular vegetation contributes to its formation.

A sample of the air-dried material was analysed, with the following results:—

Reg. No. 371/31.

	Per Cent.
Moisture	6·76
Volatile combustible matter	71·90
Fixed carbon	18·68
Ash	2·66
Sulphur	0·48
	Gals. per Ton.
Crude oil and tarry matter yield on distillation	75·47

The quantity is too small to warrant further investigation. It is noteworthy that similar material has been forwarded from Lady Barron, and is stated to occur in a peaty deposit.

VI.—CONCLUSION.

The geological and topographical surveys resulted in the production of the geological maps of the Smithton north-east and south-east quarter-sheets.

The bedrocks of the district consists of sedimentary rocks of the Cambro-Ordovician System, including part, at least, of the Dundas series. The elucidation of the structure of the district has given valuable information about the stratigraphy of these rocks. Previously the base of the Dundas series had not been recognised, but from the Smithton surveys it appears that the rocks underlying this series consist of the quartzites, slates. conglomerates, &c., occurring between White Hills and Sisters Hills. The latter rocks are possibly of Cambrian age, and may pass down into the pre-Cambrian.

Another discovery was the existence of the thick dolomite beds, interbedded with the Dundas series, near the middle thereof as far as this series is represented in the Smithton and adjacent districts. These dolomite beds had not previously been known, nor had they been found in any other part of the State.

Although the district is occupied by Cambro-Ordovician rocks there is little, if any, evidence of mineralisation within it. This lack of metallic mineral deposits is ascribed to the absence of Devonian granitic rocks, with which such deposits are genetically associated. However, as the Balfour district is approached (granite occurs in that district) there is slight evidence of mineralisation, as is evident from the quartz reefs and galena-siderite veins of Gorgey Creek.

The Smithton district contains non-metallic mineral deposits, including limestone and dolomite. The most important limestone deposit is that along the Lower Scotchtown-road. This limestone is of good quality, and has been quarried on a very small scale and "burnt" for lime. This deposit could be developed, and would readily supply the Smithton and adjacent districts with lime for constructional purposes, and with lime or ground limestone for agricultural purposes.

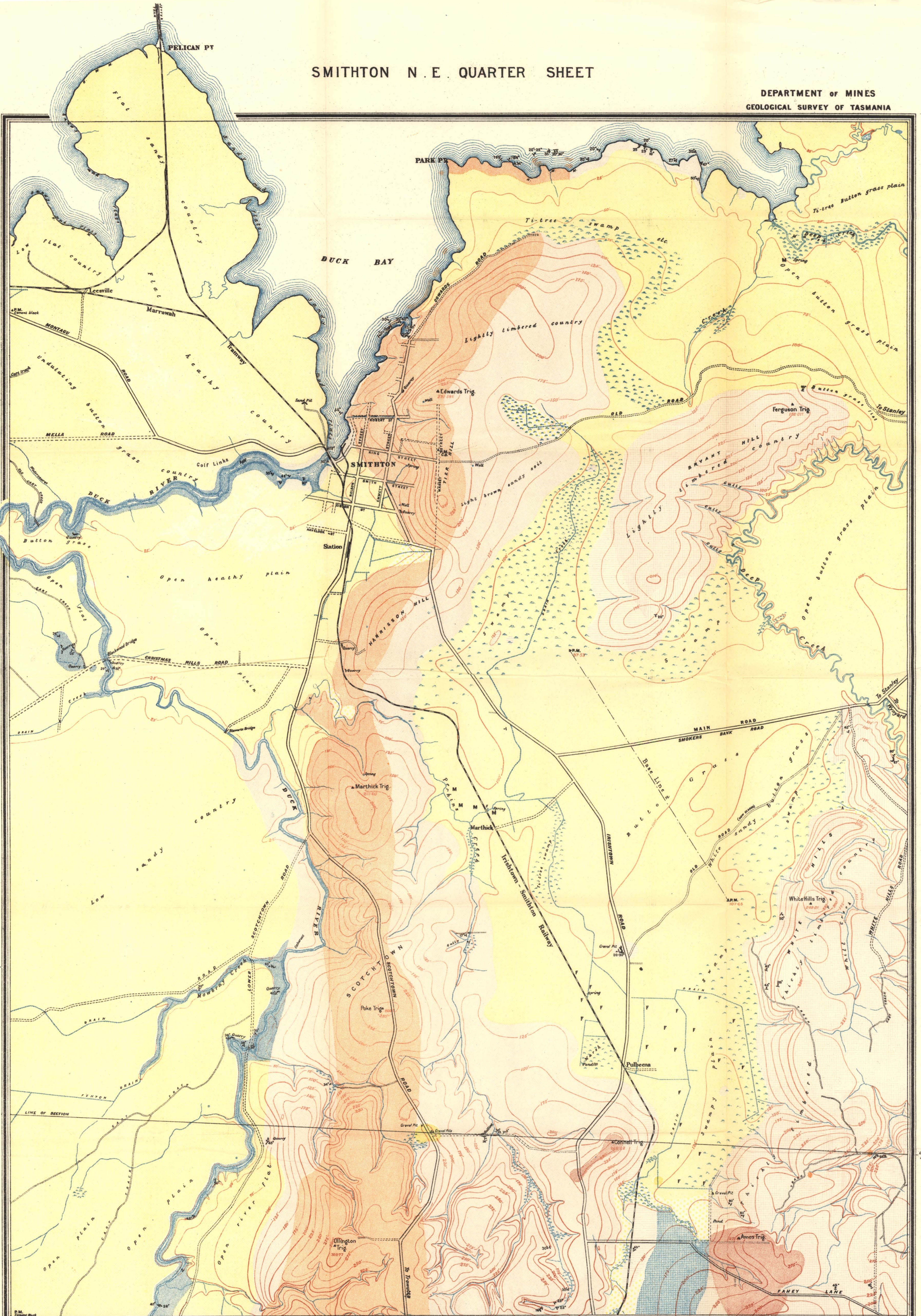
The dolomite represents a deposit capable of possible commercial exploitation. It occupies a considerable tract of country (5 miles by $2\frac{3}{4}$ miles), and the quantity available is therefore extremely large. The quality of the crystalline type, as revealed by the sampling so far carried out, is very high grade. If the paper-pulp industry using the sulphite process is established on the North-West Coast, it is possible that supplies of dolomite would be required, and these could be obtained from the Smithton deposit. The dolomite could also be used for the manufacture of magnesium salts, such as epsom salts, technical carbonate, carbonate, oxide, &c. These salts have uses in certain industries, and also for medicinal and toilet purposes. They are at present imported into Australia, and, as far as is known, none is manufactured here. There is thus the possibility of the establishment of an industry for manufacturing the above magnesium salts.

P. B. NYE, Government Geologist.
R. J. FINUCANE, Field Geologist.
F. BLAKE, Field Geologist.

Hobart, 16th April, 1932.

SMITHTON N. E. QUARTER SHEET

DEPARTMENT of MINES
GEOLOGICAL SURVEY OF TASMANIA



SMITHTON SOUTH EAST QUARTER SHEET

Triangulation and Theodolite survey by K.J. Finucane B. Sc.
Levelling by F. Blake and K.M Harrisson District Surveyor
Topography and Geology by K.J. Finucane B. Sc. and F. Blake Field Geologists
Surveyed in 1929 and 1930
Draftsman T.N. Hewitt

Photo Algraphed by Walter Shimmins, Government Printer, Hobart Tasmania. September 1931

Scale One Inch to 20 Chains
20 10 0 20 40 60

Contour Interval - 25 Feet
Public Works Datum - Mean Sea Level Hobart

EXPLANATION of Geological Signs and Colours

QUARTERNARY	PLEISTOCENE RECENT	Alluvium etc. / Mounds deposits (M)
		Freshwater - Peats, marls, clays etc. (F) / Marine - Sands, gravels etc.
TERTIARY		Gravels
PALÆOZOIC	CAMBRO - ORDOVICIAN / DUNDAS SERIES	Dolomite stage
		Slates, breccias & limestone stage
		Cherts, slates etc. substage / Dolomite substage
		Grey-green Quartzite stage
		White Quartzite stage
IGNEOUS	TERTIARY	Basalt
	DEVONIAN	Dolerite

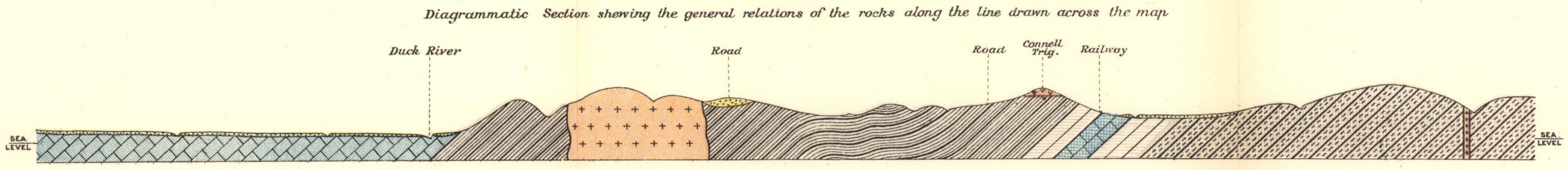
Strike and Dip

LEGEND

First class Roads shewn
Metalled do do
Unmetalled do do
Reduced Levels do 320.78
Approx Heights do 200 ft
Triangulation & Permanent Marks shewn

Approximate mean declination 1929
Datum R.S. end of Base

Diagrammatic Section shewing the general relations of the rocks along the line drawn across the map

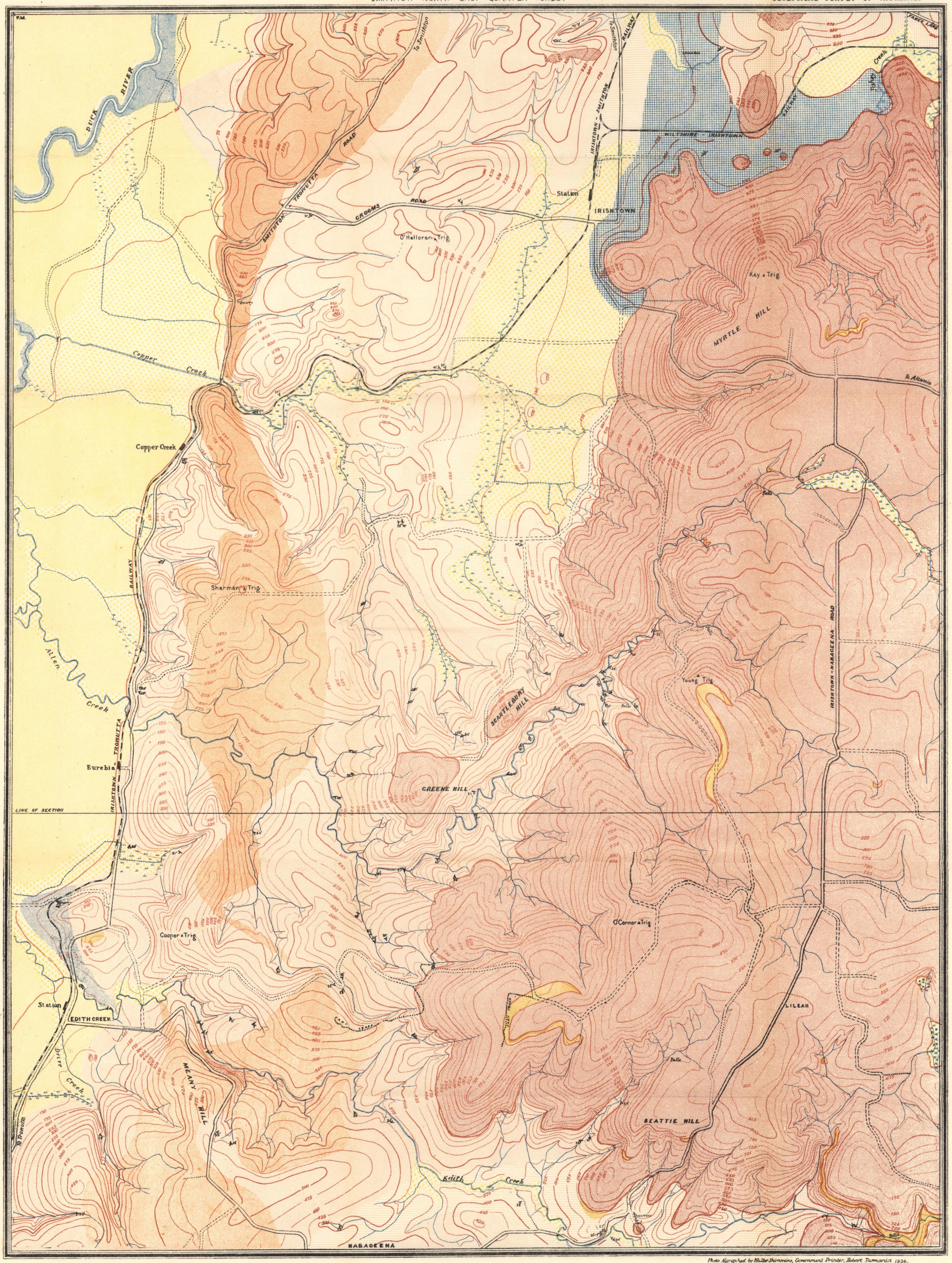


Horizontal Scale, One inch to 20 Chains
Vertical Scale, Three times the Horizontal

SMITHTON S. E. QUARTER SHEET

SMITHTON NORTH EAST QUARTER SHEET

DEPARTMENT of MINES
GEOLOGICAL SURVEY OF TASMANIA



EXPLANATION
of
Geological Signs
and Colours

5 cm

QUARTERNARY	RECENT	Alluvium etc.
	PLEISTOCENE	Marine-Sands, gravels etc.
TERTIARY		Sandstone, clays, lignites, conglomerates, grits, etc.
PALÆOZOIC	CAMBRO-ORDOVICIAN, DUNDAS SERIES	Dolomite stage
		Slates, breccias & limestone stage
		Cherts, slates etc. substage
		Dolomite substage
		Grey-green Quartzite stage
IGNEOUS	TERTIARY	Basalt
	DEVONIAN	Dolerite
		Strike and dip

LEGEND

First class Roads shewn
Metalled do. do.
Unmetalled do. do.
Triangulation & Permanent Marks shewn △

Approximate mean declination 1934

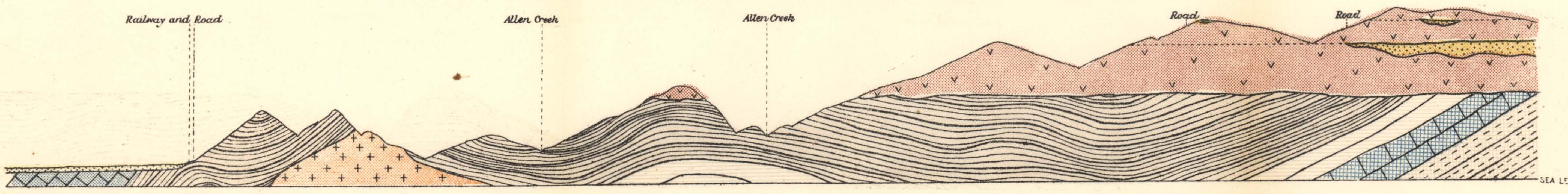
Levelling, Triangulation and Theodolite survey by K.M. Harrisson District Surveyor.
Topography and Geology by F. Blake and K.J. Finucane B.Sc. Field Geologists.
Surveyed in 1929, 1930 and 1931.
Drafting by F. Blake.

Photo Algraphed by Walter Shimmins, Government Printer, Hobart Tasmania 1934.

Scale One Inch to 20 Chains

Contour Interval - 25 Feet
Public Works Datum - Mean Sea Level Hobart

Diagrammatic Section shewing the general relations of the rocks along the line drawn across the map



Horizontal Scale, One inch to 20 Chains.

Vertical Scale, Three times the Horizontal.