K 1927/16-46

THE LILYDALE LEBRINA DISTRICT

1. Introduction

The geological examination of the Lilydale district was carried out as the result of a request by the Lilydale Municipal Council for investigation of the mineral resources of the district. Slates and sandstones of the Cambro-Ordovician System were known to occur, and to contain slates of commercial value and also quartz reefs with gold. Permo-Carboniferous rocks were also reported to exist and in these, strata deposits of shale and limestone had been located and it was hoped that seams of coal would be found. Further, alleged discoveries of other minerals and materials were reported.

The results of the geological examination are given in the following report.

11. Location and Access

The Lilydale district is situated in the county of Dorset in the northern part of Tasmania. The township of Lilydale which is the principal centre, is 13 miles north of Launceston, but is distant therefrom 21 miles by rail and 17 miles by road. The north-eastern railway, from Launceston to Herrick enters the district at Turner's Marsh (13½ miles) and passes out of it at Wyena (31½ miles) after traversing the district in a general north-easterly direction. The Main road to the north-eastern districts also traverses the district, entering it at Underwood (14 miles) and leaving it at Wyena (28 miles).

111. General Statement and Acknowledgements

The field work upon which the geological sketch map is based was carried out with the aid of the land charts - Dorset No. 1, No. 2 and No. 3. Numerous topographical and other features were added, and contours also placed upon the plan. This field work was performed during the period from 21st August till 10th September - a total of 21 days. The total area of country examined was approximately 70 square miles.

During the greater part of the above period the writer was accompanied by Mr. R. Lowe of North Lilydale who acted as guide on behalf of the Municipal Council, and the local residents. The writer desires to express his appreciation of the services of Mr. Lowe whose knowledge of the district and the various occurrences greatly facilitated the investigations. He also desires to express thanks for the hospitality, courtesy and assistance rendered to him by many other residents of the district.

IV. Literature

The only previous report dealing with the Lilydale-Lebrina district is the Geological Survey Bulletin No. 27. "The Bangor Mineral District" by W.H. Twelvetrees. This publication describes the slate deposits of Bangor and North Bangor, and the quartz reefs of North Bangor.

V. Physiography

The topography of the Lilydale district varies considerably, being in some parts of very high relief

and in others of low relief.

A dominent topographic feature is Mt. Arthur which occurs in the immediate east of the district. This mountain rises abruptly from the surrounding country to a height of 3,895 feet. The general elevation around the base of the mountain is 2,000 feet and the surface falls in every direction from it. The present streams have worked their way back towards the mountain and the spurs formed between them radiate in all directions from Mt. Arthur and form prominent features of the district. Other features in the Southern and South-western parts are the Brown Mountain (1770 feet) and the Dismal Range. (1200 to 1400 feet). Between Lilydale and Lebrina Hall's Tier courses to the north-west at an elevation of 1000 to 1100 feet between the headwaters of the Second River to the south and those of Piper's Brook and Denison River to the North. In the northern and north-eastern, conspicuous hills and mountains are Red Hill (950 feet) above Lebrina, and Mts. Brown and Wilson which form the northern end of a spur to the east of the eastern branch of Denison River.

The less elevated part of the district is in the west where it attains an elevation of less than 400 feet above the sea.

The whole of the drainage of the area examined is toward the north into Bass strait. The principal river system developed is that of Piper's River. The parent stream rises to the south-west of Mt. Arthur and after flowing three miles in a south-westerly direction, it makes a sharp turn and flows through the western part of the district in a general north-westerly direction. It eventually turns and flows due north into Bass Strait. The most important tributaries are the Second and Third Rivers which have general westerly courses and enter the main creeks in the western and north-western foothills of Mt. Arthur, the more important of these headwater streams being Campbell's Creek, Rocky Creek, Doak's Creek and the northern branch of Second River. The Third River rises on the western slopes of Hall's Tier between Bacala and Tunnel and flows westerly to join the Piper River one and a half miles to the north of the junction of the Piper and Second Rivers.

The northern and north-eastern portions of the district are drained by the Piper's Brook and Benison River. The Pipers Brook rises in the vicinity of Lebrina and flows in a north-north westerly direction to join the estuary of Piper's River one mile from the coast.

The Denison River rises by means of two main branches which unite near Wyena and flows in a general northerly direction to join the Little Forester River. The western branch rises on the north-eastern slopes of Hall's Tier and the eastern branch on the northern foothills of Mt. Arthur.

The development of the topography has been largely influenced by the geological structure of the district. The mountains and hills in the south such as Mt. Arthur, Brown Mountain, and the Dismal Range are all composed of diabase and form the most elevated

part of the district. In the north, the elevated regions are composed of slates and sandstones with in some cases overlying basalt. The streams have carried out their work of erosion and denudation in the softer Trias-Jura and Permo-Carboniferous rocks and attacked the harder diabase etc. only when unavoidable thus leaving the latter rock types to form the elevated regions.

VI. Geology

1. Summary. The oldest rocks occurring within the district are those of the Cambro-Ordovician system and these form the bedrock of the whole district. Into these has been intruded small amounts of a basic igneous rock type probably in the form of dykes and of Devonian age. Overlying the above, there occur strata of the Permo-Carboniferous system. Trias-Jura rocks succeed the Permo-Carboniferous but have been almost entirely removed by denudation. Upper Mesozoic diabase intruded the Cambro-Ordovician, Permo-Carboniferous and Trias-Jura strata, attaining its greatest development in the two latter systems. Basalt occurs in the form of small surface flows around Lebrina and at one locality overlies river gravels of Tertiary age. Recent alluvium has formed along the courses of the present streams.

2. The Sedimentary Rocks.

(A) Cambro-Ordovician System. The Cambro-Ordovician system consists of slates, sandstones and quartzites. The slates are all dark coloured although at the outcrop some are light coloured due to weathering. The sandstones are medium-grained, light-coloured types, and are quite sub-ordinate in amount to the slates. Dark coloured quartzites have formed by alteration of some of the sandstones.

These strata have a general strike varying from north north-west to north-west throughout the district. In the North Lilydale district they are dipping either vertically or at high angles to the north-east, with occasionally a high dip to the south-west. The turn-over of one anticline is visible in a quarry alongside the road a short distance to the east of the bridge over the northern branch of the Second River at North Lilydale. Abnormal strikes and dips occur above short distances and this area apparently represents a zone of intense folding and faulting. The same conditions hold true for the northern extension of those rocks into the Lebrina and Wyena areas.

In the small area exposed to the north-west of Lilydale the dips are to the south-west at medium to high angles.

In the Bangor area the dips are at angles of 30° and less to the north-east, whilst to the north dips of 15° to the south-west are recorded. In this area, however, only slates outcrop, and only the one set of planes are visible. Whether these represent cleavage planes coincident with the bedding planes, or cleavage planes which completely mask the bedding planes, could not be determined. In this connection it may be noted that similar low dips of cleavage planes have been found in the Back Creek and Lefroy districts to the north and Montgomery states "...for the strata, especially the slates, show very frequently a distinct lamination, probably the result of former crust-pressures,

along approximately horizontal planes, whereby the original bedding planes are obliterated. The strata, therefore, appear at first sight to be lying horizontal. On the coast at the mouth of the River Piper, and in the splendid section afforded by the Australasian State Quarry, however, it is clearly seen that the lamination is traverse to the true stratification, and that the strata are really inclined at high angles of dip".

These strata have therefore been folded into a series of anticlines and synclines. This folding is most intense in the North Lilydale and Lebrina areas, and possibly less so in the Bangor area. No detailed section of the strata could be determined or an approximate estimate of the thickness obtained but the latter must be considerable. Wide belts of slates without sandstones occur, and in other localities sandstones are interbedded with the slates.

The area in which those strata outcrop have been mentioned above. The North-Lilydale-Lebrina area is the largest of these, and covers at least 15 square miles. The area to the north-west of Lilydale is a small isolated one. The Bangor area is small and forms a narrow belt with a north-westerly trend, and which is probably continuous with the Lefroy area.

No fossils have been obtained from these strata and their age cannot be definitely determined. They are identical with the slates and sandstones which occur throughout the north-eastern parts of Tasmania and are known as the Mathinna slate and sandstone series. This series is referred to the Cambro-Ordivician system. On general lithological and structural grounds they can be correlated with the Ordovician system of Victoria but the absence of graptolites in the Tasmanian series prevents any definite correlation.

(B) Permo-Carboniferous System. The rocks of this system are largely developed, and outcrop over approximately one-half of the district including the Lilydale, Karoola, Lower Turner's Marsh, Bangor and Bacala areas, and form the agricultural and orcharding land in these localities.

Many good exposures of these rocks occur and detailed sections of the strata are obtainable. The system is divisible into the following series:

Upper Marine Series
Greta Coal Measures
Lower Marine Series
Basal Conglomerates

(a) Basal Conglomerates. The base of the Permo-Carboniferous system consists of conglomerates with erratic boulders which rest on the Cambro-Ordovician strata. These conglomerates pass up into soft puggy sandstones containing pebbles. The pebbles are generally very much rounded, but in the railway sections between Lilydale and Bacala where the line runs practically along the boundary of the Permo-Carboniferous and Cambro-Ordovician strata, an occasional pebble can be found showing facetting, polishing and grooving.

Similar pebbles and boulders are obtainable in a cliff face along the Pipers River near Cassidy's corner, one and a half miles south of Bangor. The pebbles and boulders in these strata are composed of numerous different rock-types, granite, gneiss, schist, quartzites, sandstones, slates, quartz etc. all of which represent very resistant types. While some of these types (quartzites, sandstones, slates and quartz) may have been derived locally, others such as granites, gneiss and schist have been derived from distant sources. The Granite may have been derived from adjacent outcrops in north-eastern Tasmania, but the gneisses and schists must have been brought still further distances as these types are not known to occur in eastern Tasmania. This evidence of the facetted, polished and grooved pebbles and boulders, the occurrence of erratic boulders and the transportation of rock types from distant sources proves conclusively that glacial conditions prevailed during the deposition of these conglomerates. The mudstones containing pebbles into which the conglomerates pass upward are generally stratified and it is probable that the glacial material was deposited under water. In the North Lilydale area irregular beds of sandstones are interbedded with the mudstones.

These basal members occur at various elevations throughout the district. Along the Pipers River they are found at altitudes of 350 feet, while along the railway between Lilydale and Bacala they are found at 600 to 800 feet above sea-level. Going east from the North Lilydale district towards Mt. Arthur they are found at increasing altitudes to over 2000 feet, the bedrock of Cambro-Ordovician strata rising similarly. This difference in elevation is due to block faulting and tilting which has affected both the Permo-Carboniferous and Cambro-Ordovician strata.

(b) Lower Marine Series. The pebbly mudstones pass upwards into thinly bedded shales and limestones. The shales and limestones contain pebbles similar to the underlying mudstones but not to the same extent. This series is very fossiliferous, some of the shales being crowded with fenestella and protoretepors.

The principal genera present are:

Polyzoa	Fenestella	Protoretepora
Brachiopoda	Spirifera	Productus etc.
Gasteropoda	Several genera	

The limestone bed is of indeterminate thickness and occurs interbedded with the very fossiliferous shales.

This series is best exposed at the following localities:-

Above the Bangor road between Cassidy's corner and the bridge over the Piper's River.

Along the north bank of the Second River - two miles south-east of Bangor.

Three quarters of a mile south east of Lilydale.

Near Cassidy's corner the thickness of the series is about 150 feet and along the Second River a similar thickness is also visible.

(c) Greta Coal Measures. Overlying the Lower Marine Series, there occurs a zone of sandstones with interbedded grits and shales. The sandstones are generally fine to medium in grain, with the coarser grits occurring as distinct beds in them, and are almost indistinguishable from the Ross sandstones of the Trias-Jura system. Half a mile south-east of Cassidy's corner the Karoola oil-shale is interbedded with shales and sandstones at the top of the sandstone cliffs.

The sandstones are visible along the east bank of Pipers River to the south of Cassidy's corner; along the north bank of the Second River two miles south-east of Bangor; and along the northern flank of the main spur running from Mt. Arther towards Lilydale. The greatest thickness exposed is about 100 feet and while the base and summit are not visible in sections it is probable that the thickness does not exceed 150 feet.

In one of the sandstone cliffs one mile north of the summit of Mt. Arthur, the writer obtained numerous fossil plant remains from an interbedded shale. These remains represented one form only viz. Gangamopteris.

These interbedded shales must be therefore of fresh water origin and this sandstone series occurring as it does above the Lower Marine must represent the Greta Coal Measure horizon.

(d) Upper Marine Series. Although not visible in sections directly overlying the Greta-sandstones, the upper portion of the Permo-Carboniferous System consists of shales and mudstones of various types. The lower members of this portion are thinly bedded friable mudstones and shales containing rounded pebbles in small amounts. They resemble to some extent the basal mudstones and the shales of the Lower Marine Series. They differ from these however in the smaller content of pebbles and also of fossils, the latter being only occasionally found. Interbedded with these and becoming increasingly prominent as the summit of the system is approached, the thickly-bedded white, siliceous mudstones, so plentiful in south-eastern Tasmania occur. In other districts, these white mudstones directly underlie the Trias-Jura basal conglomerates and represent the summit of the Permo-Carboniferous, and are found to contain marine fossils sparingly.

It may be remarked here, however, that in these districts, the Greta horizon was not recognized and it was assumed that a continuous series existed from the Lower Marine up to the summit of the Permo-Carboniferous. The whole of these strata have been referred to as Lower Marine, which is probably erroneous, as it embraces both the Lower and Upper Marine series.

Even where the Upper Marine is recognisable as at Lilydale it is doubtful how far it really extends upwards and what it embraces. The Tomago and Newcastle series do not appear to be represented and there may have been continuous marine sedimentation from the Upper Marine to the end of the Permo-Carboniferous.

The precise thickness of the Upper Marine

series in the Lilydale district could not be determined, but it is at lease 300 feet.

The Permo-Carboniferous strata are either horizontally bedded or dip at low angles. The general dip of the system is to the west or south-west at angles of 5^{o} to 10^{o}.

(C) Trias-Jura System. The Greta sandstones of the Lilydale district and the Ross sandstones of the Trias-Jura are almost indistinguishable. Fossils are seldom obtainable in these rocks and hence considerable difficulty was experienced in the mapping of them. Undoubted felspathic sandstones belonging to the felspathic sandstone series of the Trias-Jura occur to the south of Underwood and some of the underlying silicious sandstones around Underwood must, therefore, be referred to the Ross sandstones series. Apart from this association the only other guide is the total thickness of the sandstones and where this exceeds 100 to 200 feet, the writer regarded them as Trias-Jura. On this evidence the sandstones to the north-west of Mt. Dismal and those around Brown Mt. (except those near Karoola) were mapped as Trias-Jura.

No detailed sections can be described, but at least 400 feet of the Ross sandstones are exposed along Five Mile Creek to the north-west of Mt. Dismal. Smaller thicknesses occur around Brown Mt. and are overlain to the south of Underwood by 100 to 200 feet of the felspathic sandstone series.

(D) Tertiary System. The only sedimentary rocks of this age are the gravels and conglomerates representing a deep lead near Lebrina. They overlie Cambro-Ordovician slates and sandstones along the railway line to the west of Denison Gorge, and on the low hill to the east of Lebrina they are overlain by Tertiary basalt. The course of this lead is to the north-north-west and the ancient stream probably flowed in that direction.

(E) Recent. Recent deposits of river gravels and alluvium have been formed along the courses of the present streams. They occur mainly along the Pipers and Second Rivers and Beak's Creek. The alluvial flats along the Pipers River are a mile wide in some localities and average over a quarter of a mile for a length of three miles. Those along the Second River are not so extensive, but have an average width of a quarter of a mile.

3. The Igneous Rocks.

(A) Devonian

(a) Granite. Granite does not outcrop in the district although boulders are numerous in the basal conglomerates of the Permo-Carboniferous system. The nearest exposures are in the Lisle Valley 5½ miles to the east-north-east, and at Lone Star Creek and Panama to the North-East.

The granite is the typical Devonian type which occurs in the north-eastern districts of Tasmania but is somewhat finer in grain. It consists of plagioclase quartz, biotite and hornblende.

(b) Basic Dykes. Igneous material of uncertain origin occurs at Several localities within the district. The largest exposure is on the north bank of

the Second River three miles east of Lilydale, where a belt of igneous material 30 to 40 feet wide can be traced for a length of nearly three quarters of a mile. It consists of decomposed igneous material with which is associated a dark green, slightly foliated type with dark spots. Similar decomposed material also occurs to the west and north of Wyena.

The original type appears to have been of ultra basic or basic composition, but could not be definitely determined without a microscopic examination of suitable material.

The field relations of this rock were very obscure. It appeared to occur as small bodies without any definite strike, except at North Lilydale where it forms a long, narrow body. The strike of this latter occurrence is 50° to 60° west of north and apparently different to the strike of the slates which however are not observable in the vicinity. The rock therefore is probably intrusive into the Cambro-Ordovician slates.

The writer has also observed the same rock type in the Mathinna and Mangana districts. It is always associated with the Cambro-Ordovician slates and sandstones and particularly in the vicinity of quartz reefs. It is always difficult to determine its relation to the slates and sandstones but sometimes it is certainly transgressive. The fact that it always occurs in association with the Cambro-Ordovician strata and not with any later ones such as the Permo-Carboniferous proves that its age is somewhere between these two. The intrusions may be connected with the Perphyroid or the Devonian periods of igneous activity. Its general occurrence in the vicinity of quartz reefs and the absence of any indications of porphyroid activity has led the writer to assign it provisionally to the Devonian.

(B) Diabase

This rock occurs in the eastern, southern and western parts of the district, and forms the elevated country in these localities. It is identical with the typical diabase found in many other localities in Tasmania and need be only briefly discussed here. It is composed essentially of a plagioclase felspar and a light-coloured augite in about equal proportions. The only variation in the rock is in the size of the component crystals. The coarse grained varieties occur in the larger bodies and are similar to gabbros. The medium grained varieties are the most common and on slightly weathered surfaces have a typical doleritic appearance. The fine-grained varieties occur at the margins of dykes, sills and the larger bodies.

The diabase is everywhere intrusive into the Permo-Carboniferous and Trias-Jura strata. Two narrow parallel dykes 4 to 5 feet wide are well exposed in the deep railway cutting near Lalla and are intrusive into Permo-Carboniferous mudstones. These dykes are completely decomposed and one does not reach the present surface. Narrow dykes are also visible in the cuttings between Karoola and Turner's Marsh and are parallel to the main junction of the diabase and Permo-Carboniferous strata. The main junction at this locality is also exposed and is definitely transgressive. The junction of the diabase

and felspathic sandstones on the road to the south of Underwood is also transgressive. The field relations and the geological map prove that the same holds true for all the other junctions of the diabase with the Permo-Carboniferous and Trias-Jura strata. No evidence of sills was visible and the diabase occurs in the form of large transgressive bodies. The summit of Mt. Arthur has been formerly regarded as being formed by a sill overlying Permo-Carboniferous sediments. The summit of the mountain was not visited on this occasion and the enormous amount of fallen diabase boulders renders the elucidation of the geology of the flanks very difficult, but it appears to be fairly certain that the mountain represents an elevated portion of a large transgressive body.

The whole of the diabase on the eastern, southern and western parts of the district forms part of this large body. Outside of the district examined it extends westerly to Mt. Direction, southerly to Launceston, and easterly apparently as far as Mt. Barron.

A glance at the geological map will show that the boundary of the diabase is almost entirely with the Permo-Carboniferous and Trias-Jura Strata. Only at one locality, three miles to the east of Lilydale, does it come into direct contact with the Cambro-Ordovician strata. This forms a striking example of what has already been established in many other parts of Tasmania viz. that the diabase intrusions attain their maximum development in the Permo-Carboniferous and Trias-Jura systems. The field relations where the diabase does come in contact with the Cambro-Ordovician strata are not too clear as much of the diabase appears to be slip material from the flanks of Mt. Arthur, but it is probable that the diabase is transgressive with respect to the slates.

The only evidence of the age of the diabase is that it intrudes the Permo-Carbpniferous and Trias-Jura strata and is, therefore, post Trias-Jura. In other areas in Tasmania it is overlain by Lower Tertiary sediments and basalts and is regarded as being of Upper Mesozoic age, no more definite determination being possible at present.

(C) Basalt

Several small patches of basalt occur in the vicinity of Lebrina and they probably represent the isolated remnants of a former continuous sheet. The present elevation of the basalt is about 800 feet above the sea. It rests directly on the Cambro-Ordovician slates and sandstones at nearly all localities but at the hill to the east of Lebrina a deposit of Tertiary river gravels occurs beneath the basalt. These gravels represent deposits in the valley of the stream down which the basaltic lava flowed when poured out on the surface.

The basalt is a dense, fine grained, basic type individual crystals not being visible in hand specimens. It is composed of felspar and augite and probably also olivine. Vesicular varieties also occur and appear to be less basic than the denser ones.

The flow appears to have been thickest at Red Hill where approximately 150 feet of basalt is now exposed.

4. Structural

The structural features of the different systems and rocks have been dealt with in describing each of these above. The Cambro-Ordovician system forms the bed rock of the district and the strats have been folded into a series of anticlines and synclines. The Permo-Carboniferous system overlies the Cambro-Ordovician and the strata are horizontally bedded or dip at angles of 5° to 10°to the south west or west,

and are succeeded apparently conformably by the Trias-Jura System. In the north-eastern Tasmania it is found that the Permo-Carboniferous basal members overlie a generally level surface (representing a former peneplain) at an elevation of approximately 2000 feet above sea-level. This height is attained and exceeded by the summit of the Cambro-Ordovician and the base of the Permo-Carboniferous System in the vicinity of Mt. Arthur. Going west however, the junction of the two systems decreases in elevation gradually until along the railway line between Lilydale and Bacala, it is only 600 above sea-level, while along the Pipers River it is still less. This may represent the original slope of the Cambro-Ordovician basement or it may have been caused later by faulting. The general dip of the Permo-Carboniferous system as determined by the Greta sandstones along the flanks of Mt. Arthur is similar in amount and direction, and strongly suggests the existence of tilting of the Permo-Carboniferous strata and the Cambro-Ordovician basement due to block faulting possibly accompanying the diabase intrusions. The district therefore represents a tilted block the downthrow being to the west or south-west, the general tilt of the block being in that direction.

Minor faulting also occurs in the strata of these systems. In only a few cases can it be detected, and where possible the faults have been shown on the Geological Map.

The granite which does not outcrop within the district examined, undoubtedly underlies the slates and sandstones and forms part of the batholith of North-eastern Tasmania. The Devonian basic rocks occur as dykes in the Cambro-Ordovician. The Upper Mesozoic diabase occurs as transgressive masses in Cambro-Ordovician. Permo-Carboniferous and Trias-Jura systems but attains its greatest development in the latter two systems. The Tertiary basalt occurs as thin surface flows.

VII Economic Geology

1. Coal. The coal seams of Tasmania occur in the Permo-Carboniferous and Trias-Jura systems. As it was known that Permo-Carboniferous rocks outcropped in the Lilydale district it was thought that coal would exist and the examination of the district was made chiefly with this object in view.

(A) Trias Jura It is probable that the rocks of the Trias-Jura System formerly extended continuously over portion at least of the Lilydale district, but they have been almost entirely removed by denudation. No trace of the upper felspathic sandstone series remains. A very small area of the middle or felspathic sandstone series exists to the south of Underwood. A larger area of the Ross to Lower sandstone series occurs around Brown Mt. and probably also to the west of Mt. Dismal.

The coal seams of this age are interbedded with the felspathic sandstones and mudstones of the felspathic sandstone series. This series occupies only a small area south of Underwood and hence the chance of locating coal seams is restricted to this small area. No seams have yet been discovered although search has probably not been made. The felspathic sandstones are bounded by diabase on the south, and the quality of any coal existing there would be affected for a short distance from the diabase.

Thus it is evident that even if search in the small area of felspathic sandstones near Underwood results in the finding of seams of coal, the total quantity available would be very small and portion of these would be useless due to alteration by the intrusive diabase. No great advantage would be gained therefore by carrying out the prospecting work in the search for coal at this locality.

(B) Permo-Carboniferous. Coal seams are found in at least two horizons in the Permo-Carboniferous System in Tasmania. Seams occur in the Greta Coal Measures at the Mersey, Preolenna, Barn Bluff and Pelion fields; and in the Tomago or the Newcastle Coal Measures at Preolenna, Barn Bluff, Pelion, Mt. Cygnet and Bruny Island. At some localities such as Latrobe the coal seams do not exist in the Greta Coal Measures, but seams of Tasmanite shale occur at the same horizon.

Permo-Carboniferous strata cover a large proportion of the surface of the Lilydale district and the basal conglomerates, Lower Marine series, Greta Coal Measures, and Upper Marine series have been recognized, but no evidence of presence of the Tomago or the Newcastle Coal Measures was obtainable, although they may possibly exist.

No seams of coal have been discovered in the Greta Coal Measures, but one seam of oil shale has been found to the North of Karoola. This oil shale is not a Tasmanite shale, but more resembles a black, carbonaceous shale. In spite of this difference, it is probable, that on an analogy with the Latrobe fields, no coal seams occur in the Greta Measures at Lilydale. However, at Preolenna both kerosene shales and coal seams occur as well as carbonaceous shales, so that the above deductions are not necessarily correct. The sandstones forming the Greta Coal Measures outcrop as bold cliffs in many parts of the district, but only carbonaceous shales are found. It is therefore highly probable that coal seams do not occur in the Greta Coal Measures in the Lilydale district.

The Tomago or the Newcastle Coal Measures have not been recognised in the district, although some of the sandstones to the west of Piper's River may represent these horizon, but no evidence is available in this connection.

Thus although a fairly complete section of the Permo-Carboniferous strata are exposed in the district there does not appear to be any seams present. The evidence is not absolutely definite, and, while a drilling campaign would be the only satisfactory way to settle the question, such a procedure certainly cannot be recommended on the evidence available.

2. Oil Shale. It has already been pointed out above that a seam of oil shale outcrops within the Lilydale district. The outcrop is situated near the summit of the hill on the east bank of the Piper's River above the bridge on the road from Karoola to Bangor about midway between these localities. High cliffs of sandstone form the upper part of this hill and the oil shale has been exposed just above these cliffs. The base of the hill is composed of glacial conglomerates overlain by fossiliferous mudstones, and limestones of the Lower-Marine Series. The sandstones with interbedded shale represents the Greta Coal Measures overlying the above series, the shale occurring in the upper portion of this series.

The seam has been exposed in a shallow shaft but the bottom of this has been filled in by fallen material and the shale was not visible. Numerous pieces lying on the dump represented the only material available for inspection.

The shale is a carbonaceous variety and is very black and dense on freshly broken surfaces with very narrow brilliant streaks through it. It weathers to a dirty grey colour and the bedding planes become very pronounced. In the weathered material, flakes of white mica are very conspicuous. The shale is rather tough and bruises when struck with a hammer and does not break readily. It is soft and easily cut with a knife the streak being of a dull brown colour. It is not inflammable with a lighted match, but burns when in contact with red hot coals in a fire.

The material exposed on the dump was considerably weathered and useless from the point of view of having it analysed and tested for oil contents etc. The late Mr. W.H. Twelvetrees on the occasion of his visit in 1918 obtained a sample of shale which was probably suitable for analysis as it was examined in the Geological Survey Laboratory with the following results:

Moisture at 100°C.	0.80	per cent
Volatile Combustible matter	27.80	" "
Fixed carbon	21.30	" "
Ash	50.10	" "
	100.00	" "

This analysis shows the shale to consist of about 50 per cent non-combustible matter and 50 per cent organic matter (fixed carbon and volatile combustible matter). The non-combustible matter is clay-material white mica, and fine particles of other minerals such as quartz, and the organic matter is distributed throughout the shale in this fine sedimentary material.

The shale tested in the Geological Survey Laboratory gave a yield of 15 gallons of crude oil or distillation. Preliminary tests on samples of the shale were carried out by Mr. D.M. Griffin, Manager of the Railton Latrobe Shale Oil Works with the following results:-

Crude Oil	19.7 gallons per ton (2240 lbs.)
Ammoniacal water	14.0 " " "
Permanent gas	2000 cubic feet per ton.

The crude oil was reported as being "of a paraffin base, semi-solid at 62°F., dark-green by reflected light and red by transmitted light, odour not unpleasant, and with a specific gravity of 0.920 at 60°F. The yield of crude oil from the shale may therefore be taken as 15 to 20 gallons of solution per ton. The ammonia content is expressed as 14 gallons of solution per ton, but the concentration is not stated and the yields in pounds of ammonia sulphate per ton is therefore not known.

The shale has been opened up by what appears to have been a shallow shaft which has now fallen in. The upper visible portion of the shaft exposed soft mudstones and the shale is interbedded with the mudstones and overlies the sandstones in the cliff face. It was reported to the writer that the shale bed consisted of seams of shale and clay with a thickness of three feet, the clay seams amounting to two inches, but this could not be verified. Mr. Twelvetrees reported the shale as being exposed in a six-foot drive, the floor of which was covered with clay and prevented

an examination of the seam. He stated "With the associated bands the seam may perhaps be about 18 inches thick and dipping slightly into the hill. A few slabs of shale are scattered on the grass about the entrance. Until the cut is cleared of mullock, the actual thickness of the solid seam cannot be determined. The probability is that there are a few thin layers of shale with intervening clay". The thickness is thus reported as 18 inches and three feet thick, and it certainly cannot exceed the latter figure otherwise it would be exposed in the sandstone cliff a few feet to the west.

The shale seam has been discovered at the above locality only and nowhere else in this district. It was reported to the writer that it has also been found in a creek, a quarter of a mile to the east, and in the Second River two miles to the east. These supposed outcrops could not be found, and the strata exposed at these localities is below the shale horizon so that the shale cannot occur there. The shale, however, should be found at localities other than where it has been discovered if it extends for any distance. The locality where it occurs is the north end of the cliffs along the east bank of the Pipers River and denudation has removed the seam to the immediate west, north and east, so that it will not be found in these directions. The seam should occur above the sandstone cliffs to the south, and search would reveal it if it extended in that direction. The sandstones dip in a general southerly direction and so the seam would be found at lesser heights above the river in that direction and eventually the river-level itself. Another area where the Greta Measures outcrop is along the north bank of the Second River to the east of Bangor and search above the sandstones might reveal the shale. The Greta sandstones outcrop prominently along the north-western flanks of Mt. Arthur, but no outcrop of shale has been located. Search in this area is not recommended as only a very narrow belt of sandstones exist, the transgressive diabase occurring a short distance to the south of the cliff face. Sandstones probably belonging to Greta Measures also outcrop to the west of the Pipers River between Karoola and Bangor, and search should be carried out for any extension of the seam.

It has been considered that the mining of the shale and its distillation would result in the establishment of a valuable shale-oil industry. With the facts available at the present time, the prospects of commercial success are far from bright, and, indeed the present development of the shale seam is altogether insufficient to warrant such thoughts. The shale has been exposed at only one locality and its thickness is not known definitely though it is reported to be between 18 inches and three feet. The known extent of the shale is confined to the summit of the hill on which it outcrops, and probably does not exceed one acre, but an extension to the south may be fairly confidently relied upon. The oil and ammoniacal contents are 15 to 20 gallons per ton and 14 gallons per ton respectively. Shales with an oil yield as low as this figure have been utilised in Scotland but this is possible because of the large yield of ammonium sulphate which the Karoola shale does not give.

Essential steps before any consideration of the question of establishing a shale-oil industry are:

(i) Determination of the quantity of shale available. This would entail prospecting and development work to prove the thickness and extent of the seam. Such work would need to be performed in the area to the south of the outcrop and the others indicated above. Surface trenches, shafts and adits would be suitable means of prospecting over most of the areas referred to, but if the seam is proved to dip below the surface bore-holes would probably be the best means.

(ii) Determination of the oil, Ammonia and other contents of the shale.

After portion or all of the above work had been carried out a bulk sample or samples of unweathered and undecomposed shale should be obtained and tested in a distillation plant.

(iii) When the quantity and quality of the shale are satisfactorily determined, the question of mining, treatment and other costs should be investigated in order to ascertain whether the industry would have any prospect of commercial success.

3. Limestone. Beds of limestone occur in the Lower Marine series of the Permo-Carboniferous System in the Lilydale district. They are found a short distance below the sandstones of the Greta Coal Measures, and it is significant that in many cases when the sandstones are exposed in cliff faces, the limestone occurs below. This association is due to the fact that surface and underground waters containing carbon dioxide dissolve the limestone and carry it away in solution. Cavities are thus formed under the sandstones and large bodies of these rocks fall under the action of gravity, leaving vertical cliff faces at the line of rupture.

Limestone was found to outcrop at several localities within the district. The longest outcrop is along the east bank of the Pipers River between Bangor and Karoola. The northern end of this outcrop is a few hundred yards south of Cassidy's corner and it extends for almost a mile to the south where the bed probably dips below river level. This bed should underlie the hills to the east of this outcrop and be exposed on the northern slopes to the flats of the Second River but it was not located during this investigation. Surface workings would, however, quickly reveal the presence of the bed.

The extension of the same bed was also found outcropping along the northern bank of the Second River to the north east of the above locality. It was traced for half a mile along the flanks of the hills and probably extends both to the east and west. Between the first locality described and this one, the limestone has been removed by the denudation of the valley of the Second River.

A boulder was found one mile to the south of Bacala and its source could not be located, but further search might find the limestone bed outcropping in the vicinity.

Limestone also outcrops to the north of the Mt. Arthur Road, one mile south of Lilydale,

but the bed here does not appear as prominently as in the above localities.

The limestone is a bluish-grey, compact variety containing abundant fossils. It appears to be of good grade as far as can be judged by eye but has one disadvantage as regards quality in that it contains numerous pebbles of other rock types. These pebbles are generally well rounded and consist of quartz, quartzites, granite, schist, gneiss and similar types.

The bed was not found outcropping in the solid but the pebbles and boulders could be traced right to where it could be found, and a small amount of work would soon expose the bed. The largest boulders found were up to four feet in diameter and the bed must therefore attain this thickness at some portions Owing to the absence of a solid outcrop no representative sample could be obtained in order to determine its composition by analysis. As stated above, the limestone appears of excellent quality except for the included pebbles. These pebbles are sufficiently numerous at some parts to render the limestone useless for some purposes such as cement manufacture. Not only would they increase the silica percentage but they would also cause additional difficulties in the process of fine-grinding. The quality may be quite satisfactory for other purposes such as grinding for agricultural purposes or burning for quicklime to be used for mortar and agricultural purposes.

In order to determine the thickness and quality of the beds, it is recommended that surface workings be undertaken to cut and expose the bed. Representative samples could then be taken and assayed and the quality of the stone and its suitability for particular purposes determined.

Although the bed outcrops on cliff faces, the conditions are such that underground mining methods would have to be employed to obtain the limestone. Quarrying could be performed for a short time but the thickness of overburden that would need to be removed would soon render this method expensive.

The outcrops are situated up to 100 feet and more above river level and there would be a sufficient height available for the economical working of kilns etc. if the quality proves suitable for burning purposes.

4. Building Stones. Sandstones belonging to both the Permo-Carboniferous and Trias-Jura System occur within the district. The Ross Sandstones of the Trias-Jura system are specially suitable for building, ornamental and monumental purposes and for grindstones etc. Members of this series outcrop around Underwood and Brown Mt. and in common with those which occur at other localities in Tasmania, should prove suitable for the above purposes. The general conditions for quarrying and transport are fairly favourable.

The Greta sandstones of the Permo-Carboniferous system are very similar to the Ross sandstones and great difficulty was experienced in differentiating between the two series. If anything the Greta sandstones appear to slightly less consolidated,

and therefore more friable than the Ross sandstones. In some localities particularly those along the cliffs (a short distance to the north of the Mt. Arthur road, where the transgressive diabase has probably slightly altered the sandstones, they appear to be equal in quality to the Ross sandstones. The facilities for quarrying are very favourable along these cliffs, and waste material could be disposed of very easily.

5. Slate. Deposits of slates of commercial value have been known to exist in the Lilydale district as long ago as 50 years. The late Mr. Twelvetrees reports that the Bangor slate section was held prior to 1872 by Major L. Hood and was again surveyed for Messrs. Aikenhead and Blair in 1872, and that T.C. Just's quarry in the northern part of the Bangor area was also worked about the same time. Several years later, it is stated that a Launceston syndicate began to quarry the slate at Bangor. "After an interval of about 13 years these proprietors were succeeded by the Melbourne firm of David Blair and Joseph Clarke, who sank a main shaft and raised slate from underground. These owners imported Welsh and Cornish quarrymen, put up some 50 cottages, installed an extensive slate-quarrying plant and carried on with bustle and activity for about three years." Operations were finally suspended in 1888 and no further work has been carried out since.

The Bangor slate area is situated on the east bank of the Pipers River at its junction with the Second River, north-west of Karoola station. Good roads connect the area with these two railway stations. The mine was connected with Egg Island jetty on the east bank of the Tamar River by 11 miles of tramway, but this has fallen into a state of disrepair and has been converted into a road for many miles of its length. Roads also connect with Lilydale 5 miles to the east, and with the Pipers River district to the north.

The slate area consists of a belt of Cambro-Ordovician strata exposed along the course of the Pipers River. At Bangor this belt is about 20 chains wide, but to the north-west it widens to at least one mile in the vicinity of Just's Quarry. The same strata are reported to extend uninterruptedly to the Lefroy district, and a slate quarry was also opened in this latter district. In the Bangor area the Cambro-Ordovician strata are covered to the east, west, and south by Permo-Carboniferous rocks and, to a less extent by recent alluvium. The Cambro-Ordovician strata consists of dark coloured slates, the sandstones and quartzites which occur in other parts of the district being absent or subordinate in amount. The slates split readily due to the presence of numerous planes situated closely together. The planes represent cleavage planes, but whether they are co-incident with the bedding planes, or cross the latter and completely mask them, could not be definitely determined, as only the one set of planes were visible. These planes dip at low angles up to 30° to the north-east, the strike being north-west. Mr. Twelvetrees reported the dip to the west of the quarry to be slightly to the south-west. In the north Bangor area the dip is flat on Freeman's property, and Mr. Twelvetrees reports it to be 15° to the South-west at Just's Quarry.

The only information available as to the quality of the slates has to be derived from poor grade material on the dumps and from slates which have been used in the construction of houses. The slates on the dump split readily but somewhat irregularly into thin sheets, and appear to be only slightly suitable for producing commercial slates. As this material represents rejected slates, the first grade material which has been used for the production of the marketable slates must have been of good quality from the point of view of splitting. An examination of the slates used on houses and those of marketable quality which have been left on the ground supports this statement. Of course, the quality of the slate deposit as a whole depends upon the proportion of good grade material that it contains. No records are in existence to show what the actual proportion was, but judging by the size of the dumps of waste material, the proportion of good grade material could not have been large. The question of whether the most efficient use was made of the material would greatly affect this proportion, but nothing can be said on this point as work ceased many years ago.

The post office at Bangor was roofed with slates from the quarry, and in the case of the manager's house, four miles west of Bangor, the walls as well as the roof were constructed of slates. These buildings bear testimony to the excellent weathering properties of the slates. The house at Bangor has been continuously occupied while the other has not and so has fallen into general disrepair. Except where broken by stones etc. the slates on the roof at Bangor appear to have weathered extremely well, any defects in the roof being due to the understructure of wood. In the former manager's house, the portion of the slates which have had a free surface exposed to the air have lasted very well. The portion of them however, included in the overlap where they have been subjected to dry conditions, shows a tendency to flake. The slates which were stacked and have been lying in the soil and grass for about 35 years where they would experience more severe conditions, have weathered exceedingly well and have shown little or no tendency to flake.

While the above buildings bear testimony to the lasting or durable properties of the slates, they also show one defect in the slates viz., their discolouration on weathering. This discolouration consists mainly of brown stains due to oxides of iron. Mr. Twelvetrees reported the presence of minute grains or crystals of pyrite in the slates and this mineral on oxidation forms the source of the ironstaining solutions. Whitish patches occur on some of the slates which have lain in the grass, and may be due to calcium carbonate.

The slates used upon the buildings discussed above was probably not the best grade such as was sent to market, and in considering the qualities based upon observation of these slates, due allowance must be made for this fact.

The quantity of slate (irrespective of quality) in the Bangor area is considerable. The belt of Cambro-Ordovician slates is 20 chains wide and one mile long. A large amount of prospecting and development work would be essential to determine what portion or portions of this belt would yield slates of commercial value. Even in these portions allowance would have to be made for the proportion of waste material which occurs in the production of saleable slates. In the southern end of this belt where the slates have been quarried and mined, the various workings have proved the useful slates to extend over a total width of 400 feet. The length has not been determined but it can be safely anticipated to extend to the north west along the line of strike. The shaft from which the slates were mined was about 250 feet deep and proved them to extend to that depth.

The commercial exploitation of these slate deposits depends upon many factors, direct observation and evidence of which cannot now be obtained. The attempts to work the slates in the past have apparently proved unprofitable, but the exact reasons for the failure are not definitely known. The qualtiy of the marketable product and the cost of producing it suggest themselves as the most probable causes. The quality of the slates has been discussed fully above, and as far as could be observed the slates appear to be durable and weather well, but become discoloured brownish in some cases. The discolouration appears to be the only defect in the quality of the slates, and, as some of the slates do not become discoloured, it might be possible to select and market only those slates which do not contain iron minerals capable of staining the slates on weathering. Whether this could be done could only be determined after the slates had been worked for some time when the required information might be obtained in order to separate the bands containing iron minerals and those which do not. Such a selection would tend to increase the cost of production by lowering the proportion of marketable to waste material.

The cost of production depends mainly upon the proportion of finished product to total rock removed and upon the method of working. The proportion of finished product to total rock removed would appear to be low judging by the size of the dumps formed during the working in the past. No data are available however to determine this figure, and it cannot be said whether it is above or below that found in working slate deposits in other parts of the world.

The deposits were worked in the first attempts by means of quarries or open-cuts, but the last company to operate used underground mining methods from a vertical shaft. This change in the method of working was presumably effected in order to obtain the better quality slates which were said to occur at depth. No definite information is available, however, as to whether these anticipations were realised, and if so, to what extent. A very large increase in the quality and perhaps the proportion of marketable material would be essential, in order to justify the much more costly method of underground mining compared with quarrying. The relation

between the costs of the two methods varies with circumstances but in some cases the costs of underground mining is at least 50 per cent more than costs of quarrying. It is therefore evident that, other things being equal, quarrying methods should be resorted to where possible. The general conditions at Bangor are favourable for quarrying as the hill rises to a height of over 100 feet. One apparent drawback to quarrying is the lack of space for disposal of the waste rock on the northern side of the junction of the Pipers River and Second River. Land would have to be obtained to the south of the Second River for dumping purposes. In order to make the most use of the land it would be advisable to instal a mechanical elevating system and form a conical shaped dump. This would involve an increased outlay of capital and slightly larger, working costs which however would be fully justified if by this means the slates could be worked by quarrying methods.

In any further attempt to work these slate deposits at Bangor it is recommended that the following procedure be adopted.

(1) Development and examination of the slates above river-level with a view to determining whether the quality if good enough and the proportion of this material sufficiently high to enable their extraction to be a profitable venture.

(2) If the above procedure yields favourable results the slates could be worked by ordinary quarrying methods. This would involve provision for a dumping ground to the south of the Second River and it is recommended that a mechanical elevating system be installed for disposing of the waste rock.

(3) If the quality and proportion of marketable materials above river level is not suitable for profitable extraction, search at greater depth would have to be resorted to. If suitable, underground mining methods would have to be employed.

(4) It is recommended that as any further working proceeds, every endeavour should be made to locate particular bands containing pyrite or other iron minerals in order to reject the material from these bands, and so produce only these slates which will not stain on weathering.

6. Pyrite. Pyritic minerals were reported to occur at a few localities within the district.

In the south bank of the Pipers River three quarters of a mile upstream from Karoola, cubical crystals of pyrite have been obtained from the rocks in the bed of the river. At this point there is a fault visible in the cliffs, Permo-Carboniferous mudstones occurring to the east and sandstones (probably of the Greta Series) to the west. The pyrite crystals undoubtedly occur in this faulted area and were formed either as result of the faulting or by later solutions traversing the fault plane. No crystals are visible in the fault plane above the water level in the river during periods of flood such as when the writer visited the occurrence. As exposed, the occurrence has no ecomomic importance.

Copper pyrites was stated to occur in the deep railway cutting north-east of Lalla. Greenish

coloured water occurs in the drainage channels at a certain point of the cutting and gave rise to this idea. At this point a fault in the Permo-Carboniferous strata is visible, and pyrite containing copper may occur The green colour of the water does not appear to be that of copper and other agencies may have caused this colouration.

7. Carbonaceous Clay or 'Plumbago', It was reported that 'plumbago' occurred along Barrett's Creek a tributary of the Pipers River to the west of Bangor. On examination this material proved to be black, compact carbonaceous clay forming part of the recent deposits along the course of Pipers River, and not plumbago or graphite.

8. Gold. The north-eastern districts have been the most important gold fields in Tasmania, gold being obtained in considerable quantities at Beaconsfield, Lefroy, Lisle, Mt. Victoria, Mathinna and Mangana. The geological features in all these localities are essentially the same. The Cambro-Ordovician slates, sandstones and quartzites form the country which contain the quartz reefs. These strata are intruded at numerous places by Devonian granite, and the formation of the quartz reefs was genetically connected with the intrusions of this granitic magma. The hydrothermal solutions given off in the consolidation of the magma traversed the Cambro-Ordovician strata and on arriving at positions where the chemical and physical conditions were suitable, deposited their content of quartz, gold and other minerals. The granite crystallised, and the quartz reefs were formed some distance below the existing surface of the earth. Extensive denudation of the surface since their formation has removed large thicknesses of the overlying rocks and the granite, and reefs have thus been exposed at the present surface. The alluvial gold deposits are secondary and have been formed by the disintegration of the outcropping quartz of the gold along the courses of the present and former streams.

Cambro Ordovician slates, sandstones and quartzites outcrop over a large area of country in the northern part of the district, and extend for considerable distances beyond the limits examined during the present investigation. Granite is not exposed within the district but occurs at Lisle, Lone Star Creek, and Panama to the immediate north-east of the district. It also outcrops in the Back Creek area some distance to the north-west. The conditions are therefore favourable for the occurrence of gold reefs in parts of the Lilydale district.

Quartz reefs occur in the North Lilydale area but contain little or no gold, and no gold has been found in the Second River in the vicinity. The only alluvial gold in this area is found near a small creek flowing from the south east into the Second River near the North Lilydale bridge. A small amount of alluvial gold is reported to occur in the streams forming the western branch of the Denison River but no reefs have been discovered in this area. General gold bearing reefs have been found and opened up in the area to the north-west of Wyena. Alluvial gold has been found in appreciable quantities in the creeks in this area. Another area in which quartz reefs containing gold occur is that to the north-west of Bangor.

It is apparent from the above that the gold quartz reefs occur in isolated areas between which zones barren of reefs exist. The same fact has been deduced in other goldfields in the north-eastern district of Tasmania. It is probably due to the nature of the earth-movements which affected the strata during the granitic intrusions, particular zones being rendered favourable to the passage of the gold-bearing solutions. An important contributory factor was the nature of the strata, slates being apparently more favourable than sandstones. A large amount of detailed field work would however be required to determine the factors which influenced the formation of zones with gold-bearing reefs and those which are barren.

The lodes are of the quartz-gold-arseno-pyritic type. The quartz is generally the opaque white variety especially when the reefs are barren, but occasionally it is dark coloured and sometimes glassy. Arsenopyrite is the most plentiful sulphide, but galena chalcopyrite and pyrite also occur in small amounts. The gold occurs 'free' i.e. not contained in the sulphides but a small amount is also contained in these minerals.

(A) North Bangor Area

Gold-bearing quartz veins have been reported to occur at two localities in this area.

On G.W. Freeman's property, a number of trenches have been cut along a general line with a trend from north-west to south-east. These trenches were apparently located along the line of a supposed lode, but they are partly filled in at present and little or no quartz is visible in them.

At the north-western and a deep trench has been cut for 50 feet in a generally westerly direction. Loose pieces of quartz are lying around the entrance, but no vein or veins are visible in the sides of face of the trench. The country in the trench is black slates with horizontal bedding or cleavage. Going south-easterly along the trenches pieces of quartz occur to a small extent upon the surface. The exposed portions of the trenches, however, reveal no veins, and if quartz veins were actually intersected they must how be covered by detrital matter or water. Towards the south-eastern end one short trench reveals broken slate cemented by limonite but it is seen to be purely superficial and does not extend into the underlying slates. In the most south-easterly trench a formation 6 to 9 inches wide and containing quartz is exposed. The strike is indefinite but appears to be east and west. This narrow formation containing quartz appears to be the only one exposed in the trenches. If its strike is east and west the other trenches would not intersect its extension if such exists.

The late W.H. Twelvetrees reports that samples taken and assayed by the Government Assayer give the following results:-

Gold	2 dwt. 3 grns per ton
Silver	4 " 11 " " "

These occurrences have no economic importance as far as they have been exposed. There is no evidence to anticipate any imporvement in size or value though this could only be decided by further prospecting work but further expenditure does not seem to be justified.

Mr. Twelvetrees visited and described another quartz vein on McKenna's property to the southeast. It was somewhat wider but contained similar values to that on Freeman's property.

(B) North Lilydale Area. Several veins of quartz and other formations some of which contained gold have been exposed in this area. They occur on both sides of the northern branch of the Second River two and a half miles north-east of Lilydale. These formations have a general trend from north-west to south-east and are therefore parallel with the bedding of the slates and sandstones. A dyke of basic igneous material follows a parallel course on the north side of the Second River and can be traced for a length of nearly a mile. The parallel course of the dyke is suggestive of a relation with the quartz reefs but no direct evidence was obtainable in this connection.

The most north-westerly occurrence of quartz is situated near the road bridge over the northern branch of the Second River at North Lilydale. In a road cutting a few chains east of this bridge veins of quartz occur in a quartzite which appears to occupy the cap of an anticlinal fold in the slates and sandstones. These veins are narrow and of no importance.

In the river immediately to the south-east, it was reported that a quartz reef 15 inches wide occurred but it was covered with water and could not be examined. It is on the same line of strike as the quartzite in the road cutting and probably represents the veins in this quartzite. No gold was reported in the quartz.

R. G. Lowe's Property. Further to the south east along the same strike pieces of haematite with oxides of manganese occur in the cultivated paddocks belonging to Mr. Lowe. Small amounts of quartz and slate are attached to some of the pieces and were reported to contain gold. A short trench did not reveal any of these minerals in depth, but a shallow water-hole and a drainage ditch exposed a formation consisting of slates and the above oxidised minerals together with a small amount of quartz, judging by the dumps from these works. These excavations could not be examined in order to determine whether these mixed slates and oxides represent a lode formation or not. It is stated that a small creek flowing westerly across the strike of this possible formation is the only one in the area along the course of which alluvial gold has been obtained. A grab sample of the haematite and oxides of manganese was assayed in the Geological Survey Laboratory with the following results:-

Gold	Nil
Silver	Trace

A small amount of prospecting work may be justified in order to prove whether a lode formation exists and, if so, what is the size and value of it. The evidence of the alluvial gold and the grab sample are rather conflicting in connection with latter.

(2) B.D. Green (163 acre). The same reef can be traced across the south-west corner of the property of Mr. B.D. Green. It maintains a similar strike and the

quartz is of the same white and barren nature.

(1) Geo. Brown (50 acre) For half a mile to the south-east from the above occurrences, the surface of the ground is covered with a coarse quartz grit, and the bedrock is not visible. On Geo. Brown's property a line of pieces of quartz indicates a quartz reef. This reef has a north-west to south-east coarse and is apparently on the continuation of the line of strike of the above occurrences. The solid reef is not exposed, and the quartz is very white and barren-looking.

(3) G. Somerville (187 acres). The reef continues into the north-western part of this block now owned by Mr. F. Kelp. While apparently on the same line of strike and following a similar course, the character of the reef changes to the south-east. It consists of narrow veins of quartz in a soft sandstone, which however may be the result of weathering and in depth, the soft sandstone may give place to quartzite. This formation may represent an independent, parallel one discontinuous with the above white quartz reef but on much the same line of strike. This formation continues through the property to the north of Mr. Kelp's house and is exposed on the fall to the Second River. Mr. Kelp has had numerous grab samples assayed at different times in the past and stated that gold occurred in most of the samples. Some of the assay certificates showed results up to 3 and 4 ozs. per ton. A grab sample taken by the writer and assayed in the Geological Survey Laboratory gave the following results:-

Gold	Nil
Silver	Trace

The sample was only a grab one as the formation was nowhere exposed to permit of representative sampling. The other results (if the samples were taken from the same formation) indicate that the formation contains gold at some places, and a small amount of prospecting work may be justified. The conditions are favourable for prospecting by adits and a few short adits would expose the formation at selected points along its course. It has not been traced further to the south-east than opposite Mr. Kelp's house, but several quartz veins occur in that direction and may represent the continuation of the above formation.

All these quartz reefs consist of white, barren-looking quartz similar to that in the reef to the north-east described above. A three-foot hole was sunk on one of these and is stated to have exposed a formation 3 feet wide consisting of veins of sandstone but containing no gold.

A shaft was sunk to a depth of 12 feet upon another occurrence. A small excavation near the shaft proves the reef to be three feet wide and to consist of white quartz. The strike was W. of N. and the dip to the south. A representative sample taken across this reef was assayed in the Geological Survey Laboratory with the following results:

Gold	Nil
Silver	Trace

This reef is therefore valueless at this point.

A short trench has exposed a parallel reef to the above to the south east of the shaft. The reef here consists of a narrow vein with an indefinite course. Another trench a short distance to the south-east has intersected the same reef. It occurs in slate country, and has a north-westerly strike and a dip to the south west. Six inches of quartz are visible but it was found that the quartz did not contain any gold.

Further to the south-east a trench was cut to intersect the last two reefs described above. The more southerly reef of the two was cut, but was small. A one-inch vein was intersected to the north-east and probably represents the northerly reef which was cut in the 12 foot shaft.

Kelp and Boultbee's Prospect. These workings are situated on the north side of the road near the south-east corner of G. Somerville (now F. Kelp) 187 acres. Prospecting work was commenced alongside the road and in sinking a shallow shaft, apparently some indication of gold was obtained. A dip tunnel was commenced from road level and driven for about one chain into the top of the spur. A few feet from the entrance a large boulder of quartz was encountered. It is stated that the quartz was of a 'sugary' nature and that samples from it assayed up to 4 oz. of gold per ton.

The entrance was started in soft sandstones and pebbly mudstones. As the dip tunnel descended gravels and grits were passed through and underlying these soft blue clays containing water-worn pebbles. It was stated that the floor of the tunnel at the lowest part exposed slates with a north-north-westerly strike. The sandstones, mudstones, and gravels are horizontally bedded or dip at very low angles. They represent the basal members of the Permo-Carboniferous strata and are probably glacial in origin although no glaciated pebbles were obtainable, the underlying slates of Cambro-Ordovician age forming the bedrock upon which these beds were deposited.

The slab of quartz represented an isolated block of boulder included in the Permo-Carboniferous beds and was undoubtedly conveyed some distance (probably by glaciers) before being deposited. It is therefore, useless to search for the source of the quartz in the immediate vicinity, of where it was found. The work performed was not justified and further work is not recommended.

Thos. Pedin (204 acre). This block is now owned by Mr. P. Brown, and is situated to the north of the Second River. Several occurrences of quartz veins and other formations have been found on this property, but have not been developed.

About five chains east of the homestead, in a cutting on the road, thin beds of sandstone occur interbedded with purple-coloured slates. The sandstones contain thin veins of quartz and casts of cubical crystals of probably pyrite are visible. The formation is small and indefinite and is of no economic importance.

In the cultivated paddocks immediately to the north of the road cutting, pieces of material composed of oxides of iron and manganese, occur. Similar material is also said to occur to the south of the road, but in less quantity. The material is similar to that found on Mr. Lowe's property, one and a quarter miles to the west.

No attempt has been made to obtain this material in the solid, and it can not be stated whether it overlies a lode formation or not.

A loose piece was assayed in the Geological Survey Laboratory with the following results:-

Gold	Nil
Silver	Trace

The material does not, therefore appear to be gold bearing, and it is doubtful if further work is justified. Any work performed should be directed towards obtaining the material in the solid if it so exists.

Going south from the cutting through the cultivated paddocks on northerly flank of the ridge between Second River and Fern Creek, numerous lumps of quartz are met with. The quartz is a dense white variety, and contains greenish patches probably representing residual material from the replaced slates. There appears to be one main reef with a strike from north-west to south-east, but small quantities of similar quartz are found right to the summit of the ridge and suggest other small reefs. A grab sample was assayed in the Geological Survey Laboratory but was found not to contain any gold.

At the summit of the ridge near the south-west corner of the property, a formation of quartzites and soft sandstones with quartz veins occurs. The quartzite contains small cubical crystals of iron pyrite. The strike is from north-west to south-east, and the formation can be traced some distance to the south-east. A grab sample was assayed in the Geological Survey Laboratory with the following results.

Gold	Nil
Silver	Trace

The quartz does therefore, not contain any gold and as is the case with the majority of the formations consisting of quartz veins in quartzites it is of no economic value.

F.L. Rees (now Kelp) and M. Boultbee. A large amount of quartz is shed over the adjoining portions of these properties and is derived from probably a large quartz reef with a strike from north-west to south-east. This reef is approximately along the line of continuation of the quartz reef on P. Brown's property to the north-west, and may represent the extension of the latter. The quartz is of a white and barren-looking nature. A shaft was sunk on this reef at the south-eastern end, near the northern boundary of H. Boultbee's land. The shaft is now filled with water, but the large quantities of quartz on the surface testifies to the presence of the reef in the shaft. A grab sample was assayed at the Geological Survey Laboratory with the following results;

Gold	Nil
Silver	Trace

The quartz is therefore, of no value, although a representative sample instead of a grab one would have been more desirable to settle the point. If a representative sample confirms these results, further work would not be recommended.

Conclusions. Although a number of quartz reefs and formations of quartz veins in sandstone and quartzite have been found, they have not yet been proved to be of any value. Assays of samples obtained by private individuals from some of the outcrops showed the presence of gold and silver. Only a very small amount of work has been carried out and the conditions were not suitable for obtaining representative samples. The grab samples taken during the investigations yielded no gold and only a trace of silver. The absence of gold in detectable quantities in the streams also, points to the fact that the quartz reefs carry little if any, gold. The only work that is at all justified is such that would expose them in the solid at a few points along their course, particularly where gold has been shown to exist by assay. This procedure would definitely decide the widths and values of the reefs and formations at these points, and prove whether any further work was justified.

(C) Lebrina-Wyena Area. Gold has been obtained in small quantities from the alluvial material along the course of Drinkwater Creek. A small stream flowing easterly into the Denison River. These deposits are not wide or of any large extent, and are often restricted to the actual bed of the creek. The gold has been derived from the lodes contained in the mineralised northern part of this zone. It is stated that 40 to 50 ounces of gold were obtained from the shallow portions of the deposits, but that the deeper portions have not been worked. In this yield there was included a small nugget weighing 13 dwt.

Quartz Reefs. A number of quartz reefs occur in a small zone extending from the Lebrina Gold Mine in a north-easterly direction to the Drinkwater Creek. A large amount of surface prospecting has been carried out within this zone but only at the Lebrina Mine at the south-western end has underground mining taken place.

Lebrina Gold Mine. This mine was situated upon Lease 883/G of 20 acres an adjoining lease 868/G of 10 acres, also being held. These leases were taken up during the latter half of 1909, and the reefs were apparently discovered at a somewhat earlier date. The Lebrina Gold Mining Co. N.L. was formed and worked the mine until 1911. The work carried out was chiefly prospecting on the surface. The Lebrina Gold Mines N.L. was formed in 1912 and carried on operations until 1915. or 1916, when financial troubles arose and the mine has been idle since.

In addition to several prospecting shafts, the underground workings consist of two adits and a main shaft from which a level was opened up at 100 feet.

The No. 1 adit was driven from the small gully to the south of the Lebrina-Scottsdale road in a northerly direction. The reef was cut at 40 feet and was driven on to the north-east for 170 feet where the drive

connects with the underlay prospecting shaft from the surface, The maximum heights of backs was obtained at the shaft, but amounted to only 30 feet.

The No. 2 adit was commenced 310 feet to the south-west of the No. 1 adit. It was driven in a north-easterly direction for 150 feet and cut the reef. It then followed the reef to the north-east for a distance of 410 feet connecting with the underlay shaft and going to the north-east of it, 60 feet of backs being obtained at the shaft.

The main shaft was sunk from a point 30 feet north-east of the entrance to the No. 1 adit. It was a vertical shaft, 10 feet by 4 feet, with three compartments, and with a depth of 100 feet. A crosscut was driven to the north-west and cut the reef at 35 feet. Drives followed the reef at this 100 foot level to the north-east and south-west for distances of 80 feet.

These workings can only be entered for a few feet beyond the entrances of the adits and the important portions of the mine could not be inspected. They have proved the reef to have a strike of 50°, with dips varying from high to the south-east to high to the north-west the resulting dip being vertical. The width of the lode varied from a few up to 24 inches, the average being about 10 inches. The reef is not exposed at the surface being covered by the thick accumulation of soil, but its presence is indicated by the numerous fragments of quartz in the soil. Where out by the No. 1 adit the reef was narrow and appeared to be pinching out to the south-west. One foot of quartz was visible to the north-east and the reef was stoped to the surface for a distance of 108 feet in this direction. Another small block of ground was also stoped between the above and the 60 feet underlay shaft. The No. 2 adit cut the reef further to the south-west than the No. 1 and the reef was only a few inches wide. The same shoot of gold-bearing quartz was probably intersected as it is stated that stoping was carried above this level to the No. 1 adit. The last parcel of quartz taken from the mine was obtained from the north-eastern and of thislevel where it connected with the 60 feet underlay shaft. It is stated that the sheet occurring here was 14 to 30 feet along with a pitch to the north-east abd was still going under foot where stoped. The parcel of 11 tons yielded 5 oz. 12 dwt. of gold by amalgamation, so that the gold content was slightly in excess of 10 dwt per ton.

The 100 feet level from the main shaft is stated to have proved the reef to be poor and mullocky. A small amount of stoping was, however, carried out from a rise between this level and the No. 1 adit. The stoping probably represents portion of the downward continuation of the sheet of stone cut in the adit levels.

The quartz from the 60 feet shaft was generally of an opaque, white nature and contained numerous vughs. Arsenopyrite was visible in the stone and pyrite was also reported to occur.

About 40 feet north-east of the 60 feet shaft, a 'break' is stated to occur, and the reef is apparently faulted and thrown 20 feet to the south-east. In the vicinity of the fault the reef is reported to be 4 inches wide and to contain gold. A trench on the faulted portion did not reveal any reef, but another to the north-east exposed what was taken to be the track of the lode. A 60 feet shaft, 140 feet north

east of the fault, was sunk with an underlay to the south-east, and exposed a small amount of quartz.

At a distance of 66 feet to the north of this shaft the reef junctions with another, known as the East reef, and it has not been traced to the north-east of the latter.

The East reef has a strike of 310° which is similar to the general strike of the strata of the area. Its nature varies from point to point but it represents a formation composed of veins of quartz in a bed of quartzite. The quartz is of the white opaque variety common to these formations. A vertical shaft was sunk to a depth of 45 feet from a point 30 feet north-west of the junction of the two reefs. In this shaft the formation was 5 to 7 feet wide and a narrow vein of quartz in this centre carried gold. A trench on the formation about 250 feet north-west of the shaft proved the formation to be 18 inches wide and to contain gold. To the south-east of the junction, another shaft was sunk (by an old Scottsdale Company it is reported) and a short cross-cut driven to cut the reef. It is stated that the formation was six feet wide with a rich leader, one and a half inches wide. Nearby this shaft the quartzite with numerous quartz veins outcrops prominently.

The mine was equipped with a head-frame, winding engine and stationary boiler, and a 10 head battery and plates were installed to treat the ore. The underground workings revealed the presence of shoots of gold-bearing quartz sufficiently rich to stope and treat. Whether these operations were profitable or otherwise, cannot, in the absence of records be determined. The richest stone was apparently obtained above the No. 1 adit the remainder being of relatively lower grade. The grade of the last parcel removed was only 10 dwt. per ton. A 9 inch sample from the surface of the 60 feet underlay shaft assayed, in the Geological Survey Laboratory, 2 dwt. 14 grs. of gold and 1 dwt. 7 grs. of silver. The width of the reef did not exceed 24 inches and averaged much less that that figure. It was unfortunate that the battery was installed before the presence of payable stone of sufficient value to warrant this step, was proved. The capital used for this purpose would have been spent to greater advantage if used to further exploit the reef in a search for gold-bearing sheets. Whether the expenditure of further capital is warranted cannot be stated in view of the lack of facilities for examination of the mine.

Other Occurrences. Numerous other veins and reefs of quartz have been exposed to the east-north-east of the Lebrina Mine. Many of these have similar bearingsto the Lebrina reef, but represent parallel, but discontinuous reefs along a general mineralised belt, rather than an extension of the Lebrina reef.

Towards the eastern boundary of the 20 acre section two trenches have revealed narrow veins of quartz, which are situated to the south of any extensions of the Lebrina reef to the north-east. In one of these trenches a vein has a bearing of 65° with a dip of 75° to the south. It occupies a cross

fracture in a sandstone bed, the quartz being of a whitish nature and reported to contain gold. No quartz is visible in the upper part of the trench, but a track four to six inches wide occurs.

To the east of the small gully, several veins and reefs more or less parallel, occur and outcrop along the low ridge between two headwater gullies of the Drinkwater Creek. The northern most of these reefs consists of white barren-looking quartz upon which a small prospecting shaft was sunk to a depth of 35 feet. The strike is 60° - 70° and this reef is probably cut again several chains to the east.

About 1½ chains to the south of this shaft, another has been sunk on a parallel lode. The strike is 70° and the dip 80° to the north, but is somewhat less in the bottom. The reef varies in width up to one foot. The quartz contains numerous vughs and is heavily mineralised, the sulphide minerals occurring being arsenopyrite, pyrite, chalcopyrite, and galena in that order of relative abundance. This reef has not been exposed further to the north-east, although its mineralised nature warrants further search.

To the east of the mineralised reef several small trenches indicate a reef with a bearing of 30° to 40°. A small shaft, 2 to 3 chains to the north-east appears to have cut this reef as it exposed a six-inch vein of quartz with a strike of 40° and a dip to the north-west. This vein does not appear to be mineralised, and would intersect the mineralised lode if both continue to the north-east.

Further to the north-east, an excavation has exposed a large body of white quartz apparently representing the continuation of the northernmost of the above reefs. The northern wall is vertical and has a bearing of 70°. A large bulge occurs on the southern side and dips south at 45°. A shaft was sunk to 30 feet on this side to cut the quartz on the dip, but did not intersect any as far as can be seen from the dump, so that the bulge does not persist in depth. This reef has also been cut further to the north-east where 3 to 4 feet of white quartz is exposed.

In the bed of Drinkwater Creek, near the north-east corner of F. Kelp's timber lease, another reef has been revealed. It has a footwall of sandstone, against which the quartz is striated. The strike of the reef is 320° with a high dip to the south-west. The width varies from 12 inches to 20 inches in local bulges. Alluvial gold including a 13 dwt. nugget has been obtained from the creek in the vicinity of this reef. A representative sample was assayed in the Geological Survey Laboratory with the following results:-

Gold	Nil
Silver	Trace.

so that the reef is valueless.

To the north-west of the last occurrence and on private property belonging to Mr. Kelp, numerous pieces of material consisting of oxides of iron occur on the surface. At one locality numerous trenches have been cut and revealed a capping of this material, three feet in width. Underlying this are several veins of

quartz containing pyrite and which represent fissure fillings. The formation is vertical with a strike of 55°. No gold was apparently obtained from this formation.

On the east side of the gully to the east of the Lebrina Mine and to the north-west of the three parallel reefs described above, another lode has been intersected. It has a strike of 55° and a vertical dip, up to one foot of mineralised quartz being visible.

Conclusions. It has been shown above that the Lebrina Mine area contains a number of gold-bearing mineralised quartz reefs. These form an auriferous mineralised zone extending from the Lebrina Gold Mine in a general east-north-easterly direction for about half a mile. The reefs, with the exception of the East reef, occupy fault fissures, and are therefore likely to attain some persistency in length and depth. The Lebrina reef has been the most important one and the ore which has been mined from this reef and treated in the battery of the Lebrina Mines, but with what result can not be stated. Further prospecting work is justified in a search for other reefs or for shoots of payable stone in those already discovered. In common with other portions of the north-eastern district, the reefs do not attain any great width.

Tertiary Alluvial Deposit. Old river gravels and conglomerates are exposed in the railway cuttings immediately to the west of Denison Gorge between Lebrina and Wyena. They are composed of pebbles and boulders of slates and sandstones together with a few rock types foreigh to the neighbourhood, in a finer matrix. At some points, finer grained layers composed wholly of slate fragments are visible. No quartz was obtainable from these deposits. The trend of these deposits is to the north-north-west and they can be traced as far as the hill to the east of Lebrina station where they are covered by the Tertiary basalt. Search further to the north-west would probably prove them to extend further in that direction.

Although, where visible, these alluvial deposits do not traverse strata containing auriferous lodes, a small amount of prospecting work is justified in order to determine whether they contain gold or otherwise, as quantities of it may have been transported by the ancient streams.

(D) Lilydale Area. A vertical shaft was sunk to a depth of 96 feet in the flats bordering Beak's Creek, half a mile to the north-east of Lilydale. The surface here is occupied by recent alluvial which probably extends to shallow depths. From descriptions of the material obtained from the shaft it is evident that pebbly mudstones of the Permo-Carboniferous system were encountered. These strata were mistaken for 'wash' and the shaft was sunk in an endeavour to reach 'bottom' with a view to locating gold deposits. As it is evident that Permo-Carboniferous strata were sunk through, no payable deposits of alluvial gold would be met with even if the bedrock of Cambro-Ordovician strata were met with.

(E) Underwood Area. It was reported to the writer that gold occurred in pyritic quartz veins on

the property of Mr. J. Burns, one and a half miles to the west of Underwood, and on the south side of Pipers River. A few small excavations were made on these veins, but they were in the bed of a small creek and were completely covered by water at the time of the writer's visit. The surrounding country is composed of diabase, and the occurrence of quartz veins and gold in this rock is rare in Tasmania, though a few cases are known to occur. No deposits of any commercial importance have, however, been found in the diabase up till the present. It is unfortunate that this occurrence could not be examined, as the presence of gold was reported to have been determined by assay in the Geological Survey Laboratory.

VIIL Conclusions

The geological examination of the Lilydale-Lebrina district has shown that some of the reported occurrences have no economic importance while others may have, but require further development. The prospects of locating coal seams are small although small quantities may be discovered around Underwood, but will have only a limited extent. Oil-shale containing 15 - 20 gallons of oil per ton has been located in one portion of the district, but further prospecting work is required to prove the extent, thickness and oil content of this shale before the deposits can be said to possess economic value or not. The beds of limestone are worthy of further prospecting in order to determine the thickness and quality which may prove suitable for its extraction and treatment for agricultural and lime burning purposes. The future exploitation of the Bangor slate deposits depends upon the quality and method of working as affecting the cost of production, but in the absence of facilities for examination and also records of past workings, these factors could only be decided by further development of the deposits. Some of the sandstones beds may prove suitable for building and monumental purposes. The gold quartz reefs have not proved to contain gold in payable quantities as so far developed. The Lebrina-Wyena area is the most favourable one for the occurrence of such reefs and further prospecting is recommended. In the other areas any justifiable work to prove the reefs, is outlined.

P.B. Nye M.Sc., B.M.E.

GOVERNMENT GEOLOGIST

Hobart.
21st January, 1924.