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DEPARTMENT OF MINES

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No. 46

THE GEOLOGY OF THE ROSSARDEN-STOREYS CREEK DISTRICT

by

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Fig. 1.—Aberfoyle Mine, looking north-west towards Ben Lomond.

FOREWORD

This Bulletin presents a comprehensive account of the Physiography, Geography, History of Development, Stratigraphy, Structure and Economic Geology of the Rossarden-Storeys Creek District.

Officers of this Department have, in the past, made numerous geological investigations in the district and many reports, published and unpublished, have been prepared on individual prospects and on various aspects of mineralisation in the area. In 1929, the Rossarden-Storeys Creek District was described by Reid and Henderson as part of the Avoca Mineral District (Bulletin 40) but since then no truly regional study has been attempted. The author's aim in preparing this Bulletin has been not only to make available to the public a collation of all these reports but also to considerably supplement or amend the conclusions and recommendations of previous authors in the light of his own observations in the field. Mr. Blissett's work was hampered to some extent by the fact that many of the old prospects and mines had fallen into disrepair so that re-examination of them could not be attempted. However, by detailed study of present workings and of the literature on former workings, he has drawn an extremely useful picture of the regional pattern of mineralisation and has made recommendations with regard to future exploration and development.

As this region contains the principal tin-producing mine in the State and the largest individual producer of wolfram in Australia, as well as resources of coal, silver-lead and uranium, this up-to-date account of mining activities and indications of the future prospects of the area should prove a welcome addition to the mining literature of Tasmania.

J. G. SYMONS, Director of Mines.

Department of Mines,
Hobart, February, 1959.

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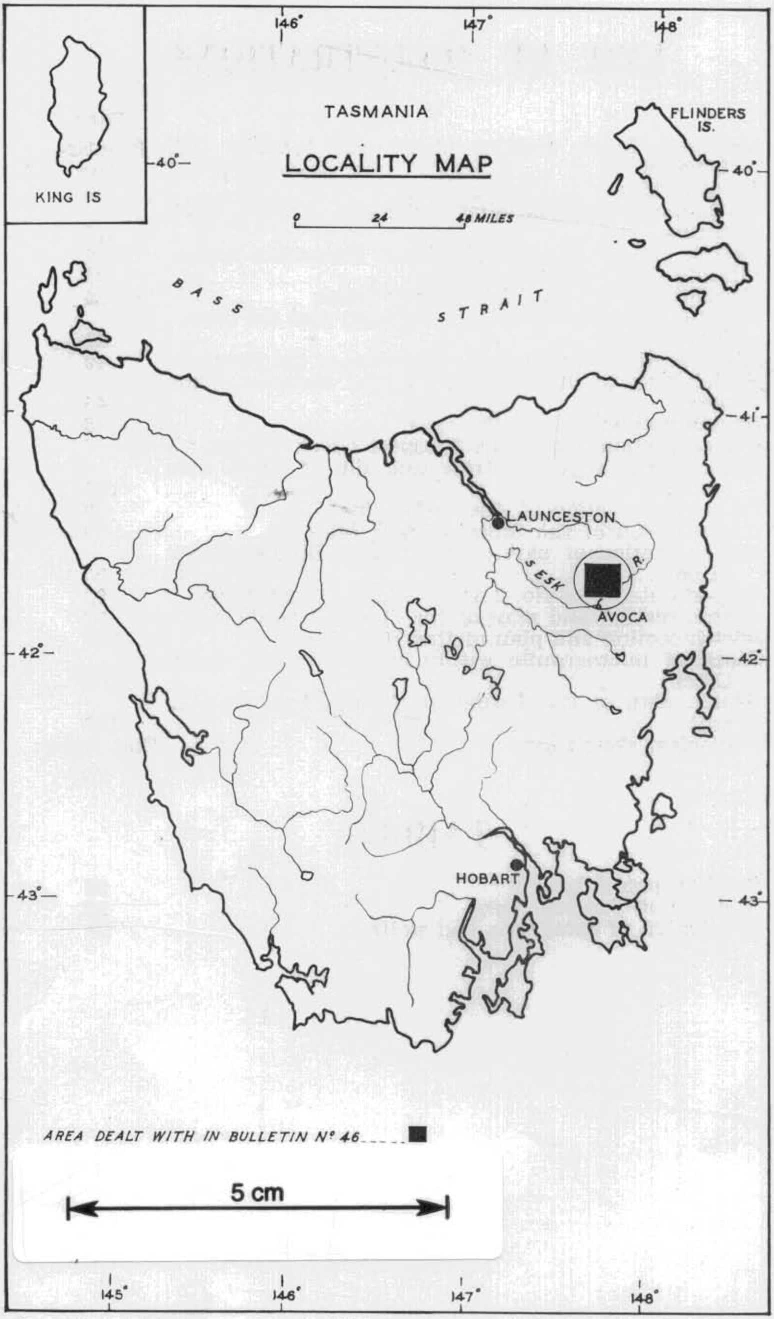


Fig. 2.—Locality map.

Geological Survey Bulletin No. 46

The Geology of the Rossarden-Storeys Creek District

ABSTRACT

The dissected plateau between Ben Lomond and the South Esk Valley in north-eastern Tasmania has attracted attention for at least 70 years because of the tin and tungsten mineralisation. Silver-lead also occurs, and uranium was discovered in 1955. Coal has been worked since about 1905 south and south-west of Rex Hill.

The plateau owes its structure to a basement of Lower Palaeozoic rocks which in Devonian times was intensely folded, and intruded by the Ben Lomond granite with accompanying mineralisation. After peneplanation, during which the granite was partly unroofed. flat-lying Permian grits, sandstones and mudstones with a local development of limestone were deposited, followed conformably by Triassic sandstones, with coal seams in the upper beds. The Jurassic was marked by a wide scale intrusion of dolerite which was followed in early Tertiary times by block faulting. Further uplift may have taken place in the late Tertiary or Pliocene. Long erosion has since shaped the present topography with only minor modifications by Pleistocene glacial activity.

The area has yielded nearly 13,000 tons of tin concentrates and about 10,000 tons of wolfram, as well as important quantities of coal.

1 Introduction and Acknowledgments

This Bulletin describes the geology of about 80 square miles round the townships of Rossarden and Storeys Creek, which are based on the small but important tin and tungsten mineral field associated with the Ben Lomond granite complex. Since 1881, the area has been examined by a number of geologists, but such investigations have usually been confined to specific mines or prospects rather than a regional survey. The last general survey was made in 1928 by Reid and Henderson as part of the Avoca Mineral District, described by them in Bulletin No. 40.

The area was mapped on aerial photographs on a scale of 1 inch to 30 chains (1:23,760). Heights were determined by aneroid barometer set daily at Aberfoyle mine and corrected when necessary by reference to a barograph. Bearings were taken by prismatic compass, and an Abney level was used to measure the inclination of structural planes, veins or gradients. Radioactivity was measured by a Phillips Austronic geiger counter, Type PRM 200. Detailed mapping was by tape, compass and Abney level. All bearings refer to magnetic north.

Field work was carried out between September 17th, 1957 and December 19th, 1957 and from January 14th, 1958 to April 1st, 1958. Much of the latter period was devoted to the examination of the underground workings at Storeys Creek mine, logging cores from the Old Battery diamond drill hole at Aberfoyle mine, and to detailed mapping of the host rocks round the two mines. Geologist A. B. Gulline assisted in the field work from October 14th, 1957 to December 19th, 1957 and January 14th to January 31st, 1958. T. W. Johnstone acted as field assistant.

We received great help from the management and staffs of the various mines concerned both in guidance underground, and in placing mine records at our disposal. We are grateful for permission to publish information relating to their respective workings. In particular, we are indebted to Mr. A. E. Dainton of Aberfoyle Tin N.L. who was also kind enough to arrange our accommodation; Mr. R. R. McGhie and Mr. G. Dixon of Storeys Creek Tin Mining Co. N.L., Mr. M. C. W. Boucher of Tasmania United Uranium N.L. and Mr. T. Bailey of the Stanhope Mine.

Mr. K. T. Kendall, Senior Draughtsman of the Mines Department, Hobart, supervised the production of the base map from aerial photographs by the slotted template method and controlled by trigonometrical points. He also was responsible for the final drafts of maps, plans and sections prepared by the Drawing Office Staff.

Previous bulletins and reports have yielded much valuable information, especially on old workings which are now inaccessible or overgrown.

To avoid confusion, the township and mine of Storeys Creek are referred to as such, while the name Story Creek is used in the Bulletin for the rivulet. The latter title is the correct name, but " Storeys Creek " has become widely used in Tasmania.

2 Location and Communications

The area mapped is bounded to the north by the high Ben Lomond Plateau which rises to over 5,000 feet, and in the west by the Castle Carey Fault, which was followed from the western side of Ben Lomond, south-east towards the township of Avoca. In the east, mapping extended to the unconformity between the Permian and the underlying Mathinna Group on the Rossarden to Mangana road.

The area is wholly within the county of Cornwall. The only settlements are Rossarden, centred on Aberfoyle Mine, and Storeys Creek based on the workings of the Storeys Creek Tin Mining Co. N.L. The nearest town is Avoca, sited in the South Esk valley, 17 miles east of Conara Junction, on the main bitumen road, and on the Fingal railway line from Conara to St. Marys. A gravel mountain road connects Storeys Creek with Avoca, 14 miles to the south. About three miles south of Storeys Creek, a branch road bears north-east through Rossarden, two miles away, and continues to Mangana, about 17 miles to the east. A gravel road links Storeys Creek with the Mangana road which it joins two miles north of Rossarden. The old Storeys Creek to Mangana road is now disused and blocked by fallen trees.

The Gipps Creek area is reached by a bush track from the Avoca-Storeys Creek road branching to the north-west at about eight miles north from Avoca. Beyond the bridge over Buffalo Brook, the track becomes rough and partly washed out, though still accessible by utility, truck or Landrover. The low lying sections may become boggy in wet weather. There are timber bridges over Sundial Creek and Buffalo Brook, but not over Gipps Creek, which is shallow, narrow and strewn with boulders.

About four miles north of Avoca, the road to Stanhope Colliery turns off to the west. Beyond Buffalo Brook which is littered with boulders and not bridged, it is merely a rough track suitable only for a Landrover.

A rough road two miles long was cut by the Mines Department from Rossarden south-west to the workings of Tasmania United Uranium N.L., while other roads shown on the map are forestry or prospecting tracks which usually offer easy access especially in the north and north-west.

3 Physiography and Geography

I. GENERAL.

The area described in this Bulletin forms plateau country up to about 2,900 feet above sea-level, between the high dolerite plateau of Ben Lomond which reaches an altitude of 5,000 feet in the north and the South Esk rift valley at about 650 feet above sea-level to the south. The present topography was formed by the block-faulting of a peneplaned terrain of Lower Palaeozoic slates, greywackes and quartzites intruded by Devonian granites, upon which horizontal Permo-Triassic sediments were deposited. In the north, streams have partly removed the Permo-Triassic cover and have exhumed the old pre-Permian land surface. In the south, most of the Permo-Triassic has been eroded away except for small outliers and the streams have cut deeply into the underlying granite and lower Palaeozoic basement. The drainage pattern is a youthful one, modified by a local base-level in the north round the Ben Lomond Marshes, the Rossarden area and near Mistletoe Creek. It is inferred that the main drainage was superimposed from Permian or Triassic formations.

II. DEVELOPMENT OF LANDFORMS.

(*a*) History.

The basement rocks are the slates, siltstones, greywackes and quartzites assigned to the Mathinna Group which were intensely folded along north-westerly trending axes during the Tabberabberan orogeny and later intruded by the Ben Lomond granites. The Mathinna Group is believed to be of Upper Silurian or Lower Devonian age, and the granites Middle Devonian. Peneplanation was well advanced prior to the deposition of Permian sediments. The Mathinna beds were entirely removed from the centre of the granite complex, the top of the granite was planed off, and the Permian was laid down on an uneven jointed surface of granite and Lower Palaeozoic rocks.

About 1,200 feet of Permian and Triassic rocks were deposited, followed in Jurassic times by the injection of a dolerite sheet up to at least 1,000 feet thick into Triassic rocks. This dolerite injection was accompanied by faulting.

Large scale block faulting occurred in Lower Tertiary times when the main structural features of the present topography were formed. It is possible that renewed uplift took place in late Tertiary or Pliocene times, resulting in rejuvenation of the streams in the area.

(*b*) Structural controls.

Block faulting has given rise to horst and graben structures with a gentle southerly tilt, forming plateau country at different levels, and showing variable degrees of dissection, depending on the relative movement of each particular block.

In the west, on the uplifted block between the Castle Carey Fault and the Gipps Creek Fault, the streams have cut into granite below the pre-Permian surface, leaving a few scattered patches of lower Permian rocks.

From north to south, the relief becomes more marked, as far as McGintie Tier which forms rounded hills and tors rising more than 1,000 feet out of the valley of Castle Carey Rivulet. The patches of Permian grits and sandstones form low regular hills in the north, and long flat ridges capping rounded granite hills in the more deeply dissected area in the south.

Between the Gipps Creek Fault and the Egan Creek Fault, higher Permian rocks are preserved on a downthrown strip of country drained by Gipps Creek, Buffalo Brook and Egan Creek, which includes the Ben Lomond Marshes formed by a thin cover of permeable Permian sandstones and grits lying on peneplaned granite. Near the point where Buffalo Brook and Egan Creek cross the Gipps Creek Fault, the pre-Permian granite surface has been uncovered and slightly eroded over a small area. Further south, on the west flank of the Castle Carey Rivulet, the granite is deeply dissected, forming a steep slope with rounded crags, and strewn with quartz gravel derived from decomposed coarse granite. A long sloping ridge of Permian grits and sandstones still remains above the granite at the summit.

The Castle Carey Rivulet flows southwards within the Prospect Creek Trough, in which up to about 500 feet of Permian rocks are preserved. The valley is V shaped with the western slopes steeper than the eastern since the stream flows near the western boundary fault, and the Permian rocks, although indurated, are less resistant than the granite which occurs on both sides of the trough. The granite surface has been exposed below the Permian in a small elongated patch immediately north of the point where Prospect Creek flows into Castle Carey Rivulet, and also in the north, east of the Gipps Creek road junction, in the valley of a small south-easterly flowing tributary of Story Creek. The latter exposure is explained by the gentle southerly tilt of the Prospect Creek Trough, confirmed by a dip of 6° in the lower Permian in Prospect Creek. North of the head of Castle Carey Rivulet, the Permian rocks form an irregular plateau surface littered with fragments of mudstone and siltstone, often fossiliferous, up to the Egan Creek Fault.

The area north-east of the Egan Creek Fault has a flat or gently sloping surface of granite, with numerous patches of lower Permian grits and sandstone, which rises up to the talus slopes of Ben Lomond. There has been little erosion since the pre-Permian surface was exposed so that the area is frequently swampy, and is drained by south or easterly flowing streams. Further to the north-east, the Permian has been entirely removed, and the pre-Permian surface of granite and Mathinna sediments has been carved by tributaries of Story Creek.

Permian rocks are again preserved in the Aberfoyle Trough. The existing surface slopes gently towards Story Creek which has slightly eroded the pre-Permian peneplain. Southwards, prolonged erosion has led to rugged relief over the whole area east of the Prospect Creek Trough. Gorges and rapids are common in the lower reaches of Story Creek and Aberfoyle Rivulet. East of the Aberfoyle Fault, a patch of Permian forms a gently sloping plateau between the fault and Aberfoyle Rivulet, the eastern boundary of which is marked by a line of cliffs high above the steep west bank of the rivulet.

In the north-east of the area mapped, an extensive capping of horizontal Permian rocks up to at least 400 feet thick forms a plateau shaped into long ridges by east and south-easterly flowing streams whose valleys have cut deeply through the underlying Mathinna beds. The unconformity is emphasised by an almost continuous line of cliffs at an altitude of about 2,120 feet round the upper reaches of Burnt Gully Creek, where the base of the V-shaped valley lies about 800 feet below the top of the plateau.

Along the whole northern boundary, the solid formations are obscured by an irregular talus slope of dolerite from the Ben Lomond Plateau. The talus slope is formed of blocks and boulders of dolerite in piles and hummocks rising steeply up to the base of the plateau, causing local disarrangement of the drainage pattern.

(*c*) Effects of lithology and minor structures.

(1) *Mathinna Group.*

On the pre-Permian surface, where little erosion has taken place, the mantle is thin and composed chiefly of angular fragments of quartzite and milky quartz, and occasionally smaller fragments of less resistant slate. In dissected areas, particularly in the valleys of the eastern streams a characteristic relief pattern has evolved, controlled by differences in rock types and also the dominant structural trends. The grain of the country trends north-westerly, with overturning of folds to the north-east. In the finer slates a regional cleavage direction was superimposed with trends a few degrees from the strike of bedding, producing prominent planes of weakness which hasten the effects of weathering. The resistant quartzites and siltstones from conspicuous strike ridges separated by lower areas occupied by more easily weathered slates. The ridges may be marked by angular crags and steep craggy valley sides with angular screes. Streams are often tortuous, with interlocking spurs, rapids and small pools. The drainage pattern is roughly parallel or angular.

(2) *Granite.*

Where the peneplaned surface is intact, the ground is frequently swampy with a mantle of quartz gravel through which low rounded domes of granite may project. Flat-lying joints due to weathering may be seen.

Eroded areas are marked by rounded tors and crags, and steep slopes marked by quartz gravel. Streams follow sinuous courses, with smooth gorges, rounded falls and rapids, potholes and stream beds littered with rounded boulders.

(3) *Permian rocks.*

The flat-lying Permian rocks have differing effects on topography. The Aberfoyle Formation includes a very variable association of permeable grits, conglomerates and sandstones which form gently rounded hills, the lower parts of which are frequently strewn with fine quartz gravel, and pebbles or small boulders of Mathinna quartz and quartzite derived from the weathering of conglomerates, as well as fragments of the rocks in the formation. Where these rocks rest on dissected granite or Mathinna beds, the junction is often shown by a line of seepages, for example west of the Rossarden bridge, and along the Gipps Creek road. If the pre-Permian surface has not been uncovered, marshes and small pools may occur, as in the Ben Lomond Marshes.

The Castle Carey Mudstone and the Prospect Creek Mudstone give rise to flat ridges and hills with scattered rock fragments. The former includes yellowish weathering shales and mudstones with fossils in the higher beds, while the latter is characterised by screes of uniform pale creamy or pale grey unfossiliferous mudstones and siltstones which are often siliceous and cherty.

Since it is thin, the Burnt Gully Limestone has only minor effects on the topography. It may sometimes be recognised by small, gentle, grassy slopes through which rounded lumps of limestone project.

The Mistletoe Sandstone is occasionally indicated by small rounded hummocks of sandstone or conglomerate with shale fragments.

(4) *Triassic Rocks.*

The Triassic sandstones west of the Castle Carey Fault are characterised by undulating topography, with a fairly deep sandy soil, and rounded hills towards the north where the dolerite cover has been worn away. Bands of mudstone or shale form gentle slopes and flats.

(5) *Dolerite.*

Near Stanhope and round Lawson Hill, the dolerite sill is marked by steep crags with talus slopes of dolerite blocks or rounded boulders, protecting the underlying Triassic rocks.

III. DRAINAGE PATTERN.

All the streams in the area are tributaries of the South Esk River, which flows south-westerly to the south of the area, and the regional drainage forms a roughly radial pattern round the Ben Lomond plateau, with modifications imposed by block faulting and by differences in lithology and minor structures. All the streams are ungraded and downward corrasion is dominant, except in the flat areas round the Ben Lomond Marshes, Burn Marsh and west of Mistletoe Creek which form local base levels. Drainage was probably superimposed from horizontal or gently tilted Permian or Triassic beds which have since been mainly removed.

Buffalo Brook cuts deeply through the granite as far upstream as the Gipps Creek Fault a short distance below the flat alluvial patches in Buffalo Brook and Egan Creek, and headward erosion will continue northwards, as in Story Creek.

North of the Storeys Creek Mine, Story Creek runs off the steep slope of the Ben Lomond Plateau, and gravels have been deposited over most of the section from the mine to Tasmania Creek. Alluvial flats extend a short distance up Tasmania and Tiger Creeks.

South from the Storeys Creek Mine, the creek flows south-easterly along the strike of the Mathinna beds as far as the Burn Marsh Fault where it turns a little west of south. South of Rossarden it cuts through gorges and rounded spurs, and forms rapids, entirely in granite country as far as the junction with Aberfoyle Rivulet. Near Hughes' Prospect, the stream makes a marked turn eastwards, possibly caused by an extension of the Egan Creek Fault.

Aberfoyle Rivulet and its tributary, Mistletoe Creek also flow down the talus slope of Ben Lomond and there is an extensive spread of gravels for about a mile, east of a fault trending north-westerly.

From this point to Aberfoyle Mine, the rivulet cuts deeply across the grain of the Mathinna Group with many sharp bends induced by strike ridges of quartzite. South of the mine, the stream tends to follow the general strike of the country rock, turning to the south-east and then due east until it turns south at right angles to the contact of the granite and Mathinna beds. For the rest of its course, the rivulet flows south-easterly within a steep V-shaped valley over granite near to and almost parallel with the contact.

IV. CLIMATE AND RAINFALL.

The climate of the district generally is mild and temperate. The average annual rainfall is about 36 inches, but this may often be exceeded, as for example from October, 1955, to September, 1956, when 65 inches were recorded. Rain falls throughout the year with maxima in the winter months, when part of the precipitation may be in the form of snow on Ben Lomond and the higher parts of the plateau. Run-off is high and in summer, the smaller streams generally dry up.

Flow in the larger streams such as Story Creek and Aberfoyle Rivulet is much reduced, and in a particularly dry summer may practically cease. Under such conditions, dams are necessary to conserve water for ore processing.

V. VEGETATION.

Various types of eucalypts occur on practically the whole of the area mapped with, in part, an undergrowth of ti-tree, wattle and scrub. The area with only eucalypt vegetation is generally open and confined to granitic country, Mathinna rocks or to steep sunny slopes. The undergrowth tends to be thicker on Permian formations and is usually dense on shaded slopes or in gullies.

Much of the eucalyptus is suitable for use in building or as mine timber. There are several old abandoned sawmills in the district and there is no shortage of wood for fuel.

4 History of Exploration and Development

The first record of mining activity was given by G. Thureau in 1881. Much of the Gipps Creek and Story Creek areas were being actively prospected, although only one mine (probably the Ben Lomond Mine) was actually producing tin. Some alluvial ground in the upper reaches of Story Creek and in Archer Creek was being worked on a small scale. It is possible that the thin outcrops of the veins later worked by the Story Creek mine were found during this period, although they are reported as being discovered in 1890. When Thureau investigated the area, interest was centred mainly on the mineralisation in the granite between Gipps Creek and the Ben Lomond Marshes. Reid (1929) states that mining started in 1872.

In 1891 and 1892, A. Montgomery examined in detail the main mineral bearing sections. Prospecting had spread to the Story Creek area, and also around Rex Hill. Near Gipps Creek, the Ben Lomond mine and also the Long Tunnel mine had been abandoned after producing only small amounts of tin. The Great Republic was in production, and up to the end of February, 1892, a total of 132 tons of cassiterite had been won from 1,560 tons of ore. In 1891, 64 tons were produced, and by early 1892, production was at the rate of at least 100 tons per annum. The Storeys Creek Tin Mining Company was working on a small scale, westerly dipping veins containing tin and wolfram, by adits driven from a tributary flowing into Story Creek from the west. At Rex Hill, argentiferous galena in granite was being mined to a depth of 33 feet, but in depth galena rapidly decreased and cassiterite appeared. There was some abortive prospecting for silver-lead in the valley of Castle Carey Creek, mainly along " lodes " which are in fact fault breccias.

In 1901, G. A. Waller paid a brief visit to the area east of Gipps Creek and Buffalo Brook, and to Story Creek. Waller suspected the presence of the Castle Carey Fault, and other large scale faulting, but time did not allow him to carry out detailed regional mapping. He recognised the pneumatolytic origin of the ore deposits and described the mineralogy in detail. The only mine working was that at Rex Hill which had been taken over by the Mount Rex Tin Mining Co. N.L. to work the cassiterite lying below the galena mined by the original company. Waller records that the present company had recovered 81 tons of tin concentrates, containing 68% of metallic tin, from 1,160 tons of ore. In Story Creek all activity had ceased except for two men working surface gravels. The Storeys Creek Tin Mining Co. had abandoned operations, after some driving and cross-cutting from Miers adit, in the south part of the present workings.

W. H. Twelvetrees reported in 1905 on the discovery of coal south and south-east of Rex Hill, and apart from this account, there is no further record of mining or prospecting until 1915 when L. Hills investigated the tungsten resources of the State as a wartime measure. The Rex Hill mine had ceased operation in 1909 and a tribute partly carried on until 1913 (Reid 1929). World War I stimulated renewed mining of tungsten in the Story Creek area where the leases had been taken over by the Storey Creek Tin Mining syndicate.

The veins were being systematically exploited from Miers adit and on the present adit levels; and output was about five tons of concentrates containing equal proportions of tin and wolfram per fortnight. Additional plant was planned to treat about 50 tons of ore per day. At this time, the only other activity was in the Gipps Creek area, where small quantities of wolfram were being obtained. from narrow veins and alluvial deposits by primitive methods.

In "The Coal Resources of Tasmania" (1922), A. M. Reid outlined the general geology of the area and described the Triassic coals near Rex Hill. He followed the Castle Carey Fault from the west side of Ben Lomond for 20 miles to the south-east.

In 1928, the main geology of the area was examined by A. M. Reid and Q. J. Henderson and described as part of Bulletin No. 40 (The Avoca Mineral District). The Storey Creek Tin Mining syndicate was the major producer, but was milling only about 35 tons of ore per day. Mining had been taken down to No. 3 level. On the west bank of Aberfoyle Rivulet, thin veins containing cassiterite and wolfram had been discovered in 1916 but were not developed until a prospecting syndicate was formed in 1926. Later in that year, the leases were taken over by Aberfoyle Tin N.L. After considerable work, an adit driven from the west bank of Aberfoyle Rivulet revealed a series of veins encouraging development, and production started in 1931. Bulletin No. 40 described many prospects round Gipps Creek, Rex Hill and in the area round Story Creek and Rossarden where much prospecting had been carried out since 1915.

Towards the end of 1928, the Storey Creek Tin Mining syndicate, which had been the main producer of wolfram in the State, and an important producer of tin, was forced to cease operations because of the low price for wolfram at the beginning of the depression years. About a year later, the leases were taken over by a tribute party and production was resumed, on a reduced scale, from 2 and 3 levels. Metal markets improved from 1933 onwards and the present company, Storeys Creek Tin Mining Co. N.L., was formed in 1937.

The last 25 years have been a period of steadily increasing production from the two major mines, with only spasmodic activity on a small scale in the Gipps Creek area. From time to time, the fluctuating price of tungsten and labour shortages have affected the Storeys Creek mine, but since 1950 the amount of ore treated has more than doubled. In 1957, 17,395 tons or ore were treated for the recovery of 280 tons of wolfram concentrates, and 29.29 tons of tin concentrates containing 21.05 tons of metallic tin. When the new plant now being installed comes into operation, this tonnage should be substantially increased.

Production from the Aberfoyle mine has increased annually since 1934, and ore milled has doubled since 1950. However, the amount of tin concentrates has only increased by one-third while the proportion of wolfram concentrates has trebled, indicating the changes in the mineral content in depth, so that today, Aberfoyle is now the major producer of wolfram in the State as well as being the most important tin mine. In 1957, 65,571 tons of ore yielded 595.58 tons of tin concentrates containing 421.79 tons of metallic tin, and 269.39 tons of wolfram concentrates.

Since Reid and Henderson mapped the area in 1928, many prospects have been visited by geologists of the Department of Mines, who also reported on the discovery of primary uranium on Story Creek south of Rossarden in 1955, and secondary uranium in Castle Carey Creek in 1956. The vein system and mineralogy at Aberfoyle have been studied in great detail by officers of the Mineragraphic Investigation Section of the C.S.I.R.O. since 1937 and were described by A. B. Edwards and R. J. P. Lyon in 1957.

5 General Geology

I. INTRODUCTION.

The rocks in the area were formed in two distinct periods of sedimentation separated by a long duration of time during which the oldest sediments were folded, intruded by granitic rocks and peneplaned before the beginning of the second sedimentary cycle. The second period was closed by the intrusion of thick sheets of Jurassic dolerite, accompanied by faulting.

Table I (p. 22) illustrates the geological history. During the first sedimentary period, the Mathinna Group quartzites and slates were deposited, probably in a deltaic or estuarine environment, and they are believed to be partly of Upper Silurian or Lower Devonian age. They are of unknown thickness and their precise correlation with other rocks in Tasmania has not yet been established, owing to the complex folding and paucity of fossil remains.

Sedimentation was closed by the Tabberabberan orogeny during which the Mathinna Group was intensely folded along north-westerly axes, followed by intrusion of the Ben Lomond Granite in the later stages of which the mineralisation of this region occurred.

Long erosion followed, probably from Middle Carboniferous to early Permian, and the area was roughly peneplaned. The granite was un-roofed and the mineralised zone worn off the centre of the batholith.

Permian sediments were deposited upon the eroded surface of Mathinna beds or exposed granite. The lowest beds were shallow fresh-water deposits becoming finer upwards. Marine fossils occur in the upper part of the Castle Carey Mudstone, indicating an invasion of the sea. The Burnt Gully Limestone contains marine fossils, while the Mistletoe Sandstone, although marine, gives evidence of a shallow water shoreline environment. The Prospect Creek Mudstone is apparently unfossiliferous, and may indicate estuarine or freshwater sedimentation, although occasional marine transgressions are probable.

The Triassic sandstones appear to follow the Permian conformably and are mainly of freshwater origin, culminating in the higher beds with the formation of coal seams, and underlying seatearths.

The Jurassic in Tasmania was marked by the widespread intrusion of thick sheets and masses of dolerite accompanied by faulting. West of the Castle Carey Fault, the dolerite was injected into the upper part of the Felspathic Sandstone round New Stanhope and Mt. Christie. Further north, it appears to intrude the Ross Sandstone, although this area was not mapped in detail.

Intense block faulting took place in Lower Tertiary times along north-westerly and north-easterly trends. Although there may be small patches of Tertiary gravel in the Aberfoyle Trough and near Mistletoe Creek, continuous erosion has followed, interrupted only by renewed uplift in the Upper Tertiary or Quaternary which rejuvenated the drainage. Much of the Permian and Triassic has been removed, thus exposing the pre-Permian surface, which in the south has been deeply dissected and destroyed.

TABLE I.
STRATIGRAPHICAL TABLE.

Group.	System.	Unit.	Description.	Thickness in feet.
Cainozoic		Dolerite talus	Tumbled blocks and boulders of dolerite.	....
		Gravels	Pebbles and cobbles of dolerite, quartz and quartzite. Dolerite abundant.	10
	Quaternary	Sandy loam		6
		Gravels	Pebbles and cobbles of dolerite, quartz and quartzite.	10
	Renewed uplift—Rejuvenation of drainage.			
	? Tertiary	Gravels	Pebbles and cobbles of dolerite, quartz and quartzite.	Thin
	Unconformity. Block faulting.			
	Jurassic	Dolerite	Plagioclase, augite, hypersthene. Mesostasis of quartz, felspar. No olivine.	Up to 1000+
Mesozoic		Felspathic Sandstone	Felspathic sandstones, some conglomerates. Coal seams in upper part with fireclays below and dark carbonaceous shales above.	300+
	Triassic	Ross sandstone	Pale fine to medium sandstone. Usually weathers to loose sandy soil with "sparkling" quartz.	400+
Palaeozoic		Prospect Creek Mud stone	Pale grey and creamy weathering siltstone, passing upwards into hard creamy and yellowish mudstones. Cherty in places.	200+
	Permian	Mistletoe Sandstone	Grey to pale grey sandstones, pebbly grits and gritty mudstones. Poorly preserved casts of productids and spiriferids.	40

STRATIGRAPHICAL TABLE—continued.

Group.	System.	Unit.	Description.	Thickness in feet.
Palaeozoic	Permian	Burnt Gully Limestone	Poorly exposed grey to dark grey crystalline limestone. Productids, spiriferids, bryozoa.	10
		Castle Carey Mudstone	Pale cream or yellowish mudstones, shales, siltstone. Some sandstone. Upper part fossiliferous. Aviculopecten, spiriferids, bryozoa.	120
		Aberfoyle Formation	Shallow freshwater conglomerates, arkoses, coarse sandstones. Some interbedded black shales. Finer near top.	150
Unconformity, Peneplanation of granite and Mathinna Group.				
	Devonian	Ben Lomond Granite	Coarse pink and cream porphyritic granites, microgranite, aplite and greisen. Tin and wolfram veins. Some galena and other sulphides. Uranium.	....
Tabberabberan Orogeny. Folding along north-westerly axes.				
	Silurian	Mathinna Group	Quartzites, sub-greywackes. Siltstones, dark slates and tuffs.	Unknown ?Minimum of 1,500

II. THE MATHINNA GROUP.

(*a*) General.

The Mathinna beds constitute an intensely folded group of arenaceous and argillaceous sediments of unknown thickness, which were intruded by the Ben Lomond granite, and which now outcrop in the north-east, and in the extreme north-west of the area described in this Bulletin. They form part of the outcrop of similar rocks which cover much of north-eastern Tasmania, and are important because they form the host rocks for much of the tin-tungsten mineralisation in the Rossarden and Storeys Creek area. They have been subjected to low grade regional metamorphism, and in the upper Gipps Creek area, contact metamorphism has taken place.

(*b*) Lithology.

The rocks range from fine grained dark slates and phyllites, to siltstones and coarse sandstones, quartzites or sub-greywackes. Thick beds of hard massive quartzites occur, but the sediments may also be thin-bedded, with rapid alternations of slates and quartzites, frequently with slump structures and turbulent bedding. Occasional bands of pale greenish tuff are present.

(*c*) Exposures.

The rocks are poorly exposed on the plateau where they are frequently obscured by a mantle of clay and fragments of quartzite or quartz. Outcrops are usually good where the plateau has been deeply dissected in the valleys, but they are often covered by scree. Structures in the beds are well shown in cores from diamond drilled boreholes.

(*d*) Age.

The Mathinna Group was formerly correlated with the Dundas Group of Western Tasmania, to which it bears some resemblance, and which is of Middle Cambrian age. However, in 1934, F. Blake discovered poorly preserved plant remains in fine sandstone interbedded with slates, south of Mara siding, near Warrentinna which lies 35 miles due north of Rossarden. The fragments were examined by Cookson (1936) who reported that, although the specimens were devoid of special diagnostic features, they bore at least a slight resemblance to *Hostimella*, which occurs in similar rocks in Eastern Victoria. If the remains were *Hostimella*, then the rocks near Warrentinna cannot be older than the Upper Silurian and could be of Lower Devonian age. Walker (1957) recorded rare fragments of *Hostimella* (?) in the Scamander Slate and Quartzite, as well as a few moulds of bryozoans, corals, brachiopods and crinoid columnals. It is probable that the Mathinna Group is equivalent to the Scamander Slate and Quartzite, and possible that they are of the same age as the rocks in the Warrentinna area, although they have not yet been definitely correlated.

(*e*) Sedimentary structures.

Structures are not well preserved in outcrops, but they are prominent in cores from the Old Battery drill hole. Thick massive quartzites occur, but there are also frequent alternations of thin bands of sandstone or quartzite, with interbedded bands and streaks

Fig. 3.—Mathinna Group quartzites and slates, showing small thrust.

5 cm

of siltstone and black slate. Turbulent bedding is common, and there are small scale slump structures, together with small clots and masses of balled up sandstone. The bands of siltstone and sandstone are sometimes finely laminated, with dark micaceous partings.

(*f*) Major structures.

The Mathinna sediments in the area mapped have been intensely folded along north-westerly axes, and in the Rossarden area the folds pitch up to about 30° towards the south-east. The beds strike generally to between 320° to 330°, while a well developed regional cleavage strikes to about 340° with dips to the south-west of 60° to 85° indicating that the axial planes have been overturned towards the north-east and suggesting pressure from the south-west.

Fig. 3 shows steeply dipping Mathinna quartzite and thin bands of slates which have been thrust over a small anticlinal fold, on the south bank of Burnt Gully Creek, about 2½ miles north-east of Aberfoyle mine.

(*g*) Sedimentation.

The rocks belong to the "geosynclinal facies" of Pettijohn (1949) characterised by mixed arenaceous and argillaceous sediments. The presence of plant remains and marine fossils in the Scamander area, and also the slump structures imply an estuarine or deltaic environment.

No conglomerates have been reported within the group and this suggests that the sediments were derived from a mature low lying land mass. From evidence in the St. Helens area, Walker (1957) assumes that there were currents from the east, and that the floor of deposition sloped to the west.

(*h*) Metamorphism.

(1) *Regional metamorphism.*

Slates are common, and phyllites occur, but sericite or chlorite schists are rare, so that metamorphism is of a very low grade.

(2) *Contact metamorphism.*

Along the eastern contact with the Ben Lomond granite, alteration has resulted in the induration of quartzites, accompanied by some recrystallisation of quartz and by the production of secondary biotite. Metamorphism is low grade and does not extend far from the contact.

Spotted slates occur near Nisbet Creek, south-west of Storeys Creek mine, and in the west, north of the Long Tunnel prospect, a capping of intensely altered sediments was examined above the granite. In the latter area, the Mathinna beds form the remnants of the roof of the granite intrusion, and immediately above the granite are converted into chiastolite slates and hornfels. They are described in detail on p. 36.

References.

Cookson, I. C., 1936—The Occurrence of Fossil Plants at Warrentinna, Tasmania. *Pap. & Proc. Roy. Soc. Tas.*, 73-77.

Pettijohn, F. J., 1949—Sedimentary Rocks. Harper & Brothers, New York.

Walker, K. R., 1957—Geology of the St. Helens-Scamander area, Tasmania. *Pap. & Proc. Roy. Soc. Tas.*, 91, 25-26.

III. THE TABBERABBERAN OROGENY.

After a considerable, but unknown, thickness of Mathinna sediments had accumulated, they were strongly folded, uplifted, and intruded by granite over a large part of north-eastern Tasmania. As shown on p. 24, the Mathinna beds are probably not older than Upper Silurian and may be of lower Devonian age. An unknown thickness of Mathinna sediments was removed, and the granite itself was deeply eroded before the Permian rocks were laid down on a peneplaned but uneven surface. This evidence suggests that orogenesis took place some time between the Lower Devonian and, at the latest, Middle Carboniferous.

The prominent north-westerly trend of the Mathinna Group, and the overturning of the axial planes towards the north-east may imply that folding was caused by the Tyennan Block of Central Tasmania moving north-east, so squeezing the sediments against another massiff to the east.

IV. THE BEN LOMOND GRANITE.

The granite forms the northern part of a complex exposed over about 20 miles and trending roughly north-westerly, between the Ben Lomond plateau in the north and the valley of the St. Paul's River in the south. Its eastern contact with the Mathinna Group is almost entirely exposed, with the exception of small areas near Rossarden where the junction is concealed by Permian beds. The western boundary is terminated by the Castle Carey Fault, which has a downthrow to the west of over 1,500 feet in places, throwing dolerite and Triassic rocks against granite. In the north, the granite is mainly obscured by Permian rocks, and by dolerite talus, but in the north-west and north-east, the relations between the granite and the Mathinna sediments can be studied. Much of the central core of the granite is concealed by horizontal or gently dipping Permian beds, which were deposited upon a peneplaned surface.

(1) Granite types.

(*a*) The most abundant granite is a coarse grained, porphyritic variety, usually pale cream or pinkish. The phenocrysts are of soda-orthoclase up to about two inches long, frequently showing Carlsbad twinning, set at random in a granular mosaic of felspar and quartz. Biotite is usually present in small amounts, while muscovite may occur, especially where greisening has taken place (see also p. 51). The following table of analyses (see p. 28) shows that it is a potassic leucogranite, or "acid" granite. The felspars are often almost completely sericitised by hydrothermal action.

The coarse variety forms the main mass of the granite intrusion which has been exposed by deep erosion, mainly before Permian times, but also partly since the Permian cover was removed on up-faulted blocks.

Towards the contact with the country rock, the granite becomes fine grained, frequently carrying tourmaline and muscovite, and is well exposed in the area south-east from Nisbet Creek to Tasmania Creek. This variety may be regarded as the marginal facies of the main granite and indicates that the granite was emplaced at relatively shallow depth, since the contact of the fine granite with the Mathinna sediments is well-defined. Typical analyses are No. 5 and 6 in the table. A thin section of No. 6 was prepared by G. Everard, Mines Department Petrologist who reports:—

"Micrographitic texture is shown by irregular grains of quartz filling the interstices between allotriomorphic orthoclase, hypidiomorphic plagioclase, and lathe-like or ragged books and plates of muscovite and biotite.

"Quartz is clear and fairly free from inclusions, but felspar is invariably cloudy and often partly sericitised. The biotite is of a greenish colour, and contains dark inclusions and minute zircons surrounded by pleochroic haloes.

"The plagioclase is albite, which is greatly exceeded by orthoclase. The orthoclase may contain rounded and embayed grains of quartz, of which many extinguish simultaneously, as if originally belonging to a single crystal, which has been corroded and divided. Some alteration has occurred to the rock after consolidation".

TABLE 2.

ANALYSIS OF GRANITES.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
SiO_2	76.00	77.54	75.72	75.78	73.72	74.96	75.06	75.70	77.98
Al_2O_3	12.52	12.91	11.51	12.92	15.11	13.78	13.61	14.20	14.01
Fe_2O_3	1.86	0.86	4.58	1.43	1.29	1.57	1.57	2.15	1.57
FeO	ND	ND	ND	ND	ND	ND	Nil	ND	ND
MnO	0.03	Nil	0.08	0.01	0.04	0.01	0.02	0.40	0.04
TiO_2	0.15	0.07	0.23	0.12	Nil	Nil	0.28	Nil	0.02
P_2O_5	ND	ND	ND	ND	ND	ND	Nil	ND	ND
CaO	0.68	Tr.	1.20	0.20	Tr.	0.12	0.52	Tr.	Tr.
MgO	0.17	0.16	0.30	0.17	0.10	0.32	0.30	0.38	0.38
Na_2O	2.87	2.98	0.50	2.57	3.87	2.88	1.61	0.27	0.20
K_2O	4.60	5.01	2.03	5.46	4.63	5.13	5.81	4.27	3.38
Ignition Loss	....	1.0	1.36	0.48	0.14	0.75	1.23	1.77	2.46

Analyst.—W. St. C. Manson, Tasmanian Department of Mines Laboratory.

1. Coarse potassic leucogranite, south of Tasmania United Uranium Prospect.
2. Porphyritic microgranite. Crags, ¼ mile south-east of Rossarden.
3. Tourmaline granite. Gipps Creek.

4. Microgranite. Xenolith in coarse granite. South of Tasmania United Uranium Prospect.
5. Microgranite. North of waterfall on Tasmania Creek.
6. Microgranite. Near contact with Mathinna Group. Story Creek.
7. Microgranite. South of old dam on upper part of Gipps Creek.
8. Aplite. No. 10 level, Aberfoyle mine.
9. Porphyry. Dyke north of Aberfoyle mine.

(*b*) The main granite appears to be intruded by irregular dykes, tongues and masses of pale grey microgranite which is often porphyritic. It occurs north of the bridge at Rossarden, near Rex Hill, in the neighbourhood of the old mines in the Gipps Creek area and also round the Tasmania United Uranium prospect. This variety forms a later differentiate of the granite. It is frequently greisened, with accompanying tin, tungsten and sulphide mineralisation and probably also uranium.

The junction with the main granite is not sharp, but may show corrosion, and some permeation of the coarse granite by the finer variety.

The phenocrysts are of orthoclase, and dark quartz which is often rounded and corroded; and they are scattered through a fine grained intergrowth of quartz and felspar.

The analysis of a specimen from the crags marking the fault scarp ¼ mile south-east of Rossarden is given above (No. 2 on the table). G. Everard states that in thin section, " a wide range in grain size may be seen. Large crystals of clear quartz and cloudy felspar with irregular boundaries, are common up to 2 or 3 mm. across. Biotite, weathered and stained by oxides or iron, occurs in smaller grains down to 0.05 mm. across, either in intergranular or poikilitic relationship to the larger crystals ".

Porphyritic microgranite sometimes contains well shaped double-ended crystals of quartz (Waller, 1901, pp. 3-4) but they usually appear to be rounded.

(*c*) *Pegmatites.*

Although pegmatites occur at the Ivanhoe Prospect, and on the eastern slopes of the Castle Carey Rivulet they are comparatively rare, and consist of large crystals of orthoclase with some quartz and sometimes tourmaline and muscovite. The granite north of Tasmania Creek is pegmatitic in places, containing mainly felspar and muscovite.

(*d*) *Aplite.*

The only true aplite mass is the cupola revealed in the workings of Aberfoyle mine (see p. 60).

In thin section, G. Everard reports a hypidiomorphic granular texture. The largest particles are interbedded grains of irregular quartz. Orthoclase occurs as relatively large euhedral or subhedral crystals, cloudy and sericitised. Albite is present in smaller lath-like crystals, relatively fresh and showing well-marked lamellar twinning. There is abundant muscovite in small " books " and larger ragged patches.

The rock is pale grey in colour, quartzose and very hard. There is apparently little variation throughout the aplite mass exposed underground. The analysis is shown as No. 8 in the Table.

(*e*) *Granitic inclusions.*

Near the lease held by Tasmania United Uranium N.L. on Story Creek, a number of nodules and blocks of microgranite were observed within the normal coarse granite. The contacts are fairly sharp and the microgranite is markedly different to the coarse granite in grain size, but similar chemically.

No. 4 on the Table gives the analysis of one specimen which closely resembles that for the coarse granite. It appears slightly poorer in CaO and is a little more potassic, than the main granite. G. Everard comments that in thin section, " the rock consists of embayed and peripherally eroded crystals of quartz in a complex matrix of quartz, felspar, mica and iron ores.

" The peripheries of the larger quartz crystals show corrosion and detached areas of quartz with simultaneous extinction indicate that, originally, they formed part of the main crystal.

" Orthoclase is in cloudy crystals with irregular borders and so much corroded that original individual crystals are now difficult to identify. Quartz and orthoclase are associated in micrographic textures.

" Some plagioclase may exhibit similar features, but albite occurs in clear fresh crystals of smaller size, tending to be lath-shaped and exhibiting lamellar twinning. Biotite is present in ragged crystals, partly altered to iron ore minerals. A faintly tinted pleochroic muscovite is also present.

"The general texture of the specimen indicates alteration subsequent to crystallisation with corrosion of the early formed crystals. Thus biotite is in ragged patches, with alteration to magnetite. Quartz has been corroded, with the introduction of aluminous material. Micrographic texture may arise from replacement.

" The rock is a fine to medium grained graphic granite."

It is suggested that such rounded inclusions may represent partly digested xenoliths of Mathinna sediments.

(*f*) *Quartz-porphyry, North of Aberfoyle.*

A few small rounded outcrops of quartz-porphyry were examined about ¾-mile north of the Aberfoyle mine (see p. 61). The analysis in the Table shows that, chemically, it closely resembles the aplite below the Aberfoyle mine, and that they are both less sodic than other granitic rocks in the area.

In the hand specimen, it is a fine grained pale grey or brownish rock with small phenocrysts of quartz and altered felspar. G. Everard reports that in thin section the rock consists of a fine mosaic of quartz, felspar and muscovite, but there are also faint greenish and brownish patches. Phenocrysts of quartz up to about 2mm. across are present as irregular, somewhat rounded grains or euhedral crystals which may be slightly rounded at the edges. There are also felspar phenocrysts and ocasional larger crystals of muscovite containing zircon crystals with pleochroic haloes.

The quartz-porphyry may be genetically related to the aplite cupola.

2. **Mode of occurrence.**

(*a*) The main granite mass is a small batholith which cuts discordantly through the Mathinna Group and is elongated parallel with the north-westerly direction of the tectonic trend produced by the Tabberabberan orogeny. The eastern contact dips at about 45° to the north-east, while the western boundary is covered by Permian, Triassic and Jurassic rocks where it is downthrown by the Castle Carey Fault.

Although the country rock has been stripped off the granite and the centre of the intrusion has been planed, the following evidence suggests that erosion is comparatively shallow:

(i) The granite becomes finer towards the eastern margin, and the contact is well-defined, with only slight contact metamorphism of the Mathinna sediments.

(ii) North of the Rossarden bridge, in the upper reaches of Tasmania Creek, and also in Nisbet Creek, there are complex injection zones, probably forming the upper limits of the intrusion. The granite is fine grained and is injected as thin dykes and veins into Mathinna sediments. Although there are spotted slates in Nisbet Creek, and the quartzites are indurated in the other areas, the degree of metamorphism is low. Fig. 4 illustrates the contact zone north of Rossarden bridge. Although obscured by alluvium, the intimate relations between the granite and the Mathinna beds can be examined when the river is low. Fine granite is injected as dykes and thin veins into quartzites and siltstones which strike north-west. Fig. 5 shows a dyke of micro-granite about 4 feet thick striking with the quartzites and dipping at 50° to the south-west. It spreads out into a small dome and throws off a vein three inches thick striking to 204° and dipping at 65° to the south-east.

Fig. 6 shows the contact between the "hanging" wall of the dyke and the quartzite, with several angular xenoliths of quartzite whose corners have been slightly rounded, with only slight induration and recrystallisation.

There is a close resemblance between the strike and dip of the microgranite vein, and that of veins north of Aberfoyle, in the Kookaburra and Old Battery Prospects.

(iii) North of the Long Tunnel mine and south of Victory Creek, the contact metamorphosed roof of the granite can be seen on an uplifted block between the Castle Carey Fault and the Gipps Creek Fault.

(iv) Tin and tungsten mineralisation appears to be confined near the western margin in the Gipps Creek area, and the eastern boundary between Storeys Creek and Aberfoyle. Although much of the central mass of the granite is obscured by Permian, or a mantle of granite gravel, there is little or no indication of mineralisation.

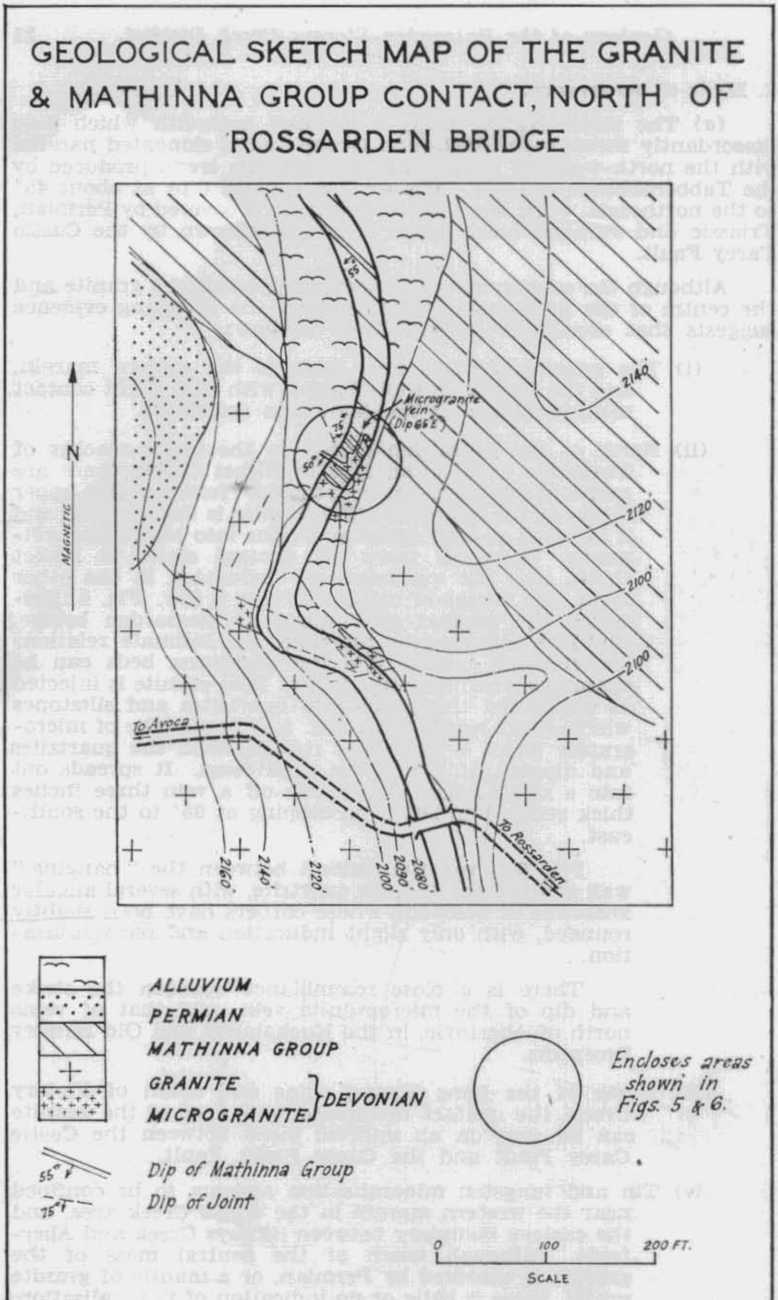


Fig. 4.—Sketch map of the area north of Rossarden bridge.

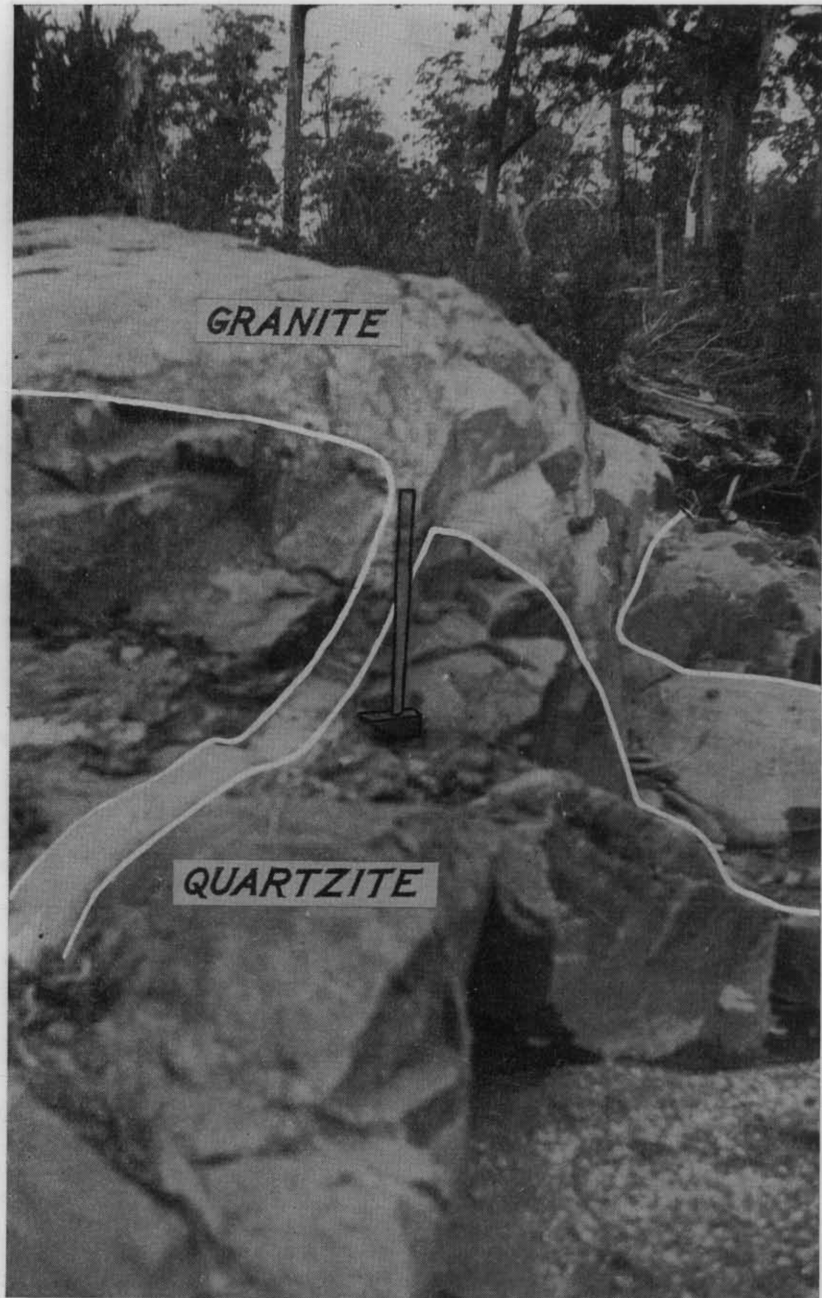


Fig. 5.—Granite dyke in Story Creek.

5 cm

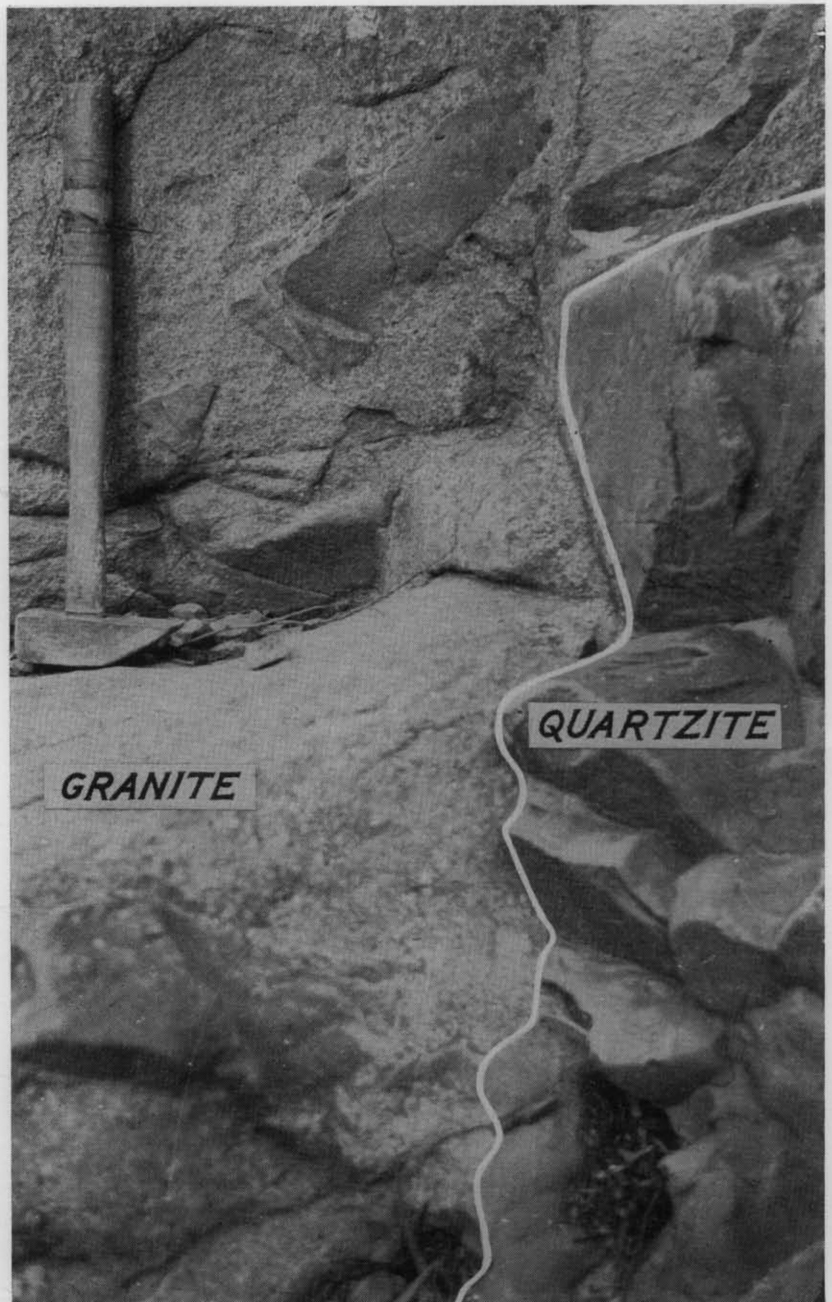


Fig. 6.—Xenoliths in granite dyke, Story Creek.

5 cm

The northern part of the granite appears to plunge beneath the Mathinna beds, and the contact in Nisbet Creek swings almost westerly, suggesting that there may be a continuous cover of Mathinna sediments preserved beneath the dolerite talus, and the Permian and Triassic rocks on the slopes of Ben Lomond.

(*b*) The aplite beneath the Aberfoyle mine appears to form a cupola with no evidence of an exposed contact with the main granite. It may be related to a quartz-porphyry dyke exposed north of Aberfoyle.

(*c*) The later injections of porphyritic microgranite appear to form tongues and poorly defined dykes within the main granite. Contacts are uneven and irregular, and generally show permeation and corrosion of the coarse granite.

3. **Internal Structures.**

(*a*) *Flow Structures.*

There is little evidence of flow structures, and the arrangement of the phenocrysts in the coarse granite appears to be at random.

(*b*) *Joint Structures.*

Joints are well developed, where exposed, and have had an important bearing on mineralisation in the Gipps Creek area, and probably near the Storeys Creek mine.

(I) *Cross (Tension) Joints.*

Such joints are caused by internal pressure acting against the partly consolidated main granite, and are formed by tension. They tend to form fractures striking in the same direction as the batholith, and are perpendicular to the original surface of the intrusion. They may form channels for mineralisation occurring in the last stages of igneous activity, so that they are frequently greisened, and may contain mineral veins.

In the area described, the joints strike generally north-west. To the west near the Castle Carey Fault, they dip north-eastwards at 35° to 40°, as near the Long Tunnel mine. Further east, dips are from 50° to 75° north-east in the Great Republic and Ben Lomond Mines. Near the eastern margin of the granite, the dip is 40° to the south-west in the Mammoth prospect. The joints therefore illustrate the radial pattern round the top of the granite.

(II) *Flat-lying Joints.*

These joints tend to form parallel with the surfaces of the granite. Although their origin is obscure, they may be related to weathering processes.

(III) *Marginal thrusts or joints.*

Such fracture planes may be formed by the wedging effect of internal pressure and usually penetrate out into the country rock, They are marginal structures striking parallel with the contact of the granite, and dipping at low angles into the granite. The veins in the Storeys Creek mine were possibly formed in this manner. They dip, usually at angles below about 45°, south-west towards the granite mass. Although the granite has not yet been reached underground, it outcrops in Nisbet Creek less than ½-mile to the south-west.

4. Age of the Ben Lomond Granite.

If the Mathinna Group is of Upper Silurian or Lower Devonian age, as discussed on p. 24, the granite must date from about middle Devonian and cannot be later than the middle Carboniferous, since it was exposed and peneplaned before the Permian was deposited.

5. Contact Metamorphism.

The roof of the granite may be seen north of the Long Tunnel Mine in the Gipps Creek area, where the Mathinna slates have been altered by thermal metamorphism. Although the zones were not examined in detail they can be summarised as follows:—

(*a*) The unaltered slate is hard, dark and usually has a well marked cleavage. It is often silty and may be interbedded with siltstones and thin beds of quartzite.

(*b*) The slate becomes spotted, and contains graphite.

(*c*) Secondary biotite appears in addition to the formation of pale coloured spots.

(*d*) Near the contact, the slate is converted to chiastolite schists or hornfels.

Spotted slates are also to be found in Nisbet Creek south-west of Storeys Creek.

Examples were examined by G. Everard, Petrologist of the Department of Mines, who describes the metamorphosed rocks as under:—

(*b*) *Spotted Slate*:—

" In thin section, the rock has a very fine grain composed of sericite, felspar and quartz. The white spots appear as areas of opaque white clay minerals and fine granular quartz. The dark spots consist of sericite containing flakes of graphite and minute crystals of magnetite, sometimes stained with limonite ".

(*c*) *Spotted slate with biotite*:—

" The rock consists of a fine felted mass of sericite with fine granular quartz and felspar. There is a little pyrite, and some opaque white clay minerals.

The white spots consist of a very fine grained quartzo-felspathic mosaic. There are also darker areas containing biotite, often altered to limonite ".

(*d*) *Altered silty slate with sheafs and needles of chiastolite (up to 1 inch long)*.

" The needles appear as rhomboidal sections of chiastolite largely altered to sericite, in a matrix of small plates and books of muscovite, and minute brown needles of tourmaline. Quartz appears as occasional small interstitial patches. Iron ore minerals are disseminated in minute crystals, and their oxidation products give a brown stain to the specimen. The rock is a pneumatolytically altered chiastolite schist ".

Thermal metamorphism is therefore of relatively low grade.

V. PERMIAN.

Permian rocks rest with a marked unconformity upon the Ben Lomond granite or the Mathinna Group (see Fig 7). Except within the Prospect Creek Trough and in the north-east, exposures are patchy and incomplete. At least 500 feet of indurated Permian sediments are preserved within the Prospect Creek Trough, and about 350 feet of horizontal beds form a plateau in the north-east dissected by Tower Rivulet, Abbotsford Creek and Burnt Gully Creek. Outcrops are frequently poor and limited. The Permian was not examined in detail west of the Castle Carey Fault. Within the Prospect Creek Trough and along the Castle Carey Fault, the Permian rocks have been indurated into impure quartzites, hard siltstones and siliceous mudstones.

The Permian rocks were subdivided as follows:—

Name.	Approximate Thickness.
5. Prospect Creek Mudstone	200 feet+
4. Mistletoe Sandstone	40 feet
3. Burnt Gully Limestone	Up to about 10 feet
2. Castle Carey Mudstone	120 feet
1. Aberfoyle Formation	150 feet

1. The Aberfoyle Formation.

The name is given to the dominantly rudaceous and arenaceous beds in the lower part of the Permian, below the Castle Carey Mudstone. The maximum thickness is about 150 feet. The formation is very variable, with frequent changes in facies both horizontally and vertically and is apparently unfossiliferous. Where the beds rest on granite, the basal members usually consist of coarse quartzose sandstones and arkosic sandstones or quartz grits, often with rounded pebbles or cobbles of Mathinna quartzite and quartz, and sub-angular blocks of quartzite. Individual beds are variable in thickness, and bands of shale may occur, as in Prospect Creek. The base of the formation is often marked by a thin boulder bed.

If the underlying rocks are the Mathinna Group, the base may be marked by a boulder bed which, however, is not always present. In the Aberfoyle area, the lowest rocks are ill sorted pale sandy and gritty mudstones with pebbles and blocks of Mathinna quartzite and some milky quartz, followed by arkosic quartz grits and yellowish weathering silty shales overlain by pale brownish medium to fairly coarse sandstone.

South of Rossarden, above the east bank of Story Creek, the base is marked by crags of pebbly sandstone with cobbles and boulders of Mathinna quartzite and also some granite.

The upper part of the Aberfoyle Formation becomes finer and is represented by ill sorted sandstones and siltstones.

2. The Castle Carey Mudstone.

The term describes the chiefly argillaceous beds resting on the Aberfoyle Formation, and overlain by the Burnt Gully Limestone, or the Mistletoe Sandstone where the Limestone is absent.

Fig. 7.—Unconformity between basal Permian and the Mathinna Group.

5 cm

The rocks are pale creamy or yellowish weathering poorly sorted mudstones, siltstones or shales, with some sandstone and occasional conglomerates. The lower part is unfossiliferous but fossils become abundant in the upper beds. *Aviculopecten*, spiriferids and bryozoa occur in blocky mudstones and siltstones, while yellowish-brown shales are crowded with *Fenestella*, *Stenopora* and other bryozoa. Fossiliferous horizons were noted in a number of localities as indicated in the geological sketch map of the area.

3. The Burnt Gully Limestone.

A thin limestone lies above the Castle Carey Mudstone, but is poorly exposed and is probably less than 10 feet thick. On the plateau dissected by Burnt Gully Creek, a few small scattered exposures of rounded grey to dark grey crystalline limestone were observed on gentle grassy slopes. The limestone contains productids and spiriferids with some bryozoa. Within the Prospect Creek Trough, it may be represented by a thin band of impure quartzite since the whole of the Permian has been silicified, but no satisfactory outcrop was seen. West of the Prospect Creek Trough, a few feet of pale silicified limestone were seen on the upthrown block, interbedded between bryozoan mudstone below and conglomerate with brachiopods above.

4. The Mistletoe Sandstone.

On the dissected plateau east of Mistletoe Creek, the Burnt Gully Limestone is followed by grey or pale grey sandstones, pebbly grits and gritty mudstones, with poorly preserved casts of productids and spiriferids. Similar silicified rocks occur, within the Prospect Creek Trough, up to about 40 feet thick.

5. The Prospect Creek Mudstone.

In the Prospect Creek section, the Mistletoe Sandstone is followed by pale grey and creamy weathering siltstones with some thin shaly bands, passing up into hard pale creamy and yellowish mudstones. The siltstone has been indurated into fine quartzite, and the mudstones are now compact and cherty with a conchoidal fracture. The formation is more than 200 feet thick and is cut off by the Eastern Prospect Fault.

About 50 feet of hard creamy silty mudstone and siltstones remain on the ridge east of Mistletoe Creek.

Correlation. (See Fig. 8).

The Burnt Gully Limestone is probably equivalent to the limestone round St. Paul's Dome in the Avoca area, and also the Enstone Park Limestone in the St. Marys area, which have been correlated with the Berriedale Limestone of South-Eastern Tasmania. Brill (1956, p. 133) showed that the zone of maximum thickness of the limestone (up to over 250 feet at Seymour on the East Coast) has a north-easterly alignment, with the limestone becoming thinner to the north-west and south-east. The " zero " isopach line on Brill's map should be drawn at least 10 miles north of Avoca to include the Burnt Gully Limestone which is reduced in thickness to less than 10 feet, from more than 15 feet on St. Paul's Dome.

The limestone is underlain by fossiliferous siltstones and shales or mudstone which resemble the Nassau Siltstone and the upper part of the Faulkner Group (Banks and Hale, 1957).

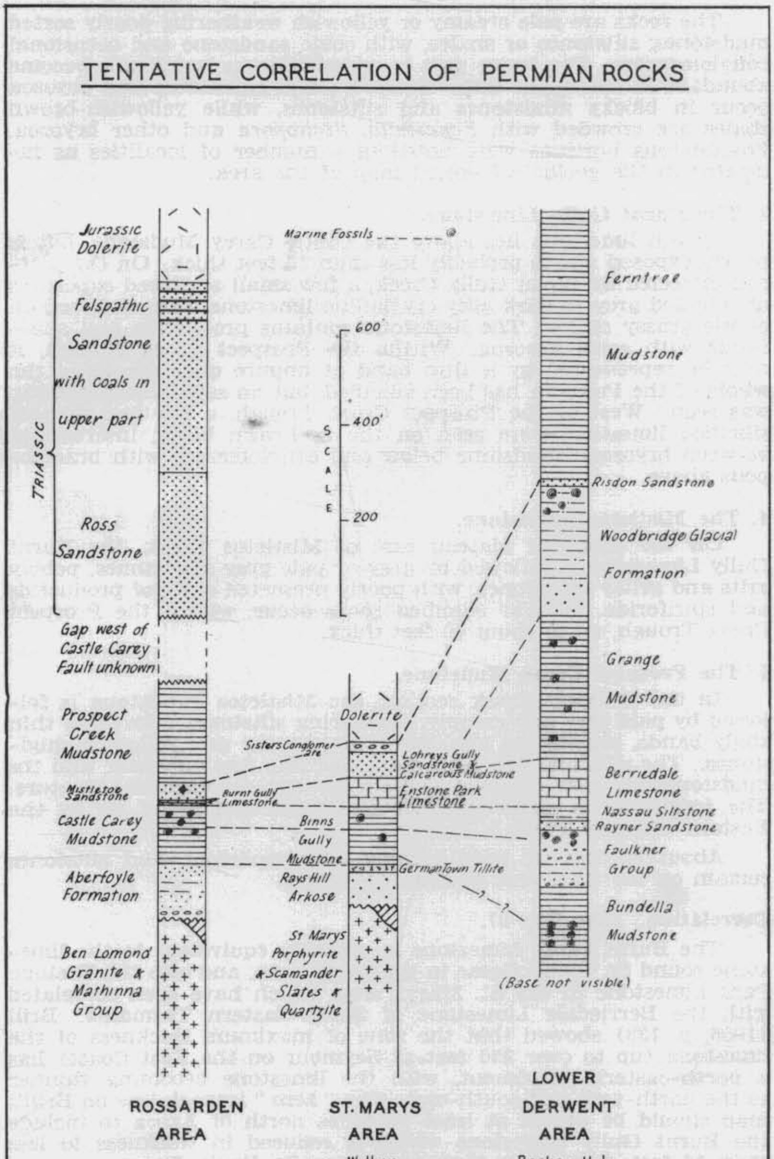
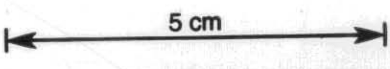


Fig. 8.—Sections showing tentative correlation of the Permian.



In the Lower Derwent area, the lower part of the Bundella Mudstone contains abundant marine fossils, but in the upper beds fossils are rare and the base of the Faulkner Group is marked by a conglomerate containing plant fragments. No fossils were seen in the Aberfoyle Formation, but in Prospect Creek, thin black carbonaceous shales occur towards the base which were probably formed in a paludal or lagoonal environment suggesting some resemblance between the Aberfoyle Formation and the lower part of the Faulkner Group. However, it is possible that the Rossarden area was near the shore-line of the sea in which the Bundella Mudstone was deposited in the south, since the Aberfoyle Formation rests directly upon granite and on the Mathinna Group, and in the St. Marys area, the Ray's Hill Arkose lies on the St. Marys Porphyrite or the Scamander Slate (Walker, 1957). This implies that in the south the Bundella marine phase was followed by estuarine and fresh-water deposition, and then by a further marine transgression in upper Faulkner times which spread over the Rossarden area, when the upper part of the Castle Carey Mudstone, the Burnt Gully Limestone and the Mistletoe Sandstone were deposited.

The Mistletoe Sandstone with its shelly conglomerates marks a return to shallow water conditions and there may have been pene-contemporaneous erosion of the Burnt Gully Limestone, since there are no beds resembling the Grange Mudstone. However, Banks and Hale (1957 p. 62) point out that the Grange Mudstone and the Berriedale Limestone may be at least partly facies variants of one another.

The Prospect Creek Mudstone is probably equivalent to the Ferntree Mudstone, but is much thinner.

References.

Banks, M. R. and Hale, G. E., 1957—Type Section of the Permian System in Hobart. *Pap. & Proc. Roy. Soc. Tas.*, 91, pp. 41-63.

Brill, K. G., 1956—Cyclic Sedimentation in the Permian System in Tasmania. *Pap. & Proc. Soc. Tas.*, 90, p. 133.

Walker, K. R., 1957.—The Geology of the St. Helens-Scamander Area, Tasmania. *Pap. & Proc. Roy. Soc. Tas.*, 91, pp. 28-29.

VI. TRIASSIC.

With the exception of a small exposure high on the slopes of Ben Lomond in the upper reaches of Story Creek, Triassic rocks are confined to the west side of the Castle Carey Fault, where they are downthrown against granite and partly concealed by the remains of the Jurassic dolerite sill which caps the Felspathic Sandstone north of Mt. Christie, and in the high ground west of Gipps Creek. The Triassic System apparently follows the Permian conformably in this area. The formations were not examined in detail.

The Triassic has been subdivided as follows:—

2. Felspathic Sandstone	400 feet+
1. Ross Sandstone	300 feet+

1. *The Ross Sandstone* reaches a maximum thickness of about 300 feet and resembles the formation of that name in Southern Tasmania. Outcrops are generally poor and the beds may frequently be recognised by the typical loose sandy soil with much pale fine to medium grained " sparkling " quartz.

2. *The Felspathic Sandstone* has been proved to a maximum thickness of more than 400 feet in borings for coal. It comprises a variable succession of pale grey felspathic sandstones with conglomerates containing rounded pebbles of Mathinna quartzites, pale siltstones and shales; with coal seams, fire-clays and dark carbonaceous shales or mudstones in the upper part. At least five coal seams are known, up to a thickness of about eight feet with partings of carbonaceous shale or seatearth, but at present the seams in the various mines have not been correlated locally, nor with other mining areas in north-eastern Tasmania. The coal seams appear to occur mainly in the upper 200 feet of the formation, immediately below the dolerite sill. South of Rex Hill, the coal seams are worked in adits driven northwards into the hillside beneath the remains of the dolerite sill, or in shallow shafts in lower ground. The coals are of variable quality, including coking coals and some anthracitic coal, and ash content may be as low as 8.5%.

" Washouts " may be expected in places, since in the New Stanhope mine, a fissure up to nine inches wide was observed in the roof of one seam, with a filling of rounded pebbles of Mathinna quartzite in a matrix of pale felspathic sandstone, indicating penecontemporaneous erosion followed by the local deposition of coarse sediments.

On the slopes of Ben Lomond, 3 seams are known in the upper valley of Story Creek at about 3,800 feet above sea level. A 50-foot tunnel driven north-east on the upper seam revealed a section measuring 7 feet 2 inches with seven seams of coal up to 1 foot 4 inches thick separated by thin bands of seatearth. Fifty feet of coal bearing beds containing plant remains are reported below the tunnel section.

REFERENCES.

HILLS, L., et al., 1922—The Coal Resources of Tasmania. *Tas. Geol. Survey Min. Res. Bull. No.* 7, 202-214.

TWELVETREES, W. H., 1905—On Coal at Mt. Rex. *Sec. Mines Report.*

VII. JURASSIC DOLERITE.

The dolerite, which was not examined in great detail, resembles that found over a large part of Central and Eastern Tasmania. In the area mapped, it is apparently intrusive into bedding planes in the higher part of the Triassic rocks and covers a large part of the formations west of the Castle Carey Fault as well as forming a cap at least 1,000 feet thick on the top of the Ben Lomond Plateau. The rock is generally uniform with gradual changes and is of medium to coarse grade. It is composed of plagioclase with both augite and hypersthene and a variable mesostasis of quartz, felspar and chlorite with some biotite and iron oxide. Olivine is rare or absent.

REFERENCE.

JOPLIN, G. A., 1957—The Problem of the Quartz Dolerites. *Pap. & Proc. Roy. Soc. Tas.*, 91, 129-132.

VIII. TERTIARY.

No deposits of definite Tertiary were found, but small patches of gravels west of Mistletoe Creek and in Burn Marsh may possibly be of late Tertiary age.

West of Aberfoyle Rivulet, north and south of the confluence with Mistletoe Creek on the downthrown side of a fault trending north-west gravels are found consisting of pebbles, cobbles and boulders of dolerite and Mathinna quartz and quartzite. The deposit lies up to about 20 feet above the Rivulet which has cut down below the gravels. The gravels are partly covered by fragments and blocks of quartzite or quartz derived from the Mathinna beds which occur on the upthrown side of the fault.

In Burn Marsh, a short distance north-west of the dam at Aberfoyle Mine, thin quartzite and quartz gravels occur on the downthrown side of the Burn Marsh Fault. The pebbles are of uncertain origin. They were originally derived from the Mathinna Group, but in part may represent the last remnants of basal Permian beds resting on the pre-Permian peneplain. A thin cover of quartz and quartzite pebbles rests over much of the higher ground round Eastern Hill and the road from Storeys Creek township to Rossarden, as far eastwards as the Aberfoyle race.

IX. QUATERNARY AND RECENT.

Superficial deposits are represented by alluvium and dolerite talus.

1. Alluvium.

Alluvial deposits are confined to the valley of Aberfoyle Rivulet north and south of its junction with Mistletoe Creek, Story Creek, the upper parts of Gipps Creek, Buffalo Brook and Egan Creek; and the lower reaches of Castle Carey Creek and the Aberfoyle Rivulet. When the mines in the Gipps Creek area and Rex Hill were working, dams were constructed on Gipps Creek, Buffalo Brook and Egan Creek, so that the original alluvium is now largely covered by swampy and peaty flats.

The most complete section is seen in Story Creek south of the mine workings. Two beds of shingle were noted, each up to about 10 feet thick, separated by about six feet of dark yellowish-brown sandy and gritty loam. The shingle beds contain rounded pebbles and cobbles of dolerite, and sub-rounded to sub-angular quartzite and quartz; and dolerite appears to be more abundant in the upper bed. The sandy loam is well exposed in the angle of Story Creek beyond the position of the Burn Marsh Fault. The alluvium is partly concealed by tailings and slimes from the mine.

2. Dolerite Talus.

The northern boundary of the region mapped is marked by a sinuous line of talus resting on existing formations. The talus ranges in size from small rounded cobbles up to blocks many feet across which have tumbled down from the Ben Lomond plateau, forming a steep hummocky talus slope which almost completely obscures the solid formations.

X. STRUCTURAL GEOLOGY.

The country discussed in the Bulletin is a block faulted area of intensely folded Palaeozoic rocks intruded by granite and overlain by horizontal or gently dipping Permian and Mesozoic rocks. In the south and west the dip is caused by the tilting of individual blocks.

Figure 9 shows the main structural features.

(*a*) Folds.

The fold axes of the Mathinna sediments strike north-westerly between about 310° and 340° and when exposed at the surface between Rossarden and Tower Rivulet the quartzites and slates appear to dip constantly south-westwards at angles over 45°. However, evidence from the Aberfoyle Mine (p. 58), Storeys Creek Mine (Fig. 15) and detailed mapping show that folding is complex with a pitch towards the south-east. Cleavages indicate that axial planes generally strike between about 330° and 350° and dip at steep angles towards the south-west. In Burnt Gully Creek, steeply dipping quartzites and slates are thrust over a small pitching anticline. It is possible that isoclinal folding has taken place and that where the top of the folds has been eroded away, or is not visible, the impression is given of uniform dips to the south-west. Since the main part of the Mathinna Group is poorly exposed much of the structure cannot be seen except in the mines or in creeks.

The main structure is probably a complex faulted anticlinorium, pitching to the south-east, with subsidiary minor folds.

(*b*) Faults.

Although there was minor faulting before and during mineralisation in the Aberfoyle and Storeys Creek mines, most of the major faulting in this region occurred after the Permian and Triassic formations were laid down. Faulting probably accompanied the intrusion of the Jurassic dolerite, but by comparison with the Launceston area (Carey, 1947) the major movements took place in the Lower Tertiary, forming horst and graben structures (see Fig. 10) which laid the framework of the present topography. Later movements probably occurred in the Upper Tertiary or Quaternary.

(i) *Major faulting.*

The main faults trend north-westerly or north-easterly, often with gently sinous outlines, and appear to be normal faults.

The Castle Carey Fault—This structure is the main fault in the area, and may be regarded as the western boundary fault of the Ben Lomond Granite. It was followed from a point near the Stanhope road junction in the south for almost 10 miles to the north-west where it becomes obscured by weathered Permian and dolerite talus. Near Rex Hill mine, basal Permian is found resting on granite on the upthrown side at an altitude of 2,480 feet. Near Mt. Christie on the downthrown block, the base of the dolerite is at 1,960 feet and is about 100 feet thick, resting upon about 700 feet of Triassic and at least 500 feet of Permian, so that movement was at least 1,500 feet. In the north, near the Ben Lomond Tungsten Mine, the throw is about 1,200 feet.

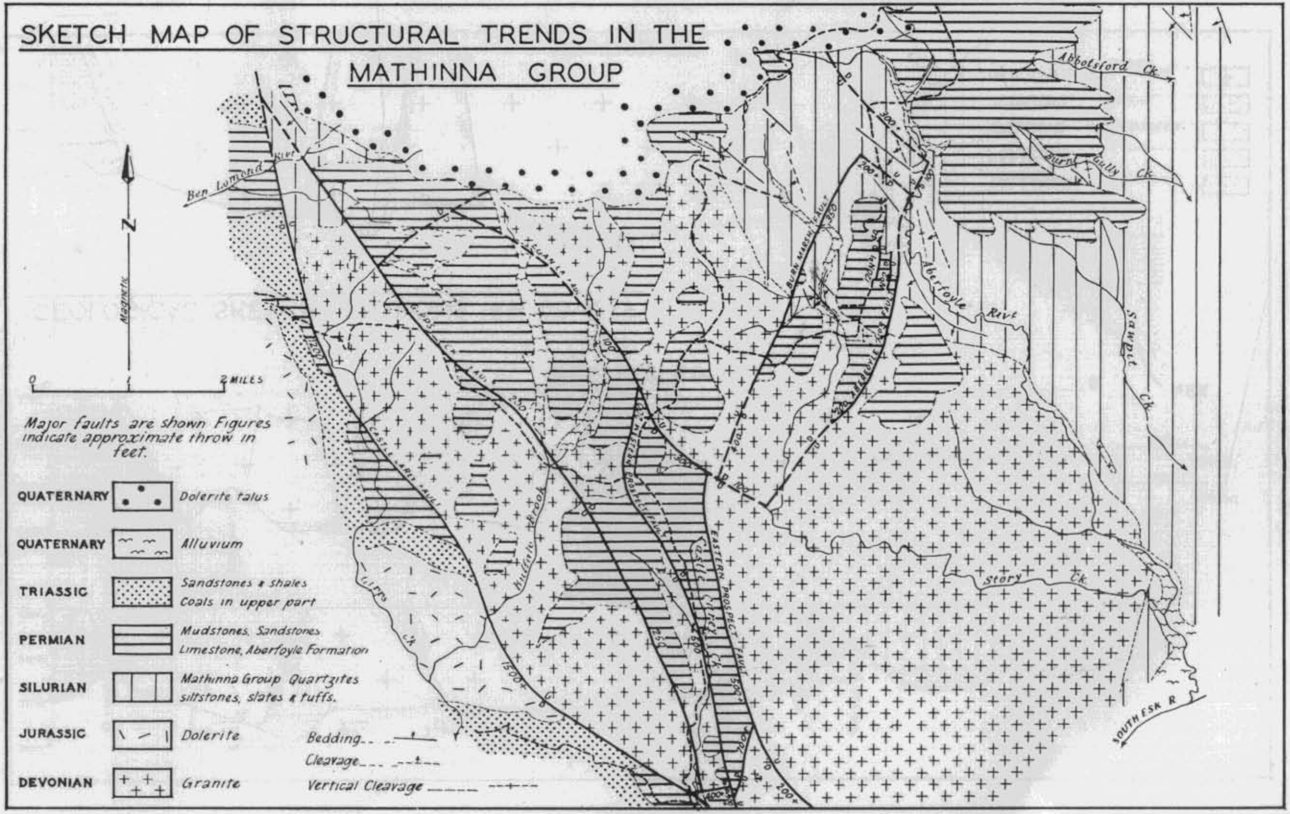


Fig. 9.—Sketch map to show main structural features of the area.

5 cm

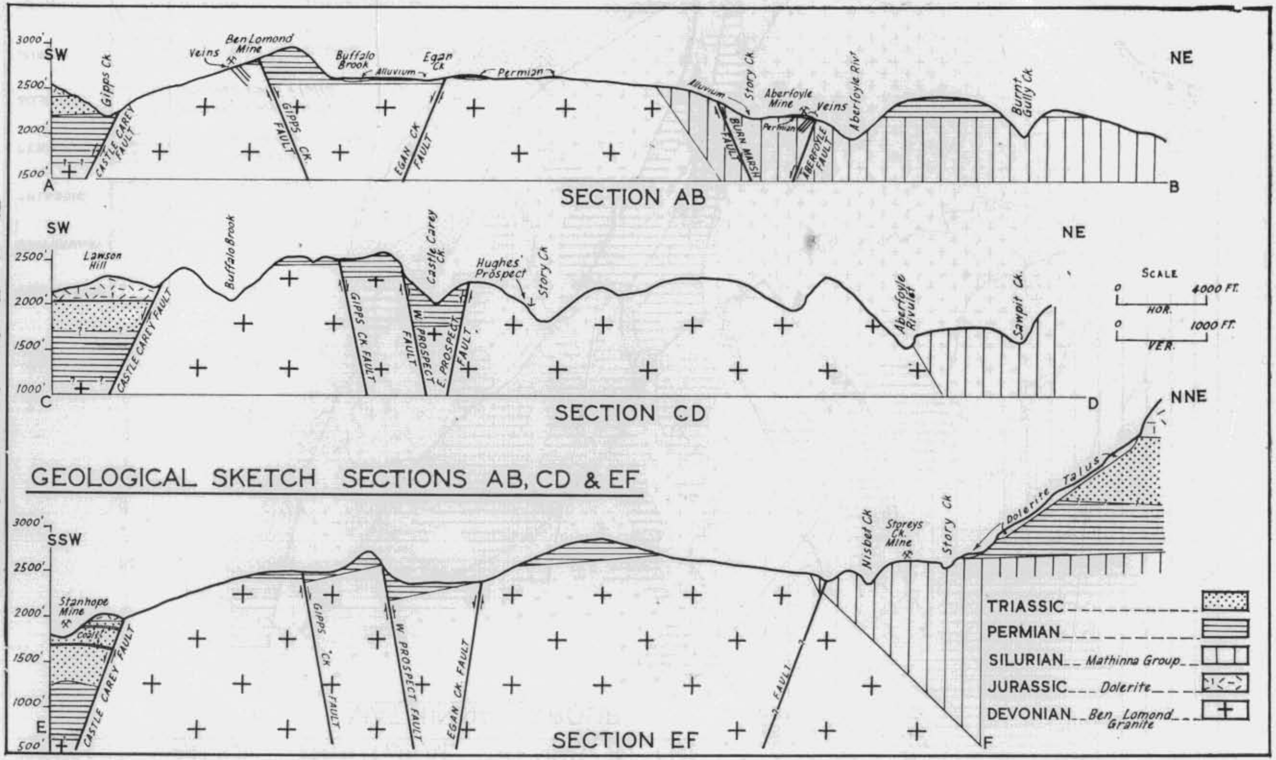


Fig. 10.—Sketch sections across the area.

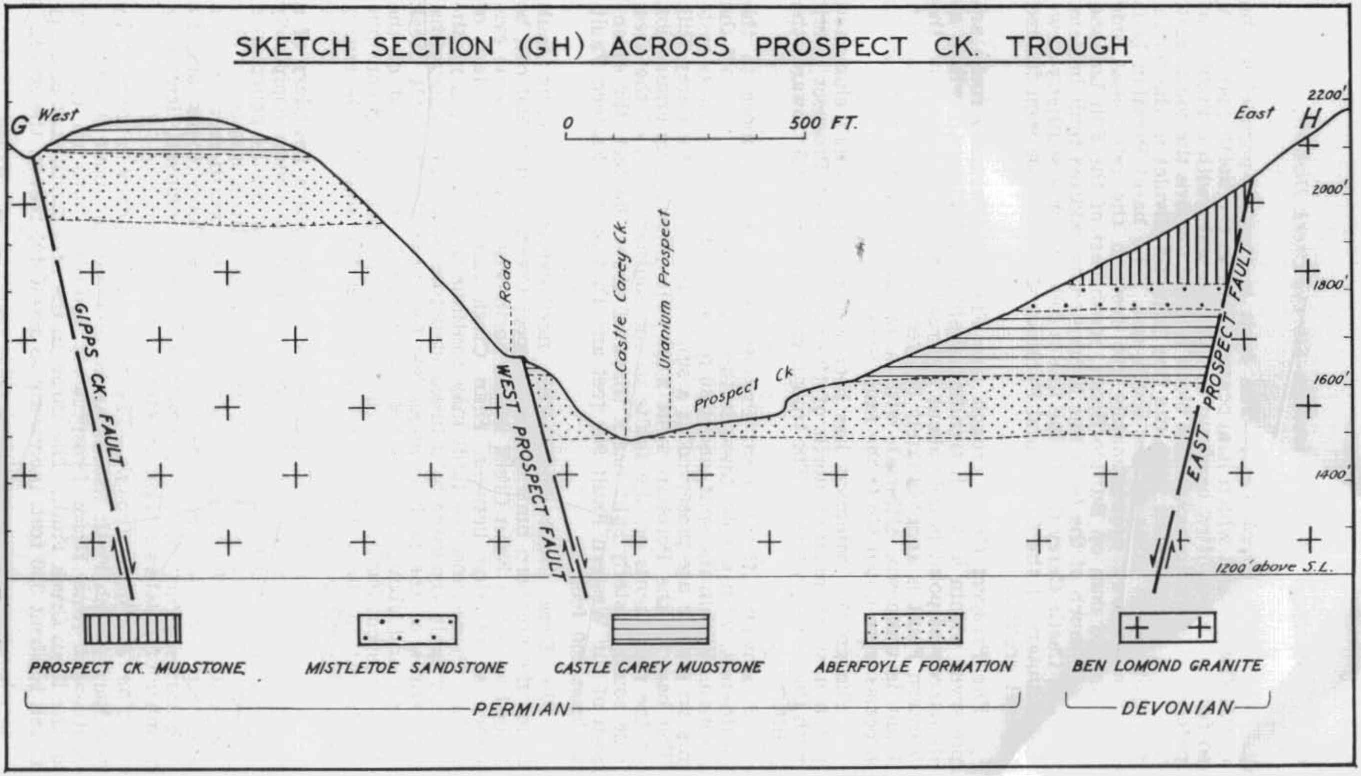


Fig. 11.—Sketch section across the Prospect Creek Trough.

The Gipps Creek Fault—The fault is roughly parallel to the Castle Carey Fault which it appears to join in the north and south, so forming an uplifted block up to 1½ miles wide, with a number of patches of Permian rocks. The block is tilted towards the south-east. The fault was followed from the Ben Lomond Rivulet in the north, for about eight miles to the south-east. The basal Permian beds are down-thrown approximately 200 feet on the north-east side near the old dam on Buffalo Brook, south-east of the Ben Lomond mine and much of the fault line is marked by oxidised fault breccia. West of Castle Carey Creek, the line is followed by a southerly flowing tributary of the Creek, and Permian strata can be seen faulted against granite.

The Prospect Creek Trough (see Fig. 11)—Permian rocks are preserved within a trough trending slightly east of south, which at its narrowest point is only about 500 yards wide. The throw on the Western Fault is approximately 500 feet, while that on the Eastern Fault is unknown, although with a minimum of 650 feet. Fault breccias were noted along the fault lines.

The granite basement has been exposed in a small elongated patch a short distance north of the confluence of Prospect Creek with Castle Carey Creek. The trough is tilted at about 5° towards the south-east.

Southwards the Eastern Prospect Fault swings more to the south-east, with a split towards the south-west which cuts off the Trough. Within the split, about 30 feet of basal Permian rocks resting on granite are preserved as a small patch on Castle Carey Hill. The base of the Permian is at 2,110 feet, allowing determination of the movements on the faults in the southern part of the area. The south-westerly split has a throw of about 700 feet, the extension of the Western Fault 900 feet and that on the Eastern Fault, at least 200 feet.

The Egan Creek Fault—This north-westerly trending fault forms the northern limit of the Prospect Creek Trough and can be traced as far as Egan Creek in the north-west. There is some evidence of faulting between Egan Creek and the headwaters of Buffalo Brook, and the fault may continue until it meets a north-easterly fault suggested by a linear structure on aerial photographs. The throw of the fault is about 300 feet near the Prospect Creek Trough and about 100 feet near Egan Creek, to the west of the West Prospect Fault. Linear structures suggest that it may continue south-east to Story Creek and may form the southern boundary of the Aberfoyle Trough.

The Egan Creek Fault marks the north-eastern boundary of a downthrown block the northern part of which is almost completely covered by Permian rocks and alluvium which rest on the peneplaned granite. The area is often flat and swampy with a mantle of clay soil and peat. The block is tilted gently to the south-east, and the southern part has been dissected by Castle Carey Creek and its tributaries. Part of the Permian has been removed, leaving a number of patches resting on eroded granite.

The Aberfoyle Trough.—The western boundary is formed by the Burn Marsh Fault which can be followed for about three miles south-west from Egans Prospect. It probably joins an extension of the Egan Creek Fault. The throw in the area north-east of Story Creek is about 350 feet, increasing to about 400 feet in the south.

The Trough is bounded to the east by the Aberfoyle Faults, which are aligned en echelon almost north-south (see p. 62). South of Aberfoyle Mine, the No. 3 Fault swings towards the south-west, parallel with the Burn Marsh Fault, and the movement is about 200 feet south of Rossarden.

Comparison of the altitudes of the basal Permian, and linear structures on aerial photographs, suggests that the trough is cut off in the north by a north-westerly fault which throws up a small horst bounded further north by a similar fault, as illustrated in Fig. 9. Mineralised fractures also indicate that the Aberfoyle No. 3 Fault may turn to the north-east to form the eastern margin of the uplifted block.

(ii) *Minor faults.*

The most important are the north-westerly strike faults within the Mathinna sediments in Aberfoyle and Storeys Creek mines. They frequently occur along the junction between competent and incompetent beds and are often marked by listric or slickensided surfaces. The amount of movement is usually small, ranging from a few inches up to several feet, and although many are post-ore, others show evidence of mineralisation indicating that they allowed the passage of mineralising fluids. The faults are described in the sections on the respective mines.

REFERENCE.

CAREY, S. W., 1947—Geology of the Launceston District. *Rec. Queen Vict. Mus. Launceston*, pp. 31-46.

6 Economic Geology

I. INTRODUCTION.

Although there are two small coal mines working Triassic coals west of the Castle Carey Fault, and substantial amounts of coal have been produced during the past 40 years, the Ben Lomond area owes its importance to tin and tungsten mining. The following table gives the production from the chief mines or prospects in the field since records were kept.

TABLE 3.

Mine.	Tin concentrates (Tons).	Wolfram concentrates (Tons).	Remarks.
Aberfoyle	11,000	3,500	From 1932
Storeys Creek	800	6,300	From 1899
Rex Hill	826	....	Also 20 tons of galena
Great Republic	132	....	....
Ben Lomond	38	16	....
Eastern Hill	25	....	....
Brock's Prospect	8	....	1939-1941

In addition, small amounts of cassiterite and wolfram have been won from miscellaneous prospects in the Gipps Creek and Rossarden areas. The total production is unlikely to have exceeded 10 tons of each.

At present, only the Aberfoyle and Storeys Creek mines are being worked.

II. MINERALISATION AND ORE-GENESIS.

Mineralisation is a typical phenomenon during the later stages of the cooling of granite intrusions, and is caused by the concentration of volatile fluids which have the property of carrying metals at high pressures and temperatures. Vapours which play an important part as mineralisers are fluorine, chlorine, boric compounds and water vapour. The cooling history of the granite is summarised as follows:—

(*a*) Crystallisation and slow cooling of the main granite mass under a cover of Mathinna sediments which may have been up to 5,000 feet thick.

(*b*) Pressure from below caused tension joints and marginal fissures within the partly consolidated coarse granite, followed after only a short period of time by the injection of microgranite, and probably the aplite at Aberfoyle.

(*c*) Concentration of the volatile fluids carrying metals which in the early stages of granite intrusion were disseminated through the magma.

(*d*) Continuing crystallisation of the granitic magma further increasing the internal pressure, which built up until it exceeded the pressure caused by the cover of Mathinna beds. Mineralisation started when the wedging effect of the concentrated fluids opened up channel-ways along existing joints, fissures and fault planes.

(*e*) The first stages of mineralisation were due to pneumatolytic or high temperature hydrothermal action, when the action of fluorine, chlorine or boron vapours is most marked. Tin and tungsten can be carried as the fluorides (SnF_4 and WF_6) and the chlorides ($SnCl_4$ and WCl_6), which decompose at lower temperatures in the presence of water vapour. The tin fluoride, for example, combines with water vapour to form tin oxide (cassiterite), and hydrofluoric acid. The latter reacts with the argillaceous wall rocks forming fluorine-bearing gangue minerals such as the white mica muscovite, pinite, topaz, triplite (manganese fluo-phosphate) and fluorite which are commonly associated with cassiterite and wolfram veins. Some of the quartz gangue may be formed in a similar manner from the decomposition of silicon fluoride, which can break down into silica and hydrofluoric acid.

The action of the volatiles also affects the granite mass through which they pass, in the process of greisening, so that the wall rock surrounding mineralised joints and fissures may be altered or greisened, as in the Gipps Creek area. If fluorine is present, muscovite is formed from biotite, and muscovite and topaz from felspar. In the presence of boric acid vapours, tourmaline may be formed.

Thus, both cassiterite and wolfram are early formed minerals, usually associated with fluorine-bearing gangue minerals.

(*f*) Under low temperature hydrothermal conditions, the main sulphide minerals were formed. The earliest were arsenopyrite and pyrite, followed by pyrrhotite, chalcopyrite and sphalerite. Much of the quartz in veins may be associated with these minerals. Galena was one of the last primary minerals to form, often associated with calcite or siderite.

The fine grained pitchblende found in the workings of Tasmania United Uranium N.L. on Story Creek may be of hydrothermal origin, since it is associated with sphalerite and galena.

III. ORE MINERALS.

(*a*) **Cassiterite.**

Tin oxide. SnO_2. (Tin 78.6%).
Usually black or brown, with an adamantine lustre.
Hardness: 6-7. Penknife may not scratch it.
Specific Gravity: 6.8 to 7.1. Therefore often apparent by its heaviness.

(*b*) **Wolfram.**

Iron manganese tungstate. (Fe,Mn) WO_4.
Usually steely, dark greyish-black, dark brown with a shining metallic lustre on cleavage surfaces.
Forms tabular or bladed crystals, often in radiating clusters near edge of veins.
Hardness: 5-5.5. Scratched by penknife.
Specific Gravity: 7.1-7.9. Note heaviness.

(*c*) **Pitchblende.**

Massive variety of uraninite (combined UO_2 and UO_3 with 50-80% U_3O_8).

Often occurs massive or as black or brownish grains with a greasy or dull lustre.

Hardness: 5.5.

Specific Gravity: About 6.4 when massive.

Found chiefly in fissure veins of hydrothermal origin often associated with pyrite, chalcopyite, galena and sphalerite.

Haematite (chocolate-red iron-ore) may also be present.

IV. STRUCTURAL CONTROLS OF MINERALISATION.

The main factors influencing mineralisation are discussed in detail in the sections dealing with each mine or prospect, and they are summarised below.

(*a*) Fissure veins associated with fault zones.

Illustrated in the Aberfoyle mine. Mineralisation also favoured by lithology (presence of hard fractured quartzites) and by fold structures.

(*b*) Marginal thrusts or joints dipping towards the granite.

As in Storeys Creek mine and Eastern Hill. Mineralisation also influenced by pitching folds, but lithology not as important as in the Aberfoyle mine.

(*c*) Tension joints within the granite.

Most of the old mines and prospects in the Gipps Creek area, and also in the Mammoth prospect. The joints are frequently greisened, forming pockets and patches of cassiterite.

(*d*) Bedding planes in the Mathinna Group.

The prospects west of Rossarden, such as Brock's and Plummers where thin quartz veins with some cassiterite follow steeply dipping bedding planes.

Fig. 12 shows the trends of the most important vein systems.

V. FUTURE EXPLORATION.

Possible areas for exploration are described in the accounts of individual mines or prospects (Chapter 7), additional to normal mine development in the Aberfoyle and Storeys Creek mines. On a regional scale, the following conclusions are drawn:—

(*a*) In the north, dissection of the granite is less intense than in the south, and therefore any mineralisation is likely to have been preserved. With the exception of Rex Hill, mineralisation occurs north of a line from the Ben Lomond Mine to Hughes Prospect, and is confined near the western and eastern margin of the granite.

(*b*) The Mathinna quartzites and slates form the roof to the granite in the north-west; and in the north-east near Nisbet Creek, the contact between the granite and the country rock begins to swing westwards. It is possible

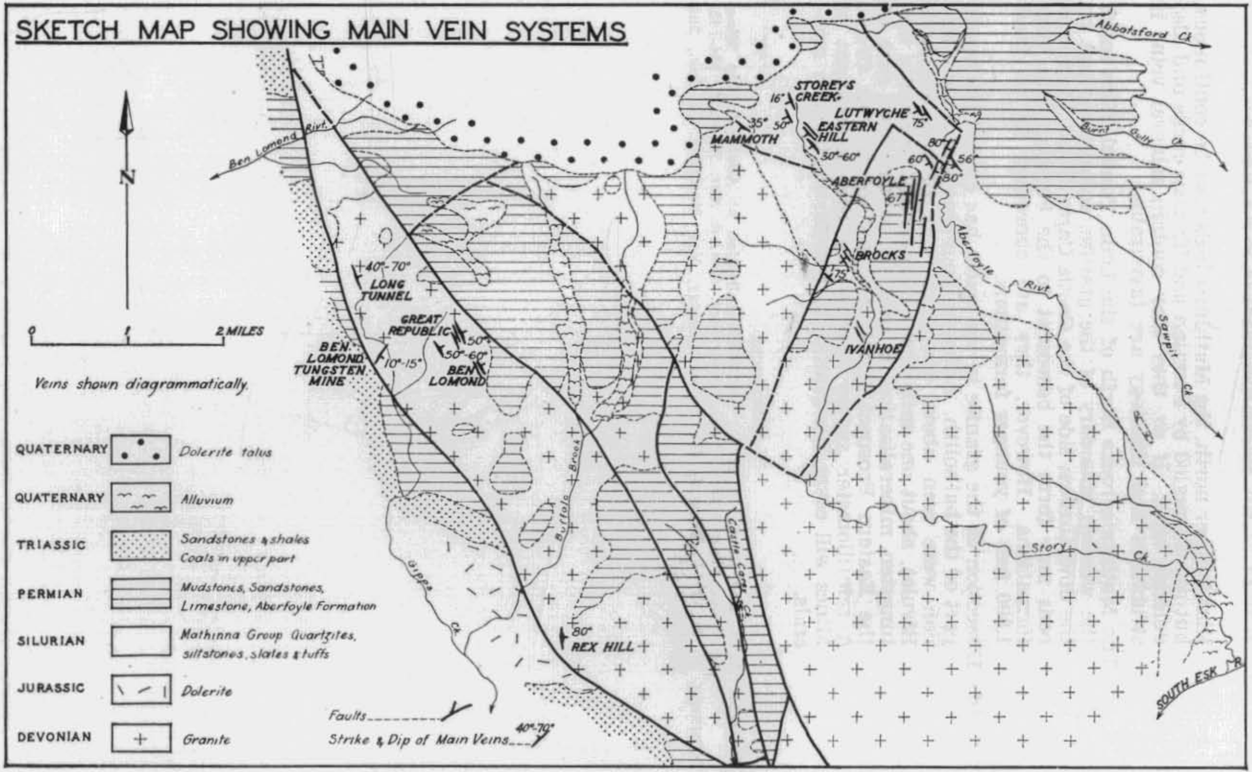


Fig. 12.—Sketch map showing strike and dip of main vein systems.

that further north, the Mathinna beds may be continuous, but are concealed by Permian and Triassic rocks and also dolerite talus. If so, they may contain mineral veins if structures and lithology are favourable.

(*c*) The Mathinna rocks north of the Long Tunnel Mine mark the western boundary of the granite, suggesting that on the downthrown side of the Castle Carey Fault, Mathinna beds may form the basement to the Permian and later formations. However, they are concealed by at least 1,200 feet of younger formations.

(*d*) Dissection of the granite in the south has eroded the upper part of the batholith. Although poor traces of mineralisation were seen above the west bank of the Aberfoyle Rivulet, about one mile east of Rossarden, economic tin-tungsten mineralisation is unlikely in the area east of the Eastern Prospect Fault and west of Sawpit Creek. A scintillometer survey planned by the Department of Mines will cover the granite to test for radioactive minerals.

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EDWARDS, A. B. and LYON, R. J. P., 1957—Mineralisation at Aberfoyle Tin Mine, Rossarden, Tasmania. *Proc. Aust. Inst. Min. & Met.* No. 181, 134-143.

NININGER, R. D., 1956—Minerals for Atomic Energy, Van Nostrand Co. Inc., 2nd Edition 27-28.

7 Mines and Prospects

I. TIN AND WOLFRAM

(a) Rossarden Area

ABERFOYLE TIN N.L.

Introduction.

In the past 30 years, the mine has played an important part in the production of tin and wolfram in Tasmania. The decrease in the proportion of tin to wolfram in the lower levels has been offset by the doubling of the tonnage treated since 1950. Aberfoyle is now the major producer of tin in Australia, yielding in 1956 about a quarter of the total production, as well as an important amount of tungsten. In 1956, an average of 230 men was employed.

Location and Access.

The mine lies one mile north of Rossarden Post Office, on the road from Rossarden to Mangana, approximately ¼-mile west of the Aberfoyle Rivulet. The Company holds the following leases:—

Consolidated lease	15M/51	290 acres
	11564M	68 acres
	44M/50	5 acres
	5510M	5 acres
	26M/51	10 acres
	70M/47	5 acres
	13W/52	10 acres (Dam site)

Topography.

Aberfoyle Mine is sited at an altitude of about 2,200 feet on a plateau which slopes gently westwards towards Story Creek and which in the east is deeply dissected by the Aberfoyle Rivulet. The plateau represents the pre-Permian peneplain from which most of the Permian rocks have been worn away, leaving a thin flat cover of pebbly mudstones round the mine, and low rounded hills of grits, sandstones and mudstones southwards.

History of Development.

Outcrops of thin quartz veins containing cassiterite within Mathinna quartzites on the west bank of Aberfoyle Rivulet have been known since 1916, but little development took place until 1926 when a prospecting syndicate was formed to investigate the veins in depth. The present Company took over later in 1926. After some trenching at the surface, two shafts were sunk to 60 feet and connected by a crosscut. The eastern shaft was an underlay shaft following a 20 inch vein, along which drives were cut at the 60 foot level. In 1928, surface exploration was abandoned and an adit was started from the west bank of Aberfoyle Rivulet, designed to test veins in depth 184 feet below the lowest surface workings. By the end of 1929, the adit was 1,050 feet long and had exposed a group of veins between 900 feet and 1,042 feet, which, although individually small and irregular, together formed a mineralised zone encouraging development. Production started in 1931 and has increased annually since 1934 when the Main Shaft was taken down to 230 feet and No. 2 level opened up. No. 2 adit was driven from the west bank of Aberfoyle Rivulet for a distance of 2,957 feet between 1936 and 1938. The main vein system was cut between 2,829 feet and 2,948 feet, about 450 feet south of the Main Shaft, and 382 feet below the collar. This system comprises eighteen veins with cassiterite and wolfram ranging from 3 inches up to 9 inches thick. A second shaft (Brandons Shaft) was sunk to 408 feet to connect No. 2 adit with No. 1 and No. 2 levels.

In 1945, a new mill was installed, designed for maximum recovery at coarse sizing to obviate over-sliming of tin. From 1948, much surface and underground drilling has been carried out, both to test future reserves and also to explore ahead of planned development.

By 1949, production was mainly from No. 4, No. 5 and No. 6 levels; the Main Shaft had been sunk to 907 feet in order to open up No. 7 and No. 8 levels, and drilling was under way to prove ore in No. 9 and No. 10 levels. The shaft was cut to its present depth of 1,380 feet by 1954, the lower 330 feet of which is in an aplite cupola intruded into the Mathinna beds. The lowest level of economic mineralisation appears to be No. 11 level, at a depth of 1,060 feet below the concealed outcrops of the main veins.

Production.

The following table shows the annual tonnage of ore treated and of concentrates recovered. (Figures taken from the annual reports of the Director of Mines).

Years.	Ore treated.	Tin Concentrates (1st grade).	Tin/Wolfram (2nd grade).	Wolfram Concentrates.
	tons	tons	tons	tons
Prior to 1932	906.5	15.74	8.64	....
1932	3,186	72.30	33.96	5.95
1933	11,410	234	218.25	9.40
1934	10.166	242.15	247.25	18.45
1935	14,487	303.50	343.50	27.50
1936	13,307	283.40	333.50	36
1937	13,489	269.50 (68% tin)		
			384.25	35.5
1938	14,354	265.60	362.75	33.25
		Tin Concentrates.		
1939	15,267	339.65		31.05
1940	16,653	318		20
1941	16,185	356.50		28.48
1942	16,609	360 (74.5% tin)		71
1943	16,462	347		84.58
1944	18,021	311.96		68.54
1945	20,213	343.46		60.30
1946	24,085	314.33		30.56
1947	30,643	474		72.93
1948	26,435	473.40		74.16
1949	27,774	396.19		98.30
1950	31,542	443.28		86

Years.	Ore treated.	Tin Concentrates	Wolfram Concentrates.
	tons	tons	tons
Prior to 1951	37,081	475.55	196.43
1952	40,322	550	337.65
1953	49,006	576.58	370.66
1954	57,841	792.23	365.20
1955	63.314	662.85	339
1956	60,042	768.68	398.36
1957	65,571	595.58	269.39

Copper, 182.56 tons; Silver, 59,506.14 ozs.

Grade of Ore.

Edwards and Lyon (1957) have described in detail the changes in grade of ore. Since 1934 the ratio of tin to tungstic oxide has fallen from 15:1 to 1.5:1 in 1955, illustrating the relative increase in wolfram in the lower levels. In 1934, the tin content of ore was 1.35% and that of tungstic oxide 0.11%. The following table, taken from company files, illustrates changes in the proportion of tin in ore milled over the past few years.

Year ending (June)	1953	1954	1955	1956	1957	1958
Tin in ore %	1.218	1.138	1.084	0.948	0.911	0.910
Tin in tailings %	0.231	0.216	0.217	0.212	0.195	0.205
Recovery %	81.7	81.6	80.4	78.05	79.0	77.9

Thus, the tin content of ore has fallen from 1.35% in 1934 to 0.910% in 1957-58, while tungstic oxide has risen from 0.11% to 0.46% in the same period.

Down to about No. 4 Level cassiterite forms more than 5% of vein material. In the 26 Vein System, the grade falls to about 2.5% on No. 8 and No. 9 levels, while wolfram increases down to No. 8 level, and then diminishes suddenly in a short vertical distance below No. 8 Level in the centre part of the vein system. The base of economic wolfram mineralisation appears to be roughly dome-shaped. The grade of cassiterite is mainly poor and uneconomic below No. 8 and No. 9 Levels, although patches of coarse cassiterite were found in greisened aplite at the contact of the intrusion and the country rock, and also associated with a fault on No. 13 Level.

Mineralisation therefore appears to occur round the aplite in rough zones, which have not yet been fully delimited. The inner zone is comparatively barren, but is surrounded by a zone containing wolfram and some cassiterite, passing gradually out into a region with increasing amounts of cassiterite and diminishing wolfram. The zones are partly controlled by changes in lithology and by structures in the Mathinna Group sediments.

Geology.

(i) *General.*

Mineralisation occurs in the form of northerly trending fissure veins with steep westerly dips, occupying a zone about 200 feet wide in folded slates, siltstones, quartzites and greywackes assigned to the Mathinna Group, believed to be of Silurian age (see p. 24). The sediments were intensely folded along north-westerly axes during the Tabberabberan orogeny in Devonian times, and mineralisation took place in the later stages of the granite intrusion which followed.

In the Aberfoyle Mine, the veins appear to be genetically connected with a cupola of pale grey aplite, the top of which is 1,050 feet vertically below the collar of the Main Shaft. The aplite does not outcrop and it is different to other fine grained granitic rocks in the Rossarden area. It may be related to poor outcrops of quartz porphyry which probably form a dyke about 20 yards wide about ¾-mile to the north (see p. 61). The aplite may be an apophysis from the main granite mass which is exposed about one mile to the south-west.

The area was peneplaned before Permian times, and this resulted in the removal of an unknown thickness of Mathinna sediments and the unroofing and erosion of the main granite. At least 1,200 feet of Permian and Triassic rocks were deposited upon this surface, followed in Jurassic times by the intrusion of dolerite sheets into Triassic formations. Long erosion followed, interrupted and modified by large scale block faulting in early Tertiary times, resulting in the sculpturing of the present topography, and the exhuming of the pre-Permian land surface round the Aberfoyle area.

(ii) *Lithology.*

(*a*) *Mathinna Group.*

The sediments form a variable series ranging from fairly coarse impure quartzites or greywackes to fine black slates. The arenaceous beds may be up to 100 feet or more in thickness, but the formation frequently includes rapid alternations of slates and quartzites or siltstones with some turbulent bedding, slump structures and scouring. Near the aplite mass, the quartzites and siltstones have been indurated with some recrystallisation and the formation of secondary biotite by low grade contact metamorphism. Lyon (1957) shows that mineralisation is generally richer where the veins cut the massive quartzites, owing to the well marked fracturing developed in them.

(*b*) *Aplite.*

The rock is a hard pale grey quartzose aplite with a finely granular or coarsely saccharoidal texture and is described on p. 29.

(iii) *Underground Structural Geology* (see Fig. 13).

The underground structures have been closely studied by Conolly (1946, 1953). Henderson (1946) and Lyon (1957) and are summarised below.

(*a*) *Folds.*

Five major folds and 19 lesser folds are recorded underground, which form a complex small scale anticlinorium with a north-westerly trend. The slates tend to be puckered and closely folded; with more open folding within the massive quartzites. The fold axes are almost parallel and plunge at about 25° to the south-east. The axial planes dip at about 85° to the south-west and the traces of their intersections with the plane of the 26 Vein System pitch steeply north.

(*b*) *Faults.*

There are two main groups of faults:

1. North-south.
2. North-west to south-east.

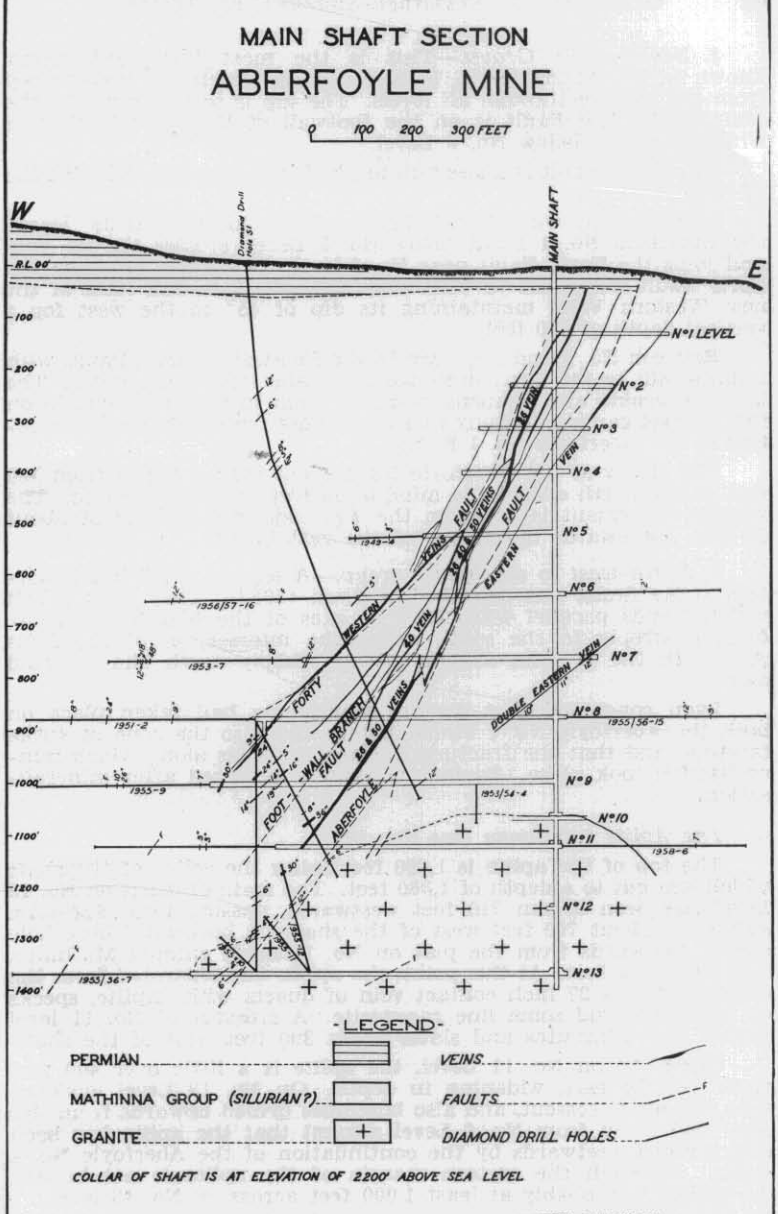

Fig. 13.—Main shaft section of Aberfoyle Mine.

1. *North-south Group.*—This is the most important group, known as the Aberfoyle No. 1 Fault System which has been traced from the surface through all levels. The dip is to the west. In the Main Shaft, the Fault is on the footwall of the 26 Vein System which it enters below No. 6 Level.

The Forty Fault is a less well marked structure parallel with the 40 Vein.

The Hanging-wall Branch Fault, which dips west at 35° leaves the Aberfoyle No. 1 Fault below No. 3 Level, crosses the 26 Vein and joins the Forty Fault near No. 5 level. Below the junction, the Forty Fault leaves the 40 Vein and forms the foot-wall fault of the new Western Vein, maintaining its dip of 45° to the west for a vertical depth of 900 feet.

Between No. 6 and No. 7 levels, the Footwall Branch Fault, with a dip of 48° to the west, splits from the Aberfoyle No. 1 Fault. The latter is weaker and steepens in dip. A fault in the aplite cupola on No. 13 level carrying patchy cassiterite may represent the continuation of the Aberfoyle No. 1 Fault.

The throw of the Aberfoyle No. 1 Fault system varies from 120 feet at the north end of the mine to 40 feet in the south end. The relative movement is down on the west side with a total of about 50 feet northwards movement of the east block.

2. *North-west to south-east group.*—A zone of small but important strike faults was described by Lyon (1957). They form a belt which trends parallel with the fold axes of the Mathinna Group, dipping steeply to the south-west. The intersection of the fault zone with the 26 Vein System pitches steeply north like the fold axes.

Lyon concluded that pre-ore movements had taken place on both the Aberfoyle No. 1 Fault System and also the zone of strike faulting, and that the fractures formed channels along which mineralisation took place. Further movement occurred after mineralisation.

(c) *The Aplite Intrusions* (see Fig. 13).

The top of the aplite is 1,050 feet below the collar of the shaft which was cut to a depth of 1,380 feet. The main crosscut on No. 13 Level has been driven 710 feet westwards, passing into Mathinna sediments about 700 feet west of the shaft. A horizontal bore hole drilled eastwards from the plat on No. 11 Level entered Mathinna beds after 120 feet. At this point, the aplite was separated from the sediments by a 27 inch contact vein of quartz with triplite, specks of sphalerite and some fine cassiterite. A crosscut of No. 11 level passed into quartzites and slates about 300 feet west of the shaft.

Therefore on No. 11 Level, the aplite is a little over 400 feet from west to east, widening in depth. On No. 13 Level evidence from the west crosscut, and also boreholes drilled upwards from this level and down from No. 8 Level suggest that the aplite has been downthrown westwards by the continuation of the Aberfoyle No. 1 Fault. Although the eastern margin of the aplite is not known, the cupola is probably at least 1,000 feet across on No. 13 level.

The bore hole drilled east on No. 11 Level was abandoned after 356 feet owing to a heavy inrush of water from fissures which may mark the position of the Aberfoyle No. 3 Fault.

The only other intersection of the aplite was in a bore hole (S3) drilled from the surface at a point 600 feet south of the Main Shaft and 800 feet further west. The hole entered the aplite at a vertical depth of 1,470 feet; that is about 100 feet lower than the junction on No. 13 Level, and 200 feet further east. Robinson (1956) contoured the top of the aplite on No. 10 Level and his plan suggests an irregular elongation in an east to west direction.

The aplite mass has not been reached south of the position of Borehole S3, nor north of the main shaft section. It is possible that it forms a roughly dome-shaped mass at least 1,000 feet across at the horizon of No. 13 Level since it plunges steeply on the west and east flanks, and probably does so under S3 hole. Its northern boundary may have an important bearing on the continuation of economic mineralisation northwards. If the cupola plunges steeply northwards, one would expect that the mineral " zones " would follow it, providing that favourable lithological and structural factors also continue in this direction.

About ¾-mile north-west of the concealed aplite, a few poor exposures of quartz-porphyry were noted, east of the water race and north-west of the Old Battery Prospect. Mineralogically the two rocks are different (see p. 30). However, analyses show a close resemblance chemically. Compared with other granitic rocks analysed, they are both relatively poor in Na_2O and richer in MgO. The quartz-porphyry appears to form a dyke-like body up to about 20 yards wide and at least 100 yards long, but the relationship with the peneplaned Mathinna sediments is obscure since the area is covered with a mantle of clay and weathered quartzite, and only a few rounded masses of the porphyry project through the cover. It is possible that the dyke may represent the northwards extension of the concealed aplite.

(IV) *Surface Structural Geology.*

(*a*) *Folds.*

Outcrops of the Mathinna Group are rare and poorly exposed in the Aberfoyle area, except on the slopes of the Aberfoyle Rivulet east of the mine, where the stream cuts through prominent strike ridges. West of Rossarden, at least one minor synclinal fold occurs with a plunge towards the south-east. About one mile east of Rossarden, the Mathinna beds strike to about 300° with dips of about 45° to the south. This trend is similar to that of the contact of the granite and the sediments in this area, while northwards, the strike of the beds swings to between 325° and 335°, east of the Aberfoyle Mine. The axial planes strike to about 340° with steep south-westerly dips.

(*b*) *Faults.*

(1) *The Aberfoyle No. 1 Fault.*—This system which is an important feature underground was also cut in No. 1 and No. 2 adits, and was formerly exposed in a trench on the Spartan lease, a short distance over the boundary of the main Aberfoyle lease (Henderson, 1946).

(2) *The Aberfoyle No. 2 Fault.*—A fault was found in No. 2 adit and in a shallow adit about 800 feet east of the old South prospecting shaft. The trend is northerly with a downthrow to the west, as in the No. 1 Fault.

(3) *The Aberfoyle No. 3 Fault.*—This fault marks the eastern boundary of the Aberfoyle Trough, and it can be traced from No. 2 adit to a point about one mile south of Rossarden Post Office, and may continue beyond (see p. 48). East of Aberfoyle, the fault trends northwards, and towards the south, it swings to the south-west in a similar direction to the Burn Marsh Fault, on the western boundary of the Aberfoyle Trough.

North of Aberfoyle, linear features on aerial photographs, as well as the trends of fractures and thin veins suggest that the fault may turn towards the north-east.

The throw of the No. 3 Fault varies from about 100 feet in the north, to approximately 200 feet in the south, with a downthrow on the west side, as on the No. 1 and No. 2 Faults.

Since, in the mine, some faulting was initiated before mineralisation, it is possible that there was also movement on the No. 2 and No. 3 Faults, althought the main faulting took place in post-Permian times. Henderson (1946) points out that only the No. 1 Fault system approaches the veins now being worked in the mine.

(V) *Structural controls of mineralisation.*

1. The aplite mass was probably injected into the core of a minor anticlinorium during the later stages of the main granite intrusion.

2. Pressure induced by initial cooling of the aplite mass formed fissures which allowed the passage of mineralising fluids in the later stages of intrusion. The fractures tend to be more open in the massive quartzites and so more favourable for the formation of veins.

3. Faulting trending in the same direction as the host rock commenced before mineralisation.

(VI) *Vein Systems.*

The veins were examined in great detail by Lyon (1957). They occupy a zone about 200 feet wide and at least 1,600 feet long. Southwards to the Main Shaft, the zone dips at 67° to the west, flattening to 53° between No. 5 and No. 9 Levels. Further south, the dip is about 57° to the west.

There are nine veins in five groups of which the 26 Vein System and the Western Vein are most important.

(*a*) 26 *Vein System.*

Composed of the "26", "50", and "40" veins so named from their distances east of the shaft in the main crosscut on No. 1 level where they were originally found. The 26 Vein is the centre vein, with the 50 vein on the footwall side and the 40 vein in the hanging wall. The 50 vein converges on the 26 vein southwards and in depth. It is the strongest vein in the upper two levels with a strike length of over 1,000 feet, decreasing to 100 feet between No. 8 and No. 9 levels. The 40 Vein converges on the 26 Vein northwards and becomes shorter in strike length in depth. The two veins have joined on No. 8 and No. 9 levels.

The 26 Vein System is nearest to the aplite intrusion at the shaft section. Six hundred feet south of the shaft, the vein swings away from the aplite and changes abruptly to a south-westerly trend.

(b) The Western Vein.

The Western Vein is found below No. 5 level where the Hanging Wall Branch of the Aberfoyle No. 1 Fault joins the Forty Fault, and tends to thin out southwards.

(c) The Eastern Vein.

The Eastern Vein is the only vein which outcrops on the upthrown side of the Aberfoyle No. 1 Fault. It lies about 100 feet east of the fault and was important only between No. 2 and No. 3 levels, near the shaft. It dips at 52° to the west and dies out on entering the fault near No. 6 level at the Main Shaft section.

(d) The Double Eastern Vein.

The Double Eastern Vein lies east of the Eastern Vein and dips at about 43° to the west near the shaft between No. 7 and No. 8 levels. It may enter the aplite intrusion at a small thrust on No. 11 level.

(e) The Contact Vein.

The Contact Vein lies at the contact between the aplite and the Mathinna beds. The junction is almost horizontal with gentle rolls. The vein is mainly barren quartz although it contained separate large masses of cassiterite and there is some greisening of the aplite in places. The upper junction with the Mathinna sediments is often angular and affected by joints and prominent bedding planes.

(VII) *Width of veins.*

Lyon (1957) showed that the areas of greatest vein width occur within the zone of most intense folding and faulting, and reach a maximum thickness where this zone affected massive quartzites.

In the 26 Vein System, the southern stoping limit, where veins are under 12 inches thick, appears to be controlled by a bed of massive quartzite dipping steeply to the south-west, and lies about 700 feet south of the shaft, while the northern limit was reported at about 500 feet north of the shaft, and affected by minor synclinal structures. The zone of greatest width lies directly above the aplite intrusion, and the veins become narrower in the lower levels. They also become poorer in depth, as mentioned on p. 57.

(VIII) *Mineralisation.*

The following account is summarised from Edwards and Lyon (1957), who have made a detailed study of the mineralogy and ore-genesis.

The veins are often banded, with a selvedge of muscovite on the walls. Crystals of cassiterite, wolfram and sphalerite usually occur inside the selvedge within a central core of quartz. Patches of pyrite, chalcopyrite and other sulphides may be found scattered throughout the quartz. Where the muscovite is absent, the cassiterite crystals form the edge of the vein and are often welded on to the host rock and green pinite derived from altered topaz may separate the cassiterite from the quartz core of the vein.

A study of the relationship between minerals showed that cassiterite and wolfram were the first to crystallise, acompanied by fluorine-bearing minerals such as muscovite, topaz and fluorite, followed by arsenopyrite and pyrite. Chalcopyrite and sphalerite were formed later from solid solutions, then galena and scheelite were deposited with marcasite and iron oxides in the last stages. Quartz was contemporaneous with the earlier sulphides and carbonates were deposited towards the end of mineralisation.

Thin sections of the country rock indicated the formation of secondary biotite by contact metamorphism suggesting that the host rocks had not been heated above about 200°C when the aplite was intruded. Experiments on ore specimens led to the conclusion that the mineralising fluids might have been originally at temperatures over 700°C and that deposition did not occur in the lowest levels of the mine owing to the poor thermal conductivity of the host rocks and possibly relatively rapid movement of the fluids, followed later by rapid cooling.

(IX) *Regional considerations.*

(*a*) *Vein systems.*

The veins in the Aberfoyle mine are different to those in the Storeys Creek mine, and other areas where mineralisation occurs in the Mathinna Group. Those at Aberfoyle are infilled fissures cutting across the grain of the Mathinna quartzites and slates, and associated with northerly trending faulting, with some north-westerly faulting.

In Storeys Creek, the veins strike north-west in a similar direction to the host rocks, with fairly gentle south-westerly dips.

Northwards from the Aberfoyle mine, although some veins trend to the north-east with south-easterly dips, the north-westerly set becomes dominant in the Old Battery Prospect.

Thus the Aberfoyle type of vein appears to be confined to the mine area.

(*b*) *Effects of the aplite intrusion.*

As shown on page 61, the sides of the aplite cupola plunge steeply in the west and east, and probably to the south. Providing favourable structures and lithology are present, the mineral zones may also plunge round the cupola. Westwards fissuring may be less intense away from the Aberfoyle Fault and so less favourable for mineralisation.

Northwards along the trend of the main mineralised zone, economic mineralisation may become deeper, depending on the depth of the aplite mass. If the poor exposures of quartz porphyry apparently forming a dyke-like mass north of Aberfoyle represent the end of the aplite intrusion, mineralisation may tend to fade out northwards.

In the south, if the cupola is truly dome shaped, mineralisation may also be found in depth, although in this direction, the Aberfoyle No. 1 Fault system apparently fades out. West of Rossarden, the north-westerly trend becomes dominant once more in Brock's and Plummer's Prospects.

(*c*) *Faulting.*

Faulting may have been initiated after the folding of the Mathinna Group and before the intrusion of the aplite. That there was a north-south structural zone of weakness is shown in Figure 4. In the area north of the Rossarden bridge, a microgranite vein 3-inches thick in Mathinna quartzite strikes to 204° and dips at 65° to the east side. It is possible that the aplite intrusion followed a similar zone.

(*d*) *Lithology.*

More open fissures occur in the massive quartzites, so that mineralisation is richer where such rocks are disturbed near fault of fracture zones. Westwards from the Aberfoyle No. 1 Fault, and east from the No. 3 Fault, conditions may be less favourable for mineralisation even if massive quartzites are present, unless there is undetected faulting beneath the Permian or gravel cover.

(X) *Conclusions.*

1. Tin and tungsten mineralisation at Aberfoyle is due to a favourable combination of structural features associated with a cupola of aplite which was injected during the later stages of granite intrusion in the Rossarden area.

2. Westwards, the concealed aplite plunges steeply down and economic mineralisation is less likely, since fissuring may not be so intense away from the Aberfoyle Faults, and one would expect the general north-westerly trend to become dominant. Any mineralisation would tend to border the aplite mass and would become deeper to the west, probably with little or no surface indication. Much of this area has a cover of Permian rocks or gravels.

3. To the east, the aplite also dips steeply. If mineralisation has taken place, the mineral " zones " may also plunge in this direction, and therefore may not be apparent at the surface. The best prospects of mineralisation would be near the Aberfoyle No. 3 Fault. On the east side of the fault, the aplite will be upthrown at least 100 feet, but the cupola may have plunged too deeply before the fault is crossed for the upthrow to have an important effect.

4. A porphyry dyke probably striking northwards at the surface about ¾-mile north of the shaft may represent the end of the aplite intrusion. This may indicate that northwards from the mine, the aplite body may not plunge too deeply and that some mineralisation may occur between the mine and the dyke.

5. The thickness of the cover of Mathinna beds between the mine and the main granite mass south of Rossarden is not known. It is not certain that the aplite joins the main granite, as there is no outcrop which resembles the aplite, although it might be a facies variant of fine granite in Story Creek. There could be a considerable cover of Mathinna sediments between Aberfoyle and Rossarden partly concealed by Permian rocks, which might be worthy of exploration.

(XI) *Recommendations.*

1. The horizontal borehole (1958-6) drilled eastwards from No. 11 Level plat, which was stopped after 356 feet owing to the inrush of water, should be continued as far as possible, if the flow of water

can be overcome. An extension of the hole would help to determine whether there is any mineralisation associated with the Aberfoyle No. 3 Fault.

2. A hole should be drilled at the northern end of a drive on one of the lower levels (for example, No. 8 or No. 9 level). The bore hole should be inclined eastwards at about 60° to test whether the cassiterite " zone " plunges northwards in depth and the information gained would guide any further exploration in the north end of the mine.

3. If a surface drilling programme were contemplated for exploration there are two probable sites:—

(i) On the east bank of the Aberfoyle Rivulet where it crosses the middle of the northern boundary of Lease 11564-M. The hole should be inclined eastwards at 45° to 60°. Any mineralisation would probably be at a considerable depth, and results obtained from the upper part of the hole would help to decide the final depth of the hole.

(ii) A hole inclined in a similar direction near the south-east corner of Lease 15M/51 and a short distance west of the road. The hole would be near the trend of the Aberfoyle No. 1 Fault and would indicate whether the zone of mineralised fractures continues and if there is an adequate cover of Mathinna beds. The bore hole should go to at least 500 feet.

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BROCK'S PROSPECT.

The prospect lies at an altitude of about 2,250 feet, above the west bank of Story Creek, north of Tasmania Creek, and about ¾-mile north-west of the Rossarden post-office. A number of thin non-persistent veins have been worked in small open cuts, trenches and shallow shafts, which are now full of water. Between 1939 and 1941, Messrs. McDonald and Floyd produced about eight tons of tin from a vein dipping to the south-west. At a depth of 54 feet in the shaft, the vein was only 2-in. thick but high grade in cassiterite. The vein was driven on at the 48-foot level for 40 feet north-west and 30 feet to the south-east.

Geology.

The prospect lies on the downthrown side of the Burn Marsh Fault which has a north-easterly trend. The veins are in the form of small mineralised fractures with steep south-westerly dips, within Mathinna quartzites and slates which are closely folded, with steeply dipping limbs, along a north-westerly strike. The strike of the fractures coincides with that of the host rocks, and some veins may follow bedding planes.

Workings.

Two shafts were sunk about 300 feet apart, the northern one of which (the Main Shaft) reached 54 feet with a drive on the 48-foot level for a total length of 70 feet. A number of open cuts and trenches were cut between the shafts, and between 1950 and 1954, a total of 20 inclined boreholes was drilled by Mr. H. E. Brock, representing over 1,400 feet of drilling. The first hole was put down 90 feet south-west of the main workings with an inclination of 60° to the north-east for a cored length of 200 feet. Although some quartz veining was encountered, no cassiterite was seen. Of 17 holes drilled within a length of 200 feet along the strike of the veins, only six revealed tin ore.

Conclusions.

Keid (1954) formed the opinion that there were no continuous veins and that only small patches of cassiterite occurred in joints, or as a mere coating on brecciated quartzite. Since this small area has been exhaustively explored to a depth of over 160 feet, his conclusions that there were no promising indications are justified.

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KEID, H. G. W., 1954—(*b*) Brock's Prospect. *Tas Dept. Mines Rep.* (Unpublished).

EGAN PROSPECT.

The south-eastern corner lies about ½-mile north-west of the Aberfoyle mine, and the leases now held are 44M/50 and 5510M, each of five acres registered by Aberfoyle Tin N.L. The leases cover part of a total holding of 40 acres in the name of J. F. Egan when Reid and Henderson mapped the Rossarden area in 1928.

Geology.

The leases occupy ground which rises out of Burn Marsh, mainly on the upthrown side of the Burn Marsh Fault, and forms the south-eastern continuation of Eastern Hill. The movement on the fault is about 300 feet and on the downthrown side, soils and thin gravels lying on peneplaned Mathinna sediments form Burn Marsh. The Mathinna sediments pass in a south-easterly direction under a thin cover of Permian pebbly mudstones. Reid and Henderson (1929) record that part of Burn Marsh was formerly sluiced for cassiterite. There are a number of thin quartz veins up to about 9-in. thick, striking north-west and dipping to the south-west within cleaved Mathinna slates and quartzites, but they are poorly exposed and the old trenches and cuts are now mainly overgrown or obscured. Some cassiterite occurs, but insufficient surface exploration has been undertaken to determine the vein systems. They may represent the continuation of the group of veins on Eastern Hill.

Conclusion.

To test the veins, surface trenching should be systematically carried out across them in a north-easterly direction. However, the distance from the granite outcrops to the south-west, and from the main veins in the Aberfoyle mine may imply that mineralisation is poor or limited.

REFERENCE.

REID, A. M. & HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40, 45-46.

IVANHOE PROSPECT.

The prospect is sited above the west bank of Story Creek, about 500 yards south of the bridge at Rossarden. Since about 1900, a number of shallow pits, trenches and shafts have been cut and intermittent sluicing operations between 1929 and 1937 have opened up a long cut down the slope south-eastwards towards the creek. The excavations are now overgrown or largely obscured by granite gravel and talus from the overlying Permian rocks; and the veins reported on by Henderson in 1937 are not visible. There is no record of the amount of cassiterite obtained from the prospect, but it was probably very small.

Geology.

Mineralisation occurred in the form of four veins within coarse greisened granite, and Reid and Henderson (1929) recorded that, in one cut, veins were associated with a pegmatite body composed of felspar and quartz with tourmaline and a little cassiterite.

Henderson (1937) reported that three of the veins had a north-westerly strike, and the other trended northwards. The granite between the veins was soft and decomposed, and a face was opened up 30 feet wide, with a depth of six to eight feet. The veins were exposed over a total length of about 120 yards, and northwards they passed under a cover of Permian pebbly sandstones, conglomerates and mudstones. The veins contained pinite and muscovite, with some tourmaline and coarsely crystalline cassiterite.

Samples taken in 1937 assayed about 0.06% tin, with one sample from a greisened body 3ft. 6 in. wide showing about 0.54%.

Conclusions.

The deposit is apparently limited in extent and of low grade. Systematic trenching in a north-easterly direction would help to determine the extent of the mineralised zone, and to guide any future exploration in depth.

REFERENCES.

HENDERSON, Q. J., 1937—The Ivanhoe Mine, Rossarden. *Tas. Dept. Mines Rep.* (Unpublished).

REID, A. M. and HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Survey Bull.* No. 40, 46-47.

KOOKABURRA PROSPECT.

The workings are sited on the edge of the plateau west of the Aberfoyle Rivulet, south of the Old Battery Prospect, and about ½-mile north-east of the Aberfoyle Mine. The veins were discovered about 1925, but there was limited activity until 1927, when the McPherson Reward Syndicate was formed to explore and develop the veins. The group concentrated on cross cutting about 130 feet vertically below the top of the plateau in an adit, driven south-west from above the west bank of the Aberfoyle Rivulet, which was planned to intersect a series of thin veins exposed in shallow excavations at the surface. The workings have long been abandoned, and there is no record of any production of cassiterite.

In 1928, the prospect formed part of Lease 10,225-M of 80 acres in the name of A. E. Davies, A. H. Smith and J. W. Ryan.

Geology.

There are two distinct groups of quartz veins bearing cassiterite, within Mathinna Group quartzites and slates, which are folded along north-westerly axes. One set strikes to about 330° with dips of 60° to 75° to the south-west, while the other series trends about 25° with south-easterly dips of 80° to 85°. In the open cut above the adit, the north-easterly trending veins cut and slightly displace the north-westerly set. They are therefore younger, suggesting that they occupy fault fissures formed by earth movements before mineralisation was complete. This supports Reid and Henderson's view (1929, pp. 57-58) based on the presence of galena in a north-easterly striking vein found 265 feet along the adit, and comparable with galena impregnation in faults in the Storeys Creek Mine (p. 81). The fissures may be related to the Aberfoyle No. 3 Fault.

The Mathinna sediments strike about 315° with dips of about 75° to the north-east in the open cut.

At outcrop the veins are generally less than 3-in. thick, and are of quartz with small crystals of cassiterite bordering the walls. Those in the north-westerly group are usually thinner than the north-easterly set.

Workings.

1. *Johnson's Adit.*

The main work carried out was the driving of an adit from above the west bank of the Aberfoyle Rivulet, 200 yards south-west of the remains of the old battery on the Lutwyche Prospect. The adit was driven for 330 feet on a bearing of 263° at a vertical depth of 130 feet below the top of the plateau, and the portal is at an altitude of 2,070 feet. A number of thin quartz veins carrying cassiterite were intersected, trending both north-westerly and also north-easterly. Reid and Henderson (1929) record that the most important vein found contained coarsely crystalline cassiterite, arsenopyrite, pyrite, galena, sphalerite and chalcopyrite. The vein is exposed at the surface, and on both horizons, it trends to 22° with dips to the south-east at 80° to 85°.

2. *The North Costean.*

This is a cut about 100 feet long, the eastern end of which is about 100 feet higher than the portal of the adit, and about 50 feet north of the end of the adit. One thin vein striking north-west and dipping at 75° to the south-west is exposed.

3. *The Open-Cut.*

An irregular open cut was excavated near the edge of the plateau, about 60 feet long, up to a width of about 30 feet. The eastern end is about 10 feet higher than the North Costean, and its western end about 30 feet higher. The Mathinna quartzite and slates strike to 316° with a dip of 77° to the north-east. In the western face of the cut, a 1-in. vein containing cassiterite trends to 330° with a dip of 60° to the south-west, and is displaced by a 3-in. vein striking to 24° with a dip of 80° to the south-east.

Summary.

The notes on the Lutwyche (Old Battery) Prospect apply also to the Kookaburra area.

Recommendations.

As in the Lutwyche Prospect (p. 72), exploratory drilling would be necessary to test the veins in depth. If drilling were considered, the area south-west of the North Costean, between the Aberfoyle Mine and this prospect, would be the logical site for boreholes inclined at 60° towards the north-east.

REFERENCE.

REID, A. M. and HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40, 57-58.

LUTWYCHE (OLD BATTERY) PROSPECT.

The name is given to workings in a number of north-westerly and north-easterly trending veins above the west bank of the Aberfoyle Rivulet, about ¾-mile north-east of the Aberfoyle Mine, and approximately 200 yards north-east of the Kookaburra Prospect. In 1928, the area was covered by Leases 10183-M of 40 acres, and 10184-M of 21 acres in the names of B. C. Lutwyche and J. Richards, bounded to the north-west by Lease 10223-M of 33 acres held by J. A. Crisp. Probably about one ton of cassiterite concentrates was obtained.

Geology.

The veins are contained in Mathinna quartzites and slates which are strongly folded along north-westerly axes. The sediments strike to 303° with steep south-westerly dips, whilst a well-marked cleavage strikes to 340°. There are two sets of veins; one group trends between 320° and 340° with dips of about 70° to the south-west while the second set strikes between 40° and 65° with dips of 70° to 85° to the south-east. The veins are generally less than 4-in. thick, and consist of milky quartz, with visible cassiterite on the margin. From evidence in the open cut on the Kookaburra Prospect, the north-easterly veins are probably later than those striking to the north-west (see p. 69).

Although there is no definite surface evidence, faulting is likely in this area. Permian rocks are preserved in the Aberfoyle Trough to the south-west at about 2,200 feet above sea-level, and north-east of Mistletoe Creek, the base of the Permian is at about 2,100 feet above sea-level. Near the Storeys Creek road junction, Mathinna sediments reach altitudes of 2,470 feet suggesting that they form part of an uplifted block. The north-easterly trending veins may occupy fissuring along an extension of the Aberfoyle No. 3 Fault. They are less numerous than the north-westerly veins which have a similar trend to the veins on Eastern Hill, and in the Storeys Creek Mine.

To the north-west, about half way between the old battery and the water race to the Aberfoyle Mine, a few poor outcrops of quartz-porphyry occur. They appear to mark a dyke trending northerly, which might be the exposed extension of the concealed aplite cupola below the Aberfoyle Mine (see p. 61).

Workings.

A number of trenches and pits, now waterlogged, have been excavated in the area and thin veins with cassiterite are recorded. The main working was the Old Battery adit, the portal of which is about 80 feet vertically above the Aberfoyle Rivulet near the remains of the old battery, and about 130 feet to the north-west. The adit was driven about 60 feet to the north-west.

Fifty feet north-west of the portal of the adit, a 3½-in. vein striking to 40° and dipping at 85° to the south-east is exposed in an old stope, whilst at the surface on the edge of the plateau, the vein is 1-in. thick, with small crystals of cassiterite, and strikes to 65° with a dip of 75° to the south-east. At outcrop, a vein 1½-in. thick, with cassiterite, is exposed, with a strike to 340° and a dip of 70° to the south-west. The Mathinna beds trend to 303° and dip steeply to the south-west, while cleavage in a thin band of slate trends to 340°.

Diamond Drilling.

Two core holes have been drilled in the area by Aberfoyle Tin N.L.

1. *Hole S*14. Inclined at 84° to the north-east. Sited approximately 900 feet west of the old battery. The hole reached a measured depth of 1,260 feet and revealed a number of thin veins with cassiterite and wolfram belonging to the north-westerly group.

2. *Old Battery Hole.* Inclined at 60° on a bearing of 310°. Sited next to the remains of the old battery. The hole was cored to a measured length of 361 feet. Although a number of veins with cassiterite were encountered, none was thicker than 1 inch. However between 320 feet and 343 feet, a total of about 8 ft. 9 in. of core was lost.

Summary.

1. In the Old Battery area, mineralisation with cassiterite occurs in two vein systems; one trending to the north-west and dipping south-west, the other striking north-east with steep south-easterly dips. The latter system appears to be the younger, probably occupying fault fissures associated with the Aberfoyle No. 3 Fault.

2. The veins may represent either poor mineralisation, or the upper part of mineralisation which could improve in depth, as in the Aberfoyle Mine.

3. If the quartz-porphyry dyke to the north-west is the surface equivalent of the aplite cupola below the Aberfoyle Mine, this area could mark the limits of the mineralised zone.

Recommendations.

The veins are relatively thin and scattered at the surface. To test them in depth, a drilling campaign would be necessary and must be regarded as pure exploration. Since the north-easterly veins appeared to be less numerous and restricted to the vicinity of a possible extension of the Aberfoyle Fault, any proposed drilling should first be planned to explore the north-westerly group in boreholes inclined at about 45° in a north-easterly direction. A possible site would be on the east bank of the Aberfoyle Rivulet, opposite the Old Battery borehole site.

The Old Battery hole was planned to test in depth the north-easterly vein exposed both above and in the adit. The results do not encourage any further drilling on these veins.

REFERENCES.

HENDERSON, Q. J., 1946—The Geology of the Tin-Tungsten Deposits, Aberfoyle area. *Tas. Dept. Mines Report* (unpublished).

REID, A. M. & HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40, 50-52.

PLUMMER'S PROSPECT.

The workings called Plummer's Prospect lie south of Tasmania Creek and east of Tiger Creek about 50 chains west of Rossarden. The mineralisation resembles that in Brock's Prospect to the north of Tasmania Creek. When Reid and Henderson reported on the area in 1929, the lease was held by J. S. Goodall, who about 1926 produced a small amount of tin from the Main (No. 4) Shaft. In 1941 Nye recorded that about 29 tons of ore from the several workings had been recently treated by the Layhoe syndicate who took over the leases in 1938.

Geology.

The host rocks are quartzites and dark slates with some thin tuffs of the Mathinna Group which were folded along axes striking north-westerly and later intruded by the Ben Lomond granite, which now outcrops in the south of the area. A capping of lower Permian grits, conglomerates and mudstones rests on the granite and is also exposed in Tiger Creek above its confluence with Tasmania Creek. There are alluvial flats along Tiger Creek and on the northern side of Tasmania Creek which, prior to 1892, were sluiced for cassiterite.

The veins strike and dip in the same direction as the Mathinna beds. Strikes vary between about 325° and 340°, and dips are steep to the north-east. The zone of mineralisation appears to be about 200 yards north-east of the granite contact and is in the form of irregular impregnations of the country rock, together with thin stringers and veinlets of barren quartz. As in Brock's Prospect, mineralisation is not continuous and although patches of rich cassiterite were reported, they quickly cut out and passed into thin, barren quartz veins.

Workings.

The following description is based on Nye (1941) since the shafts are full of water and the trenches collapsed or overgrown. Three shafts were sunk and trenches were cut across the lines of the veins. The deepest excavation is the Main (No. 4) Shaft which is 50 feet deep and from which a crosscut 75 feet long was driven eastwards.

The workings indicated four main veins.

1. *No.* 1 *Vein.*—This vein was exposed at intervals over a length of 230 feet. The strike is 327° and the dip steep to the north-east. The deepest working is an 18 foot shaft, with a southerly drive from it which was inaccessible in 1941. The workings are two feet to three feet wide which was probably the width of the vein.

A sample taken over 30 inches at a depth of 12 feet on the south side of the shaft assayed a " nil " return for tin.

About 10 tons of ore are reported to have been taken from the shaft.

2. *No.* 2 *Vein.*—No. 2 Vein has been cut in one, or possibly two places. In a 14 foot shaft, the strike is 323° and the vein was probably two feet wide, with a steep north-easterly dip.

3. *No.* 3 *Vein.*—It has been found in four places over a length of 170 feet and has a strike of 333° and a steep north-easterly dip. The main working was an irregular open cut for 30 feet along the strike to a depth of 14 feet. The vein was probably two feet to three feet wide with a maximum of five feet. A sample taken by Nye at a depth of six feet across a total of 54 inches assayed 0.42% of metallic tin.

4. *No.* 4 *Vein.*—No. 4 Vein has been exposed at a number of places over a length of 500 feet. The strike changes from 333° to 322° in a south-easterly direction, and the dip is steep to the north-east. The most important exposure was an open cut at the northern end which was 60 feet long and four feet to seven feet wide, reported to have been stoped to a depth of 15 feet, yielding 15 tons of ore. The Main Shaft was sunk to about eight feet and then along a south-westerly dipping wall to a reported depth of 67 feet. A crosscut was driven 75 feet eastwards from a depth of about 50 feet and probably cut the No. 4 and two other veins. Nye suggested that the width of the vein ranged between two feet and five feet. A sample across 42 inches at a depth of four feet at the southern end of the open cut assayed 0.45% metallic tin.

Summary.

1. The prospect includes a group of tin bearing veins striking between about 325° and 340°, with steep north-easterly dips, conforming with the structures in the Mathinna Group.

2. Although some veins may be followed over considerable distances, mineralisation tends to be mainly restricted to limited patches which have sometimes proved to be of high-grade cassiterite with little or no quartz.

3. Nye (1941) showed that the average grade of the exposed veins was about 0.4% metallic tin, and most of this had been mined, yielding about 29 tons of ore.

4. The future of the prospect would depend on the presence of similar bodies in depth. Since mineralisation is partly controlled by north-easterly dipping bedding planes in the Mathinna quartzites and slates, its character may be altered by synclinal folds in the Mathinna beds, which further north-east dip to the south-west along the strike of the veins in Brock's Prospect.

5. It appears doubtful whether the prospect could be developed, except for small-scale production.

Recommendations.

To test the veins underground, as Nye pointed out, it would be necessary to reopen and drain the Main Shaft and crosscut, and to sample the workings systematically. If assays showed there was sufficient justification, shafts should be sunk to about 100 feet, with drives and crosscuts in the veins. Drilling would be unsatisfactory because of the erratic nature of mineralisation.

REFERENCES.

NYE, P. B., 1941—Plummer's Workings (Layhoe Syndicate), Rossarden. *Tas. Dept. Mines Rep.* (unpublished).

REID, A. M. & HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40, pp. 48-49.

THE SPARTAN PROSPECT.

The prospect lies immediately north of the Aberfoyle mine and is now covered by Lease 11M/57 of 40 acres, held by E. L. Egan, which adjoins the Aberfoyle holdings.

When Reid and Henderson mapped the area in 1928, the ground was leased by R. E. McCormack. An extension of one of the Aberfoyle veins had been opened up in trenches and an underlay shaft 32 feet deep. Fragments from the dump at the top of the shaft indicate a quartz vein 4-in. to 6-in. thick containing cassiterite. The vein is in Mathinna quartzites and slates, which are covered to the west by thin basal Permian pebbly mudstone.

Work was apparently abandoned until about 1941 when Spartan Silver-Lead Mines N.L. planned a shaft to 100 feet a short distance north of the centre of the southern lease boundary. After sinking to 50 feet, operations ceased, owing to the wartime shortage of labour.

Between 1949 and 1956, four boreholes were drilled by the Tasmanian Department of Mines near the shaft. The holes were bored at inclinations between 45° and 60° to the east, and reached measured depths of between 236 feet and 450 feet. A number of quartz veins were encountered, but with the exception of one vein 1 ft. 2 in. thick. all were under 5 in. thick.

Conclusions.

(*a*) The veins in the Spartan Prospect are the northern extensions of veins in the Aberfoyle mine, and lie near the Aberfoyle No. 1 Fault.

(*b*) The low grade mineralisation of the veins met in boring is probably due to the fact that the aplite mass may be plunging in a northerly direction (see p. 61) and the bores have not met the higher grade mineralisation to be expected at or near the aplite-slate contact. With a northerly plunge for the aplite the contact would occur at a greater depth than in the Aberfoyle mine.

REFERENCE.

REID, A. M. & HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40.

ROSSARDEN AREA—MISCELLANEOUS PROSPECTS.

West of Rossarden township, the contact between the granite and the Mathinna Group trends north-westwards, and there is a number of old scattered trenches and open cuts, mainly within the folded Mathinna quartzites and slates, which strike north-west. Near the contact, the granite becomes finer, and contains muscovite and abundant black tourmaline. The granite is pegmatitic in places and is occasionally greisened. There has been little alteration in the Mathinna sediments, except for induration and slight recrystallisation of the quartzites and siltstones. The main prospects are:

1. Flaherty's Prospect.

This forms the north-westerly continuation of the veins in Plummer's Prospect, and is sited north of Tasmania Creek and south of Brock's Prospect, on the downthrown side of the Burn Marsh Fault.

According to Reid and Henderson (1929) the four trenches revealed a vein or veins striking to 335° and carrying low grade cassiterite. The workings had already fallen in by 1941, when Nye reported that the only signs of mineralisation were narrow veinlets of quartz in quartzite.

2. Jarman's Prospect.

A group of five trenches about ¼-mile west of Brock's Prospect, within a length of 150 feet were cut prior to 1941. The trenches trend easterly and appear to indicate a vein with a general northerly strike. In the centre trench, a small excavation was made under a wall dipping west at 40° (Nye, 1941). The prospect is in Mathinna beds, on the upthrown side of the Burn Marsh Fault, and may represent an extension of the veins in Flaherty's and Plummer's Prospects.

Conclusions.

1. There has been some mineralisation within the Mathinna quartzites and slates, near the contact with the granite.

2. The mineralisation appears to be of low grade, and is not persistent, therefore any future development would be limited and uncertain. It is doubtful whether drilling would be of value, owing to the patchy character of the mineralisation.

REFERENCES.

NYE, P. B., 1941—Plummer's Workings (Layhoe Syndicate), Rossarden. *Tas. Dept. Mines Rep.* (unpublished).

REID, A. M. & HENDERSON, Q. J., 1929—The Avoca Mineral District. *Tas. Geol. Surv. Bull.* No. 40, pp. 49-50.

(b) Storeys Creek Area

STOREYS CREEK.

Introduction.

The veins with wolfram and cassiterite within the Mathinna Group sediments now being worked by the Storeys Creek Tin Mining N.L. have been known and mined intermittently for about 70 years. The present company was formed in 1937, and since that time, the mine has been one of the major producers of tungsten in Tasmania, as well as recovering important quantities of tin. Although at times shortage of labour and falls in world prices for wolfram have affected production, the yearly tonnage mined since 1950 has been more than doubled, the output of wolfram has increased in proportion and that of tin concentrates has trebled. The mine has been opened up to the 435 foot (No. 8) level. In 1956, an average of 81 men was employed.

Location and access.

The mine is situated on the west bank of Story Creek, about 14 miles north of Avoca with which it is connected by a graded road. It lies two miles north-west of the Aberfoyle mine.

The company holds the following leases:—27M/46, 383 acres; 399P/M, 80 acres.

Topography.

The mine lies at an altitude of about 2,600 feet on a plateau surface which has been deeply dissected by Story Creek and its tributaries. The edge of the plateau slopes steeply down to Story Creek about 200 feet below and so early mining was facilitated by adits driven from the western slopes of the creek. The plateau is made up of folded Mathinna quartzites and slates from which the original Permian cover has been worn away, so exhuming the pre-Permian peneplain which is now being actively eroded by youthful streams flowing down from the Ben Lomond plateau.

History of development.

By 1881, alluvial ground in the upper reaches of Story Creek was being worked for cassiterite, and it is possible that the outcrops of the veins, since worked out, had been discovered on the western slopes of the valley. Montgomery reported that in 1892, the Storey Creek Tin Mining Company was working veins, on a small scale, from adits driven from the north side of a small creek flowing south-east into Story Creek. In 1901, Waller recorded that the company had abandoned work, after some driving and cross-cutting from Mier's Adit in the south part of the present workings. Tribute parties worked the veins in a primitive fashion until the early days of World War I when tungsten became of strategic importance. The leases were taken over by the Storey Creek Tin Mining Syndicate in 1916, and the veins were exploited from Mier's Adit, and also the present adit levels on the west bank of Story Creek. Although only about 2½ tons of mixed tin and wolfram concentrates were being produced weekly, additional plant was planned. By 1928 about 35 tons of ore were being treated daily, and the veins had been followed down to the 247 foot (No. 3) level. The mine closed later that year because of the general drop in metal prices.

A tribute party took over about a year later, and there was limited production until 1937 when the present company was formed. Development was resumed on No. 2, No. 3 and No. 4 levels, with emphasis on wolfram production. In that year, 11,736 tons of ore were milled for the recovery of 239 tons of wolfram concentrates, and 27 tons of tin concentrates.

Except for fluctuations in production due to labour shortages in the war years and the immediate post-war period, the tonnage milled has increased steadily up to the present time. The vertical shaft started in 1952, is now down to the 435 foot (No. 8) level.

Records and plans of the older workings are sketchy and incomplete. Since some of the old levels are collapsed, and heavily coated with slime, structures in the upper levels are obscured. Many old stopes are timbered or stowed, so that correlation of veins is difficult. However, within the past year, accurate surveying of the old levels and stopes has been undertaken in addition to routine mine survey work.

Production.

The following table, compiled from the annual reports of the Director of Mines, shows production from 1923.

Year	Ore treated (tons)	Tin concentrates (tons)	Wolfram concentrates (tons)
1923	10,360	155.6	103.2
1924	?	?	54
1925	12,066	?	170.2
1926	8,090	?	83
1927	9,968	?	?
1928	....	?	176
1929	....	?	151.35
1930	....	?	112.5
1933	3,933	42.35	90
1934	9,912	71.82	170.93
1935	10,262	87	200.14
1936	9,353	67.55	177.7
1937	11,736	27	239.2
1938	12,678	32.5	250
1939	12,271	52.1	197
1940	12,676	?	209.6
1941	13,009	67.1	205
1942	9,022	40	115.9
1943	10,556	55.45	143
1944	12,936	42.3	?
1945	11,333	21.5	148.3
1946	8,637	25	123
1947	8,695	47.5	126
1948	9,915	31.1	158
1949	10,477	14.5	166
1950	7,620	11.85	113.85
1951	6,843	12.75	93.15
1952	8,130	14.5	121.05
1953	10,598	15.24	147.7
1954	12,551	24.08	215.45
1955	12,862	30.35	216.75
1956	15,358	20.88	239.5
1957	17,395	29.29	280

During its existence, the mine has yielded about 800 tons of cassiterite and 6,300 tons of wolfram concentrates.

Grade of ore.

In 1928, Reid and Henderson (1929) reported that during the previous 11 years, the yield of concentrates per ton of ore treated varied between 0.75% and 1.75% cassiterite, and from 0.75% to 2% wolfram. For the first half of 1928, the figures were 1.194% for cassiterite, and 1.49% for wolfram. The statistics were based on production figures since the irregular distribution of the minerals throughout a quartz gangue makes sampling difficult and unreliable.

The comparable figures in 1957 were 0.17% cassiterite and 1.61% for wolfram. These proportions are partly due to the concentration of mining on wolfram, but they also reflect the increasing ratio of wolfram to cassiterite in depth, as in the Aberfoyle mine. In that year, 29.29 tons of cassiterite were obtained with a reported metallic tin content of 21.05 tons, so that the grade of the tin concentrates was about 70%.

Geology.

(i) *General.*

Cassiterite and wolfram, with subordinate pyrite, chalcopyrite and martite, occur irregularly throughout quartz veins which strike north-west and dip generally south-west at angles below about 50°. The veins cut Mathinna Group quartzites, greywackes, siltstones and slates with occasional bands of tuff, which are intensely folded along north-westerly axes with a pitch to the south-east. Figure 14 illustrates the general vein pattern.

Mineralisation occurred in the final stages of the intrusion of the Ben Lomond granite, which outcrops in Nisbet Creek, ½-mile south-west of the mine, but which has not been reached underground. Mining is now down to 435 feet, and the relative dilution of mineralisation within a thick quartz vein may indicate that the granite lies at no great depth below this level.

After the intrusion of the granite, erosion removed much of the Mathinna Group and exposed the granite core to the south-west and south. Permian and Triassic sediments were deposited on a flat but uneven surface, followed by the intrusion of a Jurassic dolerite sheet. Most of the post-Permian rocks have since been worn away, uncovering the mineralised Mathinna beds and the granite.

(ii) *Lithology.*

The Mathinna sediments resemble those elsewhere in this region and are a variable series of arenaceous and argillaceous beds showing some turbulent bedding and minor slump structures. They range from fine black cleaved slates to coarse quartzites and greywackes, with occasional bands of pale greenish tuff. There are massive beds of hard, jointed quartzite or siltstone, but interbanded thin quartzites and slates may be seen.

(iii) *Underground structural geology.*

(*a*) *Folds.*

The Mathinna beds are closely folded along north-westerly axes, with a pitch towards the south-east of about 20°, and with limbs generally dipping at over 60° (see Fig. 15). In the old workings which are coated with slime and iron oxide, it is often difficult to determine whether surfaces are bedding planes or cleavage. However, cleavages measured at a number of places in No. 1 adit suggest that the axial planes dip steeply to the south-west, as in other parts of the Story Creek area. The massive quartzites are jointed, but show few signs of bedding.

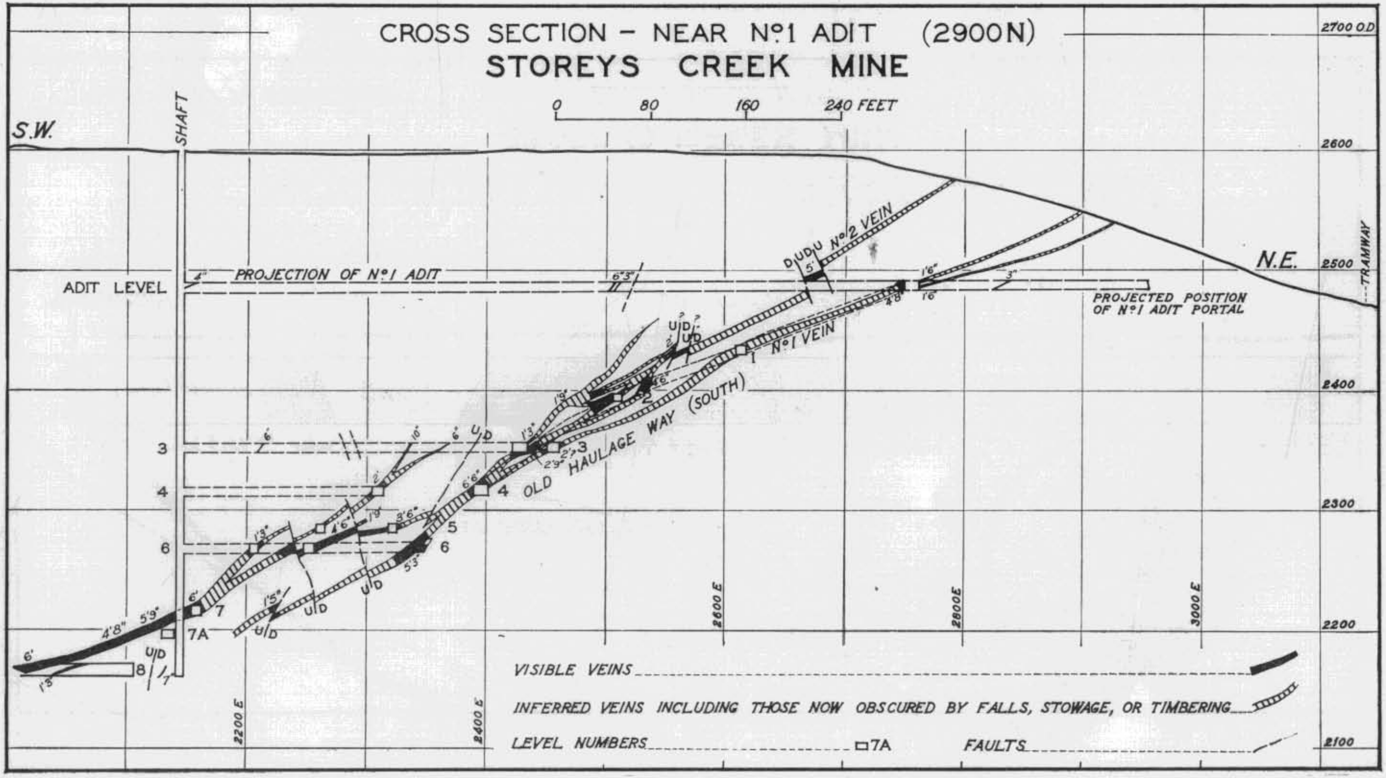

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Fig. 14—Cross section of the Storeys Creek Mine.

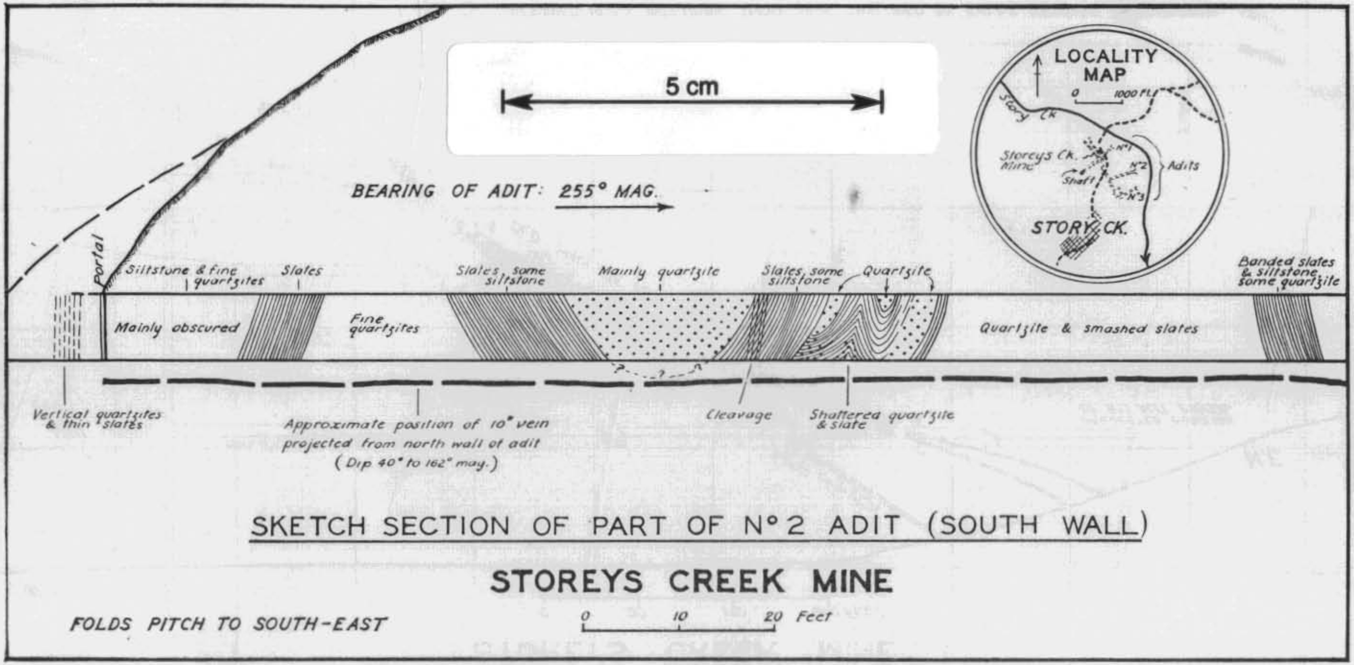

Fig. 15—Sketch section of part of No. 2 adit, Storeys Creek Mine.

(*b*) *Faulting.*

No evidence of large scale faulting was seen. There is much faulting on a small scale in a north-westerly direction, with strikes ranging between 310° and 325°, and also with a westerly trend. The movement varies from a few inches up to five feet. Many are reversed faults, generally with steep dips over 70°, but normal faults also occur (see Figure 14). The majority of the faults are post-ore and are often recognised by the abrupt termination of quartz veins.

Evidence of faulting during mineralisation was seen in at least two places. In the main crosscut on No. 6 level, a north-westerly trending fault with a throw of about three feet which dislocates a 4 ft. 6 in. vein is heavily impregnated with galena in quartz showing that faulting occurred after cassiterite and wolfram mineralisation, and before the sulphide stage was completed. Several small faults with throws of only a few inches and carrying galena were noted on No. 8 level. These faults trend to the north-east with dips to the north-west of about 55°.

Some faulting with a north-westerly direction is caused by movement along bedding planes between hard quartzite and incompetent slates, and is often marked by listric surface and slickensiding.

(iv) *Surface structural geology.*

(*a*) *Folds.*

On the top of the plateau, the Mathinna beds have been peneplaned and exposures are poor. However, fold structures may be seen on the slopes of Story Creek and its tributaries, and in road cuttings between the mine and Nisbet Creek. The sediments are tightly folded along axes striking between 300° and 325°, with dips over 65°. On the side of the road, immediately north of Nisbet Creek a minor anticlinal fold was noted, with the eastern limb dipping at 70° and the western limb at 80°.

On the west bank of Story Creek cleavages strike to between 310° and 325° with dips to the south-west of about 75°.

(*b*) *Faults.*

No definite evidence of faulting was found. Linear structures on aerial photographs, as well as the trend of a tributary of Story Creek and a slight shift of the granite outcrop imply that there may be a fault trending south-easterly from a point ¼-mile south of the Mammoth Prospect as far as Story Creek, with a downthrow to the south.

If there is a fault in Story Creek between the mine adits and the east bank, it would probably be small, since basal Permian south-west and also north-east of the mine are at the same altitude. The Permian appears to be horizontal north-east of Story Creek.

(v) *Structural controls of mineralisation.*

The main features affecting the formation of veins are:—

(i) The prominent north-westerly strike of the Mathinna quartzites and slates.

(ii) Marginal "thrusts" or joints formed in the later stages of the granite intrusion, largely due to the tectonic grain of the Mathinna rocks and to the wedging effect of the fluids concentrated after consolidation of the granite. Thus the veins, representing zones of weakness along which mineralising fluids passed, strike in the general direction of the trend of the country rock, and dip south-west towards the granite at angles usually less than 45°. The veins often cut across steeply dipping bands of quartzites and slates.

(iii) Synclinal folds in the Mathinna beds. When competent quartzites are folded with slates, the base of the fold is a prominent plane which may divert the marginal joints and the veins which later formed in them, for example, on No. 7 level south. Changes in lithology do not appear to have as important an effect as in the Aberfoyle mine. Although veins cutting slates in the Storeys Creek mine tend to be irregular and thinner than those in massive fractured quartzite, they seem to carry as much ore. However, detailed examination and sampling would be necessary to confirm this.

(vi) *Vein systems.*

In the upper levels, the most important veins are the No. 1 and No. 2 veins, which join between No. 3 and No. 4 levels at a vertical depth of about 270 feet below the top of the plateau. They diverge once more north-west and south-east of the junction and also vertically below No. 4 level (see Fig. 14). The vein system is complicated, with many splits which may either diverge and gradually peter out or which may rejoin other veins so enclosing blocks of the country rock. Detailed surveying and mapping of each individual vein is essential for correlation between the levels, and also along the main drives.

The veins so far discovered and worked in the mine form a mineralised zone little more than 100 feet wide which dips to the south-west at about 30°.

Adit Level.

The No. 1 vein is 4 ft. 8 in. thick at the head of the old South Haulage way, and splits north-eastwards to form two 16-in. veins; the upper dipping at 22° to 260° and the lower 13° to 285°. The vein probably also splits or thins southwards since in the No. 2 adit, the thickest vein is only two feet thick.

The No. 2 vein is dislocated near the North Drive junction by a north-westerly fault which probably has a downthrow on the south-west side since the vein is not repeated further along the adit.

No. 2 Level.

It is not certain whether the No. 1 vein has been exposed on this level. (See Fig. 14).

A 4 ft. 6 in. vein is exposed in the haulage way about 20 feet north-east of the drive. The vein dips at 50° to 242°, but it may join the No. 2 vein upwards if this dip is maintained.

A number of veins are exposed in the drive. A stoped-out three foot vein at the base dips steeply south-west and may join the vein described above. Three feet higher a vein 2 ft. thick dips at 30° and appears to dip at only 17° at the western side of the stope. The veins have apparently been driven on southwards for at least 300 feet.

Fig. 16—Stoped outcrop of No. 2 Vein, Storeys Creek mine.

No. 3 Level.

No. 1 vein is two feet thick and was driven on for about 400 feet. and may join the No. 2 vein to the north-west. The roof of this level has collapsed about 150 feet north of the haulage way.

No. 2 vein: About 4 ft. thick with a dip of 23° to 230°. Eastwards the vein splits into an upper vein 1 ft. 3 in. thick and a 2 ft. 9 in. lower vein.

The vein also splits south-west along the drive. The upper vein is 1 ft. thick and dips at 34° to 303°, with a pitch to the north, while the lower vein which has been stoped out and stowed was probably at least 2 ft. thick, with a dip of 32° to 250°. The latter was driven on southwards for at least 300 feet.

No. 4 Level.

The No. 1 vein is 6 ft. 6 in. thick at the bottom of the haulage way, with a dip of 23° to 247°. It apparently thins southwards and probably splits.

About 20 feet north of the main cross-cut, a westerly trending fault shifts the vein west. In the north, a 4 ft. 6 in. vein dipping at 27° to 250° has been driven on for at least 500 feet.

Work is now being carried out in a short easterly crosscut 300 feet north of the main crosscut on No. 4 Level, and in short drives off it. A 2 ft. 6 in. vein with cassiterite and wolfram, dipping at 21° has been exposed. The vein may be part of the No. 1 vein system.

No. 2 vein: Four foot thick near the main crosscut and drive, and dips at 23° to 271°.

Southwards, the vein thins and was worked for only about 150 feet. On the north side of the westerly fault (see above), a 4 ft. 6 in. vein dips at 10° to 280°, and although the drive is stoped out and partly stowed, this is probably the vein which has been driven on northwards for at least 500 feet.

Southwards, the No. 2 vein has been followed for 900 feet. In part of the old stopes, it is 5 ft. thick, and at the end of the drive it has diminished to 1 ft. 6 in., with a dip of 35° to 240°.

No. 5 Level.

No. 1 vein: May be represented by a 3 ft. 9 in. vein which dips at 24° to 260°, splitting southwards.

In the north, the vein is cut off by a north-westerly fault which is known to extend for 300 feet, with a downthrow of a few feet to the north-east.

No. 2 vein: Above the No. 1 vein, two veins join northwards to form a 6 ft. vein 250 feet north of the shaft, which dips at 30° to 230°. The vein has been driven on for at least 400 feet north.

No. 6 Level.

Lower vein: About 80 feet east of the main drive, a vein 5 ft. 3 in. thick occurs in the eastern crosscut, but splits eastwards. Work is now in progress on this vein.

Upper vein: The vein is 4 ft. 6 in. thick with a dip of 20° to 250° in the east crosscut. It is faulted twice; about 40 feet east of the main drive a small fault throws down the east side about three feet, while another on the west side of the drive has a downthrow of four feet east.

The vein splits southwards with a southerly pitch, and a number of higher veins appear.

Northwards from the main crosscut, this vein is affected by a number of small faults. It reaches a maximum thickness of eight feet, with a dip of 21° to 238° and has been driven on for 700 feet. At the end of the drive the vein is about 1 ft. thick but this may be merely a split.

No. 7 Level.

South: A vein six feet thick exposed near the shaft dips at 38° to 208°. Southwards, it is faulted and splits. The splits appear to pitch southwards, influenced by a pitching synclinal fold in the Mathinna quartzites.

One hundred and fifty feet south of the shaft, a higher 5 ft. 6 in. vein appears, dipping at 45° to 240°. Further south, other higher veins occur, and these probably join about 400 feet south of the shaft to form a 6 ft. vein with wolfram, dipping at 30° to 230°. which has been followed for 400 feet. At the end of the drive, the vein is 1 ft. 8 in. thick and dips at 35° to 254°.

North: The upper vein thins, and splits about 150 feet north of the shaft.

The vein about 60 feet lower is only 1 ft. 5 in. thick 100 feet north of the shaft, but is 4 ft. 6 in. 400 feet north. The vein thins and splits about 450 feet north of the shaft.

No. 7a Level.

A vein 5 ft. 9 in. thick at the shaft dips at an angle of 33° to 208°. At a distance of 80 feet south from the shaft, the drive on this vein has been blocked off. The vein is at least 4 ft. 6 in. thick at this point, with a dip of 42° to 218°.

A drive is now being cut in the south part of this level on a vein a few feet higher than the vein described above. At the present working face, the vein is 5 ft. 6 in. thick, dipping at 14° to 250°, and northwards it appears to thin out.

Northwards from the shaft, the lower vein varies between 5 ft. 9 in. and 5 ft. 3 in., and at the rise to No. 7 level, 80 feet north of the shaft, the dip is at an angle of 26° to 208°. At a distance of 200 feet north of the shaft, the vein narrows to 3 ft. 9 in., and dips at an angle of 37° to 227° into No. 7b level, where it joins a 3 ft. vein about 4 ft. lower, which may be the same vein as that stoped out in the north end of No. 7a level.

No. 7b Level.

The vein is about 4 ft. 8 in. thick with a dip of 15° to 203° in the south part of the level, and 5 ft. 9 in., dipping at 15° to 221° about 50 feet further north. It thins to about four feet 100 feet north of the shaft, and dips at 17° to 227°.

No. 8 Level.

In the drive near the main crosscut, the vein is at least six feet thick, and is inclined at 17° to 210°.

To the south, the vein is dislocated by a number of small faults in shattered slate and tuff, and there is some impregnation by galena.

Northwards, the strike of the vein swings sharply 100 feet north of the shaft. The vein is 5 ft. 6 in. thick with a dip of 45° to 235°.

(vii) *Mineralisation.*

Mineralisation resembles that in the Aberfoyle mine except that the veins are generally thicker and dip more gently. The main mass of the veins consists of quartz, usually white or glassy and often stained pale yellowish or brownish by iron oxides. The quartz may be dense, or may be coarsely crystalline in places.

The chief minerals are wolfram and cassiterite, while small amounts of pyrite, chalcopyrite and martite are usually present.

Wolfram: Usually appears as well-shaped bladed crystals, often in radiating patches and aggregates. Together with cassiterite it was the earliest mineral formed and tends to occur near the margins of the veins.

Cassiterite: Forms coarsely crystalline brownish blebs and isolated masses on the margins of the veins, sometimes welded on to the country rock, and occasionally separated from it by a thin border of muscovite.

Sulphides: The chief minerals are pyrite and chalcopyrite which occur as patches and blebs scattered throughout the vein.

Martite: The black variety of haematite resembles wolfram in appearance and may occur in laths or irregular patches, mainly in the body of the vein.

(viii) *Regional considerations.*

(*a*) The veins are different to those in the Aberfoyle mine which have been influenced by fault fissures within a complex anticlinal structure, and where lithology has an important bearing on the quality of the veins.

Those in the Storeys Creek mine occupy marginal joints connected with the main granite mass, which have been strongly influenced by the trend of the host rocks, and by synclinal folds in the Mathinna beds, while lithological changes do not necessarily mean wide fluctuations in the value of ore.

(*b*) The veins on Eastern Hill resemble those in the mine, although the exact relations have not yet been established.

(*c*) The granite contact with the Mathinna Group in Nisbet Creek appears to swing more westerly than further south. This may indicate that the granite plunges under the country rock northwards, as it apparently does in the north-west near Vickory Creek. If so, there may be favourable conditions for mineralisation northwards under the dolerite talus and Permian rocks.

(*d*) Mineralisation is apparently roughly zoned in the Aberfoyle mine, and there is some evidence to suggest that this may also happen in Storeys Creek, since the proportion of cassiterite to wolfram generally falls to some degree in depth. Such zones would be expected to conform approximately to the configuration of the granite mass, the margin of which dips to the north-east, so that cassiterite-bearing veins might be found below the veins now being worked but further to the north-east, providing there are structures favouring mineralisation.

(ix) *Conclusions.*

(*a*) In the Storeys Creek mine, mineralisation is present in a complex system of veins striking in a similar direction to the host rocks, with south-westerly dips generally below about 45°.

They were formed by late stage emanations from the Ben Lomond Granite to the south-west.

(*b*) The veins exhibit a complicated pattern, with much splitting and rejoining of individual members, laterally and also in depth, which renders careful surveying and mapping essential in order to work them systematically.

(*c*) The concealed granite has not yet been reached, although the flattening of the dip of the main vein on No. 8 level may indicate that it is at no great depth below this point.

(x) *Recommendations.*

The detailed survey now being carried out by the mine should reveal any veins of economic value remaining in the old upper stopes where cassiterite was first worked. Complementary to this programme the following suggestions are made:—

(*a*) The old northern workings should be examined to decide whether mineralisation carries on to the north-west. In addition, short boreholes should be drilled, inclined towards the north-east at 45°, from the northern drive of No. 2, No. 3 or No. 4 level, if accessible. Such holes would give information on any veins underlying those now worked out or reduced in thickness.

(*b*) There is a possibility that the veins on Eastern Hill may underlie those in the mine (see page 88). Boreholes inclined to the north-east at about 45° and at least 150 feet long should be drilled in the upper levels of the mine, for example from the South drive of No. 2 adit. The veins across Story Creek are thin, but may improve in depth, as do some of the veins in the mine.

(*c*) Similar drill holes between No. 4 and No. 6 levels would test the areas below the known veins.

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EASTERN HILL.

Eastern Hill is situated east of Story Creek, opposite the adits of Storeys Creek Mine, and has been prospected from time to time for more than 70 years in trenches and cuts on the top of the plateau, and in adits driven eastwards from the steep bank of Story Creek. The veins were probably discovered prior to 1881, when the gravels in Story Creek were being worked for tin. There has been little activity during the past 30 years. Reid and Henderson (1929) estimated that up to 1928 about 25 tons of tin had been produced.

The area was examined in detail by Henderson in 1936 and a drilling programme was recommended by him to test the veins in depth.

Lease:—The area bordering the east bank of Story Creek forms part of Lease 27M/46 of 383 acres held by the Storeys Creek Tin Mining Co. N.L.

Geology.

At least eight parallel veins are known within a zone about 400 feet wide in Mathinna quartzites and slates, with occasional bands of tuff. The Mathinna beds strike between 315° and 325° and are overturned towards the north-east, with dips to the south-west steeper than 70°. Cleavage imposed on the slate bands strikes about 335° with dips of up to 80° to the south-west.

The veins vary in thickness from about ½-in up to about 1 ft. and carry cassiterite and wolfram, with pyrite and muscovite in a gangue of milky quartz similar to the thicker veins in the Storeys Creek Mine. The strike coincides with that of the Mathinna Group, and the veins generally dip to the south-west at about 30° to 60°.

Although minor strike faulting occurs, there is no evidence of large scale faulting between the Storeys Creek Mine and Eastern Hill. Permian rocks west of the mine, and also to the north-east beyond Story Creek are at similar altitudes suggesting there is no major faulting southwards down the valley of the creek. If the veins on Eastern Hill were the faulted extensions of the veins stoped from the surface in the Storeys Creek Mine, it would be necessary to postulate a north-east to south-west fault with a downthrow on the southern block of at least 150 feet in which case one would expect to find some Permian rocks capping the plateau. No major faulting was seen in the mine workings. The veins in the mine frequently split, both vertically and horizontally so that it is possible that some veins on Eastern Hill, especially in the north, may join veins in the old upper workings, but it seems reasonable to infer that they may underlie the main mineralised belt worked in the mine.

Summary.

1. A group of eight thin parallel veins occurs on Eastern Hill. They may lie underneath the veins worked in the Storeys Creek Mine.

2. Although thin, they may represent the upper part of a mineralised zone, and may thicken in depth, as do the veins in the mine.

3. By comparison with the mineralisation in the mine, cassiterite may be more abundant than wolfram in the upper levels, and will probably decrease in depth.

4. It is possible that in depth some of the veins may be splits from the main vein of Storeys Creek mine which on No. 8 level is over six feet thick with a dip of only 17°.

Recommendations.

The veins should be tested in depth. There are three methods by which this might be done:—

1. By a long adit from the east bank of Story Creek. Reid and Henderson (1929) recommended an adit 600 feet long designed to cut the veins at a depth of about 230 feet below the top of the plateau, or 180 feet below the deepest excavation at the surface. The adit would serve the dual purpose of testing the veins and also for drainage and haulage should the veins be worthy of exploitation. Disadvantages would be the high cost of such a drive, and the fact that it would prove mineralisation at one point only.
2. By a series of diamond drill holes as suggested by Henderson (1936). Five cored boreholes inclined at 45° to the north-east were suggested, on the east side of Story Creek from a point opposite No. 2 adit for about 500 yards southwards, with cored lengths ranging from 130 feet in the north, to 300 feet in the south. The veins would be cut at a depth of up to 200 feet vertically below the plateau. Although drilling would be much cheaper than the driving of an adit, great care would be essential in order to obtain good core recovery in fractured ground.
3. By diamond core drilling in the underground workings of Storeys Creek Mine, preferably in the upper levels, down to about No. 3 level, and from the floor of the lower (No. 1) vein. Such holes should be inclined at 45° to the north-east, and if possible, have a cored length of at least 150 feet. The planning of an exploratory programme would depend on the information gained in the first hole. A likely site would be in the South Drive off No. 2 adit.
4. Drilling as in (3) should reveal whether or not the veins on Eastern Hill underlie those in the mine. If they do, borings would test them at a greater depth from outcrop than would holes or an adit east of Story Creek, so it is suggested that underground holes should figure early in any exploration programme.

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MAMMOTH TIN.

The leases formerly held by Mammoth Tin Areas N.L. covered the area immediately south of Nisbet Creek, within a hairpin bend on the road from Avoca to Storeys Creek, and about ½-mile south-west of the Storeys Creek Mine. A series of veins, resembling those in Storeys Creek, were revealed in pits, trenches and shallow shafts. Most of the work appears to have been done between 1928 and 1929. It is doubtful whether more than half a ton of cassiterite was produced, and there has been no recent activity, since most of the workings are full of water, or overgrown. The cassiterite is fine grained and often invisible to the naked eye.

Geology.

At least four veins occur near the contact between the Ben Lomond Granite, and the Mathinna Group quartzites and slates, on the steep southern bank of Nisbet Creek, which rises to a flat plateau surface in the south and west. Westwards, the top of the plateau is capped with a thin cover of Permian pebbly sandstones lying horizontally, or with a gentle south-westerly dip, upon a peneplaned granite surface. East of the contact, the Mathinna beds are almost vertical and are closely folded along north-westerly axes. As in the Storeys Creek Mine, the veins which were formed during the later stages of the granite intrusion occupy marginal fissures which strike between 305° and 330°, with dips to the south-west of from 20° to 40°. In the granite, the veins vary up to 12-in. in thickness, with borders of greisened wall-rock, and consist of milky quartz with tourmaline, muscovite, pyrite, a little wolfram and some fine grained cassiterite. Reid and Henderson (1929) report that where the veins pass from granite into the Mathinna sediments they are thicker and contain milky quartz, tourmaline and muscovite with a little cassiterite, but no sulphides. The mineralised zone is at least 200 yards wide and to the north-west it passes under the Permian cover.

The Mathinna sediments are slightly contact metamorphosed, with the development of spotted slates which are frequently weathered into soft rotten haematised slate containing haematised spots.

Veins and Workings.

The easternmost vein is the No. 1 vein which is exposed in a cut eight feet deep, about 350 feet south-west of the bridge over Nisbet Creek and about 130 feet higher in altitude. The vein varies up to six inches in thickness and strikes to 305°, with a dip of 35° to the south-west. It is composed of milky quartz within fine grained tourmaline-granite near the contact with the Mathinna sediments. Northwards, the vein passes under the basal Permian rocks. Reid and Henderson (1929) report that five bags of cassiterite were obtained from cuts further north where the vein was found once more on the northern side of the hill.

In 1929, an adit was driven from the side of the road, about 200 feet north-east of the main cut and approximately 80 feet vertically below the bottom of the cut. One adit was driven south-west in the direction of the dip of the veins and Scott (1929) pointed out that since the dip of the veins is less than 45°, the tunnel would have to be long and therefore costly to test the mineralised zone. He calculated that " it would be necessary to drive the adit at least 350 feet to cut the No. 1 vein ". The adit was apparently abandoned after driving 60 feet.

No. 2 vein lies about 600 feet south-west of the No. 1 vein, and was formerly exposed in a number of trenches on the plateau. The vein strikes to 310° and dips south-west at about 40°. The vein is about 12-in. wide situated within the granite with 12-in. of greisenised granite on each wall. It is composed of milky quartz with tourmaline, pyrite, muscovite and some cassiterite. It is reported to have been six feet wide in a small pit where it passed into Mathinna quartzite, and assayed 0.25% cassiterite, without wolfram and sulphides.

Between No. 1 and No. 2 veins, two parallel veins with similar dips occur.

About 300 feet west of the bridge over Nisbet Creek a vein up to 12-in. thick in granite was formerly opened up over a total length of 130 feet. The vein dips at 20° to the south-west and may be an offshoot from the No. 1 vein. Reid and Henderson (1929) stated that the vein contained a higher proportion of cassiterite and wolfram than the steeper dipping veins.

Summary.

1. A series of parallel veins resembling those in the Storeys Creek Mine occupies marginal fissures striking north-west and dipping south-west near the contact of the granite and the Mathinna sediments. The veins carry fine grained cassiterite, with some wolfram, but are relatively low grade at the surface.

2. The relationship of the veins is unknown. By comparison with Storeys Creek, it is possible that some may be splits from thicker veins in depth.

3. The veins are wider where they cut the Mathinna sediments, and are relatively narrow within the granite. However, there is no evidence to indicate whether they are lower grade in cassiterite within the granite.

4. It is likely that the contact between the granite and the country rock will dip steeply to the north-east, so that the zone of mineralisation will tend to follow this direction. Mineralisation may occur in between Nisbet Creek and the Storeys Creek Mine, where the thickness of the rocks covering the granite is unknown.

Conclusions.

1. To decide whether further development is justified, it would be necessary to explore the veins in depth.

2. An adit from the south bank of Nisbet Creek would follow the direction of dip and so would have to be about 800 feet long to cut the known veins. The greatest vertical depth below the plateau would be about 180 feet. Under these circumstances, the old adit should not be re-opened for exploration.

3. Any company interested in testing this area should consider boreholes inclined towards the north-east at about 60°, and reaching depths of 300 feet or more. Holes might be drilled from the northern slopes of an unnamed creek about 700 feet south of the road, where it turns west from the bend above Nisbet Creek. Drilling should indicate whether mineralisation becomes economic in depth. The first hole should be within the Mathinna Group quartzites, about 700 feet south-west of the bend in the road.

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(c) Gipps Creek Area

THE BEN LOMOND TIN MINE.

History.

Mining is believed to have started about 1872 and operations were already abandoned before 1892 when Montgomery reported that the workings were full of water, and the adit partly collapsed. Since that date, no further work has been carried out in the mine.

At least 38 tons of " tin ore " were produced from No. 2 vein but no other record is available.

Location.

The mine is situated about a quarter of a mile south of the Gipps Creek road and approximately 1.25 miles north-west of the bridge over Buffalo Brook.

Geology and workings.

The remains of the adit, shafts and spoil heaps may still be seen, although the underground workings have long been inaccessible. A thin vein of quartz, about 4-in. thick, striking to 325° with an easterly dip of 75° was noted, comparable with one described by Montgomery. The vein contains purple fluorite and black tourmaline, and is associated with greisened porphyritic microgranite and medium grained granite. The greisen is slightly radioactive, giving readings up to about 350 counts per minute or up to three times background radiation.

Montgomery described the underground workings in detail. Four parallel veins occur, all striking between 320° and 340; with easterly dips. The average thickness of the veins was 3 ft. 6 in. and the greatest thickness reported 15 feet. No. 1 vein was opened up in the main shaft at a depth of 100 feet, and in two 80 foot shafts to the north-west along the strike over a distance of 160 feet. The vein material is greisen composed of quartz, secondary mica, pinite, talc and tourmaline, with much fluorite and pyrite. No. 2 vein lies west of No. 1 and yielded 38 tons of tin concentrates from an opencut 40 feet long, 15 feet wide and 12 feet deep. At the bottom of the cut, mineralisation faded out leaving only a thin vein of quartz in hard quartz greisen. No. 3 vein was exposed in a shallow trench about 100 feet west of No. 2 vein and consists of altered felspar with some tourmaline. No. 4 vein is 60 feet further west and is a quartz-mica greisen vein with a little cassiterite.

An adit 735 feet long was driven from the south-west at about 105 feet below the outcrop of No. 1 vein. Although several thin quartz veins were cut, they appeared to be almost barren, with some greisening. The adit ended 120 feet short of No. 1 vein. Montgomery pointed out that if, as he was informed, the main shaft was sunk first, the costly adit was superfluous since No. 1 and No. 2 lodes could have been explored in depth from the shaft, and in any case the adit was abandoned before testing No. 1 lode in depth, thus wasting important capital.

Conclusions.

1. The orebodies were formed by mineralisation along joints and fissures dipping to the north-east. The joints are occupied by quartz veins and the ore containing cassiterite occurs as soft greisened areas surrounding the joint planes. Enrichment is extremely variable and ore shoots are limited in extent.

2. Similar mineralisation occurs at the old Great Republic Mine, about ¼-mile north-west, and other orebodies may occur to the south-east under the Permian cover.

3. Mineralisation may extend below the old workings.

4. Any such mineralisation would probably be as erratic as in both old mines. Orebodies are likely to be in the form of limited rich patches separated by hard barren granite which would involve much deadwork, as well as the rehabilitation of the old workings. Mining, even on a relatively small scale, would be a calculated gamble. If such operations were undertaken, a number of diamond drill holes to varying depths between about 150 feet and 300 feet and inclined at about 45° to the south-west should be considered since the old adit is inaccessible. Boreholes might indicate possible mineralisation in depth, but could pass through barren zones separating rich patches, thus making exploration difficult.

5. Shallow trenching in a north-easterly direction would help to determine possible continuations of veins.

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THE BEN LOMOND TUNGSTEN MINE.

The area has been held on lease periodically since 1887 and in 1889 the Ben Lomond Tungsten Mine was formed to exploit the veins. The mine ceased operations in 1901 after producing about 16 tons of wolfram concentrates. T. Briggs, the former mine manager, took over the leases in 1903 and worked the mine until his death in 1908. No record is available of production but Nye (1941) reported that the greater part of the underground workings were due to Brigg's efforts. There was sporadic activity between 1909 and 1922, and again from 1937 to 1941, but production was probably small. Reid and Henderson (1929) suggest that the old dumps had been picked over and sluiced at least once up to that time.

Location.

About one mile due west of the Great Republic Mine, on the west bank of Gipps Creek.

Geology.

Mineralisation is in the form of quartz veins with wolfram, and some pyrite or chalcopyrite. Black tourmaline and muscovite are also present. The country rock is a medium grained granite which may be porphyritic in places, and which has been greisened for a few inches on the walls of the veins. The general strike of the veins ranges between 25° and 35°, with low easterly dips of between 10° and 15°. The maximum thickness in the mine was reported as about two feet, but is generally less than one foot. The mine is near the Castle Carey Fault, on the upthrown block.

Workings.

As well as surface cuts, a total of six adits were driven from the north-east into the western slope of Gipps Creek. These workings were examined in detail by Nye in 1941. The workings disclosed what appear to be two veins, but which may be either one vein displaced by faulting or one vein which has an abrupt change both in strike and dip. What was regarded as the No. 1 vein (revealed by workings in the south-west) was stoped from the surface and in No. 4 and 5 adits. The depth from surface to the lowest adit is 200 feet, and the vein was probably up to about one foot thick, although it may have been wider in the stoped sections. The north-eastern end pitches to the south or south-east. The vein was worked over a length of 120 feet at the surface and for about 50 feet in the lowest adit (No. 5). Five samples were taken by Nye from the adits and assays indicated only traces of wolfram.

The No. 6 adit was driven for about 50 feet but did not reach a vein.

Conclusions.

1. Wolfram occurs in quartz veins with gentle easterly dips within slightly greisened granite. There may be two veins, or one vein which has been faulted or which has an abrupt change in strike.

2. All profitable ore has been taken out and mineralisation in depth is poor.

3. Nye recommended that if further exploration were considered, the No. 6 adit should be turned towards the south-west (or more accurately, to the south-south-west) or a new adit started to test the downwards extensions of the veins, and also that the faces in the No. 4 and No. 5 levels should be driven to the south-west along No. 1 vein.

However, with the present depressed state of tungsten mining, the mine has no promising prospects. If wolfram were in urgent demand, shallow diamond drilling might be undertaken. Such a programme would be purely exploratory and should be designed to test this part of the Gipps Creek area in holes inclined towards the west at 20°-30° from the vertical. Any further development would depend on the results of drilling.

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THE GREAT REPUBLIC MINE.

History.

At the time of Montgomery's visit in early 1892, about 132 tons of tin concentrates had been produced, 68 tons of which were taken out prior to December, 1890. Mining therefore probably started in 1889 or early 1890. The mine had been opened up to No. 3 level (336 feet) with considerable driving on No. 1 and No. 2 levels. By 1901, the mine had been abandoned, having worked down to about 450 feet. The workings are now inaccessible. The last attempt to re-open the mine on a commercial basis was made by a Launceston company in 1917, and the workings were full of water when Reid and Henderson mapped the area in 1928.

Location and access.

About 200 yards west of the Gipps Creek road, approximately 1½ miles north-west of the bridge over Buffalo Brook and ¼-mile north-west of the Ben Lomond Mine main shaft.

Geology.

According to Montgomery, the orebodies are in the form of thin quartz fissure veins within pipes of greisened granite. The quartz fluorite veins are rarely more than 3 in. thick, but the irregular greisened areas surrounding them may be up to four feet wide, with impregnations of cassiterite in a soft matrix of pinite, talc and kaolin. Between No. 1 level and No. 2 level, a mass of ore was removed from No. 1 vein leaving a cavity 30 feet deep, 30 feet long and 10 feet to 17 feet wide. This greisened mass was cut by a vein about 3 in. thick consisting of quartz and green and purple fluorite crystals. A shoot of rich ore between No. 2 and No. 3 levels was 10 feet wide.

The richest vein was No. 1 vein, which dips at about 50° to the north-east, down to No. 1 level, but steepens in depth.

No. 2 vein carried some cassiterite, but No. 3 vein was small and barren. Montgomery noted that in part of the south end of the rich shoot above No. 2 level, much black tourmaline appeared in the form of radiating crystals and cassiterite faded out.

The country rock in the area is a pale grey medium granite, which is occasionally porphyritic. A short distance to the north of the old mine, a small patch of Mathinna quartzite was observed capping medium grained granite.

Production.

Up to early 1892, 1,560 tons of ore were treated for the production of 131.75 tons of tin concentrates with a grade of 70% to 72% tin. The yield of metallic tin was almost 6% of tonnage milled.

Reid and Henderson (1929) estimated that the total production from the mine was of the order of 200 tons of tin concentrates.

Workings. (See Fig. 17).

The underground workings have long been inaccessible and the following description is taken from Montgomery (1892).

No. 1 vein was followed down from the surface in No. 1 underlay shaft to a depth of 67 feet. The orebody was found to be a pipe-vein pitching southwards and No. 2 underlay shaft was sunk to work it in this direction. The southerly pitch continued and the main shaft was sunk with a crosscut at the 166 foot (No. 1) level to intersect the vein. The crosscut revealed four small and unimportant veins, and met No. 1 vein after 58 feet. No. 1 level was driven north-west along No. 1 vein for 105 feet to connect with No. 2 underlay shaft.

On the 272 foot (No. 2) level a crosscut intersected No. 1 vein after 27 feet and a drive was cut for 163 feet north-west.

At the 336 foot (No. 3) level, a crosscut met No. 1 vein after 27 feet. The vein was two feet wide and rich. A northerly drive 40 feet long opened a rich shoot of ore.

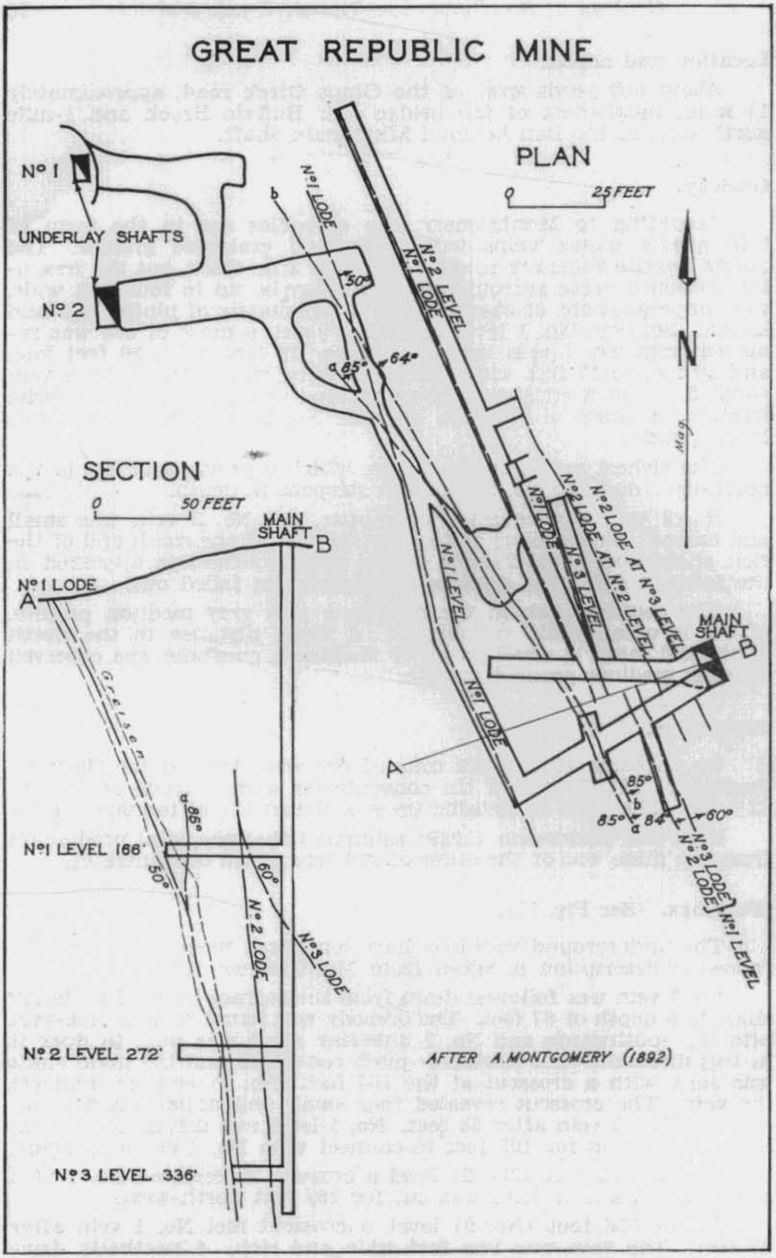

Fig. 17—Sketch section and plan of the Great Republic Mine.

The shaft was later sunk to 450 feet, and No. 1 vein was intersected in a crosscut and opened in a drive but there is no record of details. Closing of the mine was probably due to the expense involved in sinking, cross-cutting and driving to follow a relatively small and nearly vertical orebody.

Summary.

1. In the Great Republic Mine, mineralisation has taken place along fissures and joint planes striking north-west and dipping steeply to the north-east. The fissures are occupied by thin quartz-fluorite veins, within greisened granite, which has been altered by late stage magmatic fluids along the fissures and impregnated with cassiterite. The main orebody is an irregular pipe-like mass which pitches southwards and which at its greatest extent measured about 17 feet by 30 feet in cross section.

2. The main orebody, although rich in places, is extremely variable in thickness and grade. In the No. 1 and No. 2 level crosscuts, the vein was thin and poor, with a rich shoot between, suggesting some selective mineralisation in more open fissures.

3. No other orebodies were known. Waller (1901) suggested that the company should have driven north-west and south-east along the quartz-fluorite vein associated with the enrichment between No. 1 and No. 2 levels with the object of searching for other possible altered and mineralised shoots.

Recommendations.

If the workings were still easily accessible, Waller's suggestion would be a logical step. In addition, the crosscuts on each level which ended in No. 1 vein, or just beyond it, might be extended to the south-west, and also to the north-east. However, the workings may now be in bad condition and the combined expense of draining, restoration and cutting new drives would probably be prohibitive under present conditions for such exploration with uncertain prospects. The mine appears to lie in the same irregular mineralised belt as the Ben Lomond Mine, and it is quite possible that mineralisation occurs outside the vein worked in the Great Republic. Inclined boreholes drilled in a south-westerly direction might reveal mineralisation in depth, but owing to its erratic nature drilling would be of limited value.

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THE LONG TUNNEL MINE.

The name has been given to a number of adits, shallow shafts and trenches which have been cut in the high ground between Gipps Creek and Cradle Creek. The main adit was 560 feet long. Most of the work was carried out by the Clune Tin Mining Company which was formed in 1882. The Long Tunnel Tin Mining Company later took over, but when Montgomery visited the area in late 1891 and early 1892, the mine had been abandoned for a considerable time. At the time of Waller's report in 1901 the leases were held by the St. Aubyn Tin Mining Company, but little work had been done and the workings had apparently been abandoned once more. Since that date, the leases have been held by various prospectors, but no important extensions have been made to the already existing workings.

Location.

Between Cradle Creek and Gipps Creek, in the high ground approximately ¼-mile north-east of the junction of the two streams. Applicants for the 20 acre lease 6M/52 are J. F. Reynolds and J. M. Cambridge.

Geology.

The main vein consists of quartz up to 12 in. thick containing cassiterite with subordinate wolfram, chalcopyrite and muscovite within greisened granite, forming a body between two feet and four feet wide which strikes to about 340° and dips eastwards between 40° and 70°. Montgomery reported that two thin and apparently barren veins were followed in the adits, parallel to the main vein.

In this area, both coarse grey porphyritic granite, and micro-granite occur. There has been much greisening which in places has decomposed the granite. A well marked joint pattern is developed with strikes between 332° and 345°, and dips to the east side varying between 32° and 40°. Higher up the ridge to the east and north, patches of Mathinna quartzites, siltstones and slates were seen. The sediments have been subjected to contact metamorphism, with the formation of chiastolite. About ½-mile to the north, on the west side of Cradle Creek, similarly metamorphosed Mathinna beds rest on granite, and thicken northwards beyond Vickory Creek and Ben Lomond Rivulet, where at least 200 feet are found. The Mathinna sediments are the remnants of the roof of the granite intrusion.

Workings.

Shallow underhand stoping of the main vein was carried out from the surface in the early days of the mine. Montgomery states that two underlay shafts were sunk to about 20 feet, the northern one of which was connected to a crosscut adit about 100 feet long. The adit cut a barren quartz vein parallel to the main vein, and about 50 feet west of it. A drive followed the barren vein for at least 180 feet. Further south, the main adit was driven from above Gipps Creek for a total length of 560 feet. The first 200 feet had a bearing of 350°; then a change of course was made to 12° for 80 feet, at which point a thin vein striking 350° and dipping east at 50° to 60° was encountered, and followed along the strike. Previous authors have pointed out that this costly adit should have been driven eastwards rather than along the strike of the veins, in order to test the country in depth, and to determine whether other veins might be present.

Conclusions.

1. At least three quartz veins associated with greisened granite are known, trending to the north-west, with easterly dips. Only the main vein appears to contain cassiterite and wolfram, and this

vein was apparently not explored below about 30 feet from the surface, nor were there any drives along it. There is no information about the quality of the vein.

2. Mineralisation was probably due to pneumatolytic or high temperature hydrothermal action along joints and fissures in the later stages of the granite intrusion. The Mathinna Group quartzites and siltstones forming the roof of the intrusion were subjected to contact metamorphism and later mainly eroded away, partly before Permo-Triassic sedimentation, and also since Tertiary times. It is possible that quartz veins with cassiterite and wolfram may have originally been formed in the sediments, as at Aberfoyle and Storeys Creek, but have since been worn away near the Long Tunnel area.

Recommendations.

1. Present evidence suggests only limited tin and wolfram mineralisation. Interested prospectors should attempt to follow the main vein towards the north-west, and any surface trenching should be done in a north-easterly direction across the trend of veins in this area.

2. Northwards, on the west side of Cradle Creek, thin quartz veins striking to 320° were observed in indurated Mathinna slates and siltstone. Here the sediments are thin and the quartz veins barren. Further north however, the beds thicken and could form a host rock, but it should be noted that immediately north of Vickory Creek, the Mathinna beds are mainly slates with some siltstones whilst at Aberfoyle, the veins are richer in more massive quartzites. No mineralisation was seen between Vickory Creek and Ben Lomond Rivulet.

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WALLER, G. A., 1901—Report on the Tin Mining District of Ben Lomond. *Tas. Dept. Mines Report*, 31-33.

REX HILL.

History.

Argentiferous galena with sphalerite was discovered between 1881 and 1890. The Rex Hill Silver Mining Co. was formed to work the deposit and by 1891 the open cut had reached a depth of 33 feet. An adit driven to test the orebody in depth indicated that below about 40 feet galena decreased and cassiterite increased.

In 1893, the Rex Hill Tin Mining Co. Ltd. took over and produced tin on a small scale until 1900, when the Mount Rex Tin Mining Co. N.L. was organised to develop the mine in depth. Plant was installed, dams on the upper reaches of Buffalo Brook and Egan's Creek were constructed to supply water and the orebody was opened up on the 140 foot, 215 foot and 290 foot levels. The company closed in 1909 and tributors carried on until 1913.

In the year 1924 the leases were again applied for in the name of J. Stevenson as Consolidated Lease No. 9485M of 83 acres.

The mine was re-opened in 1934, and further driving and cross-cutting was done on No. 2 (215 foot) level, and a winze 31 feet deep was sunk on the White orebody. Operations ceased in 1935 because of the depletion of known ore reserves, the decreasing grade of tin in depth, and the uncertainty of finding profitable new veins.

Some 60 acres are now held as lease application No. 78M/56 in the name of E. Gray.

Location and access.

The mine site is reached by way of a winding ungraded road in a distance of one mile, northwards from the Stanhope road, from a point 1¼-mile distant from its junction with the Avoca-Storeys Creek Road.

Production and grade of ore.

The earliest records are incomplete but reports show that for—

(1) *Silver-lead.* Waller (1901) reported that about 20 tons of silver-lead ore were recovered, assaying 80 ozs. of silver per ton.

(2) *Tin.* Nye (1934) stated that a total of 826 tons of cassiterite were produced between 1899 and 1913, mainly in the period to 1905. Between the years 1893 and 1900, the Rex Hill Tin Mining Co. treated 3,000 tons of ore which yielded 170 tons of concentrates, or 5.6% of concentrates. However, by 1905, the average grade had fallen to about 1.4% of tin concentrates, representing about 1% metallic tin.

In 1934 sampling of the No. 3 (290 foot) level gave an average of 1.39% metallic tin over eight samples, all but two samples ranging between 1% and 3.1%. In 1935, Henderson made a detailed examination of No. 2 and No. 3 levels. Twenty samples were assayed and the metallic tin content ranged between 0.01% and 0.7%. Only 15 of these samples contained more than 0.25%. Thirteen samples from surface workings were analysed, giving tin contents of up to 0.34%.

General geology.

The orebodies are contained in granite of Devonian age. The main granite is a coarse pale grey or faintly pinkish porphyritic type composed of a coarsely granular groundmass of quartz and felspar, with little biotite, in which large euhedral phenocrysts of orthoclase frequently showing Carlsbad twinning are scattered at random. The normal granite appears to have been intruded by a later pale grey microgranite, which is porphyritic in places and which sometimes contains small rounded phenocrysts of quartz.

The deposits consist of impregnations of cassiterite together with chalcopyrite, pyrite, arsenopyrite, galena and sphalerite, in granite which has been metasomatised by late stage magmatic fluids. Muscovite is rare or absent so that the rock is not a true greisen. Cassiterite occurs as small crystals scattered through the altered rock, with blebs and irregular patches of sulphides. In the upper part of the mineralised zone, chalcopyrite has been partly oxidised to green malachite. Purple fluorite is visible in small fissures

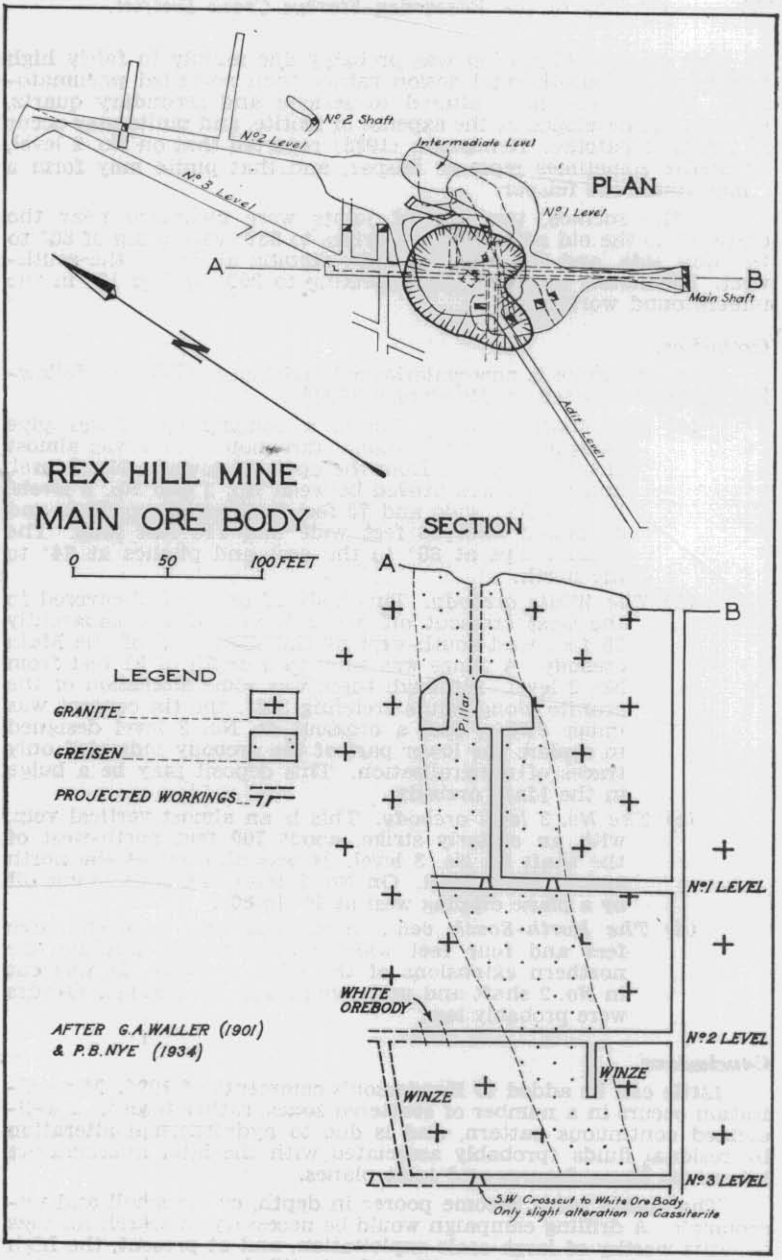

Fig. 18—Sketch section and plan of Rex Hill Mine.

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or joint planes. Alteration was probably due mainly to fairly high temperature hydrothermal action rather than so-called pneumatolysis. Felspar has been altered to sericite and secondary quartz, chlorite has developed at the expense of biotite, and pinite may occur in irregular patches. Henderson (1935) reported that on No. 2 level, sphalerite sometimes replaces felspar, and that pinite may form a fringe round the felspar.

At the surface, two sets of joints were measured near the entrance to the old adit. One set strikes to 352° with a dip of 80° to the west side, and the other to 298°, dipping at 75° to the south-west. Henderson recorded joints striking to 300° and to 17° in the underground workings.

Orebodies.

Since the mine is now waterlogged and inaccessible, the following account is based on Henderson (1935).

(*a*) *The Main orebody.* Forms a roughly cylindrical pipe elongated in a meridional direction, which was almost entirely removed from the opencut down to No. 2 level, and which was proved between No. 2 and No. 3 levels. It is 55 feet wide and 70 feet long in the opencut, and on No. 2 level 56 feet wide and 110 feet long. The deposit dips at 80° to the east and pitches at 74° to the north.

(*b*) *The White orebody.* This body of ore was discovered in the west crosscut off No. 2 level and lies apparently 15 feet west-south-west of the south end of the Main orebody. A winze was sunk to a depth of 31 feet from No. 2 level. Although there was some alteration of the granite along joints trending 303°, the tin content was under 0.38%, and a crosscut on No. 3 level designed to explore the lower part of the orebody indicated only traces of mineralisation. This deposit may be a bulge in the Main orebody.

(*c*) *The No.* 3 *level orebody.* This is an almost vertical vein, with an easterly strike, about 700 feet north-west of the shaft on No. 3 level. It was also cut at the north end of No. 2 level. On No. 3 level, the body is cut off by a plane dipping west at 70° to 80°.

(*d*) *The North-South vein.* A vertical vein between three feet and four feet wide striking north, forming the northern extensions of the Main orebody. It was cut in No. 2 shaft and probably also in No. 3 shaft. Grades were probably low.

Conclusions.

Little can be added to Henderson's comments of 1935. Mineralisation occurs in a number of scattered zones, rather than in a well-defined continuous pattern, and is due to hydrothermal alteration by residual fluids (probably associated with the later microgranite intrusion) along fissures and joint planes.

The known veins become poorer in depth, or are small and uneconomic. A drilling campaign would be necessary to search for new deposits worthy of large-scale exploitation, and at present, the high cost for uncertain results would not be justified.

Surface workings might produce tin on a small scale from altered zones. Water supply would be difficult, since the dams on Buffalo Brook and Egan Creek have collapsed, and the race linking them with the mine is in poor condition.

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GIPPS CREEK—GENERAL.

The area east of Cradle Creek and Gipps Creek, and west of the old Great Republic Mine has been widely prospected for many years, and small parties have recently been working in the north Republic area, as well as to the west of the Great Republic Mine. A small tonnage of wolfram and tin has been won from this part of the Ben Lomond field, chiefly during the years from 1899 to 1908. The country rock is dissected granite forming an uplifted block between the Castle Carey Fault and the Gipps Creek Fault. To the north, half way between Gipps Creek and Vickory Creek, the granite is capped by contact-metamorphosed Mathinna slates and siltstones, which thicken northwards. Patches of Permian rocks, rest on the granite south and south-west of the Ben Lomond Mine.

The main granite is a pale grey medium to fairly coarse variety, which is frequently porphyritic with orthoclase crystals in random orientation and which is apparently intruded by micrograpnite. There is a prominent joint pattern striking generally between 330° and 350°, with north-easterly dips. In the west near the Castle Carey Fault, dips vary between 30° and 40°, increasing eastwards to between 50° and 75°. In the Great Republic Mine mineralisation is in the form of quartz veins, occupying master joints, accompanied by greisening of the wall rocks. The veins are of milky quartz containing wolfram, cassiterite, chalcopyrite, black tourmaline, muscovite and occasionally topaz and purple fluorite. Maximum radioactivity recorded was about three times background radiation, near the Ben Lomond Mine.

The mineralised zone forms a belt up to 900 feet wide, and 1,800 feet long trending north-westerly. Cassiterite is rare near the Tungsten Mine and Hayes Prospect, and appears to become relatively more abundant northwards to the Long Tunnel workings.

The main prospects are:—

1. *Hayes Prospect.* Sited on the north bank of Gipps Creek, opposite the Tungsten Mine. Nye (1941) reported that a vein with wolfram had been worked since about 1908, in four adits driven from the creek in a line along the dip of the vein. The vein strikes between 330° and 350° with a dip to the north-east of about 13°. It averages 10 in. to 15 in. in width and is of quartz with tourmaline and wolfram. Mineralisation is irregular and tends to be concentrated in patches between barren sections. The record is sketchy, but it is doubtful whether the total yield of wolfram concentrates exceeded three tons.

2. *North Republic.* A number of holes and open cuts has been excavated a short distance north of the old Great Republic Mine, in greisened microgranite and porphyritic granite which appear to contain small amounts of fine grained cassiterite. In this area, there are a few shattered remnants of the roof of the granite, consisting of indurated quartzites and siltstones.
3. West of the Great Republic, several trenches have been cut down to a depth of about eight feet revealing thin quartz veins about 3 in. thick within hard pale grey porphyritic medium granite. The granite has been partly greisened. A little wolfram was noted, together with muscovite, tourmaline, and some topaz.

Conclusions.

1. Mineralisation occurs sporadically within a wide zone trending south-easterly between the Castle Carey Fault and the Gipps Creek Fault. A major structural control is the presence of major joints striking north-west and dipping to the north-east within the granite, which afforded a passage for mineralising fluids associated with a later intrusive microgranite. Individual shoots may be of limited length and relatively rich patches of cassiterite and wolfram may be separated by barren quartz.

2. Wolfram is predominant round the Ben Lomond Tungsten Mine, but cassiterite increases northwards. This may be explained by the fact that the north is relatively higher in the granite complex, suggesting that southwards the tin "zone" may have been eroded away since in the Aberfoyle and Storeys Creek mines, the tin zone appears to overlie the wolfram zone.

3. To explore the area fully it would be necessary to carry out a systematic trenching programme across the general strike of the veins because much of the granite is covered by a mantle of quartz gravel. The veins would also have to be tested in depth. Drilling would not be entirely satisfactory owing to the non-persistent nature of mineralisation and the cost would have to be balanced against results which may be disappointing. In its lifetime the area has produced only small quantities of wolfram and tin from scattered workings, so that under present economic conditions, expensive exploration is not warranted.

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(d) Alluvial Deposits

There are four small occurrences of alluvium which have been sluiced for tin intermittently since about 1881. Although they have yielded small amounts of tin, they are limited in extent and depth, and because the rainfall of this region is fairly high the flow of water in the streams has frequently hampered operations. The tin is derived from the weathering of tin-wolfram veins in the Mathinna Group, or from decomposed granite bearing disseminated cassiterite.

In order of importance, the deposits are:—

1. *Story Creek.*

Alluvial gravels are found in a narrow strip stretching downstream for about a mile from the Storeys Creek Mine. The width is variable, and south of the confluence with Nisbet Creek, ranges from about 100 feet to 250 feet as far as Burn Marsh, due west of the Aberfoyle Mine. Southwards from the wide bend in Story Creek at this point, the deposit is narrow, forming restricted terraces on each side of the creek, and so is of little importance.

The maximum thickness probably exceeds 25 feet. The deposit is composed of shingle beds which in places are separated by up to eight feet of yellowish-brown sandy loam.

The pebbles are chiefly well-rounded dolerite, quartzite and quartz up to about three inches in diameter. Southwards from the mine, the upper gravels are obscured by tailings from the mill.

Reid and Henderson (1929) stated that a Melbourne company worked the gravels a short distance below Nisbet Creek many years previously. The ground was tin-bearing from the top and became richer with depth. The company was unable to work below 15 feet owing to a heavy inflow of water which would have needed powerful pumps to control.

This area might be profitably worked on a small scale providing the physical difficulties can be overcome. The hard loose pebbles would be difficult to drill and provision would have to be made to control the flow of water in the wetter months of the year. In summer, there may be a shortage of water.

The cassiterite is derived from the erosion of veins within the Mathinna quartzites and slates, and is probably more abundant in the northern part of the alluvial deposits.

2. *Gipps Creek.*

Small areas of alluvial gravels occur in the lower part of Cradle Creek, southwards to its junction with, and for a short distance down Gipps Creek. The deposit includes boulders and fragments of granite, greisen and milky quartz with muscovite and needles of black tourmaline. Small quantities of cassiterite and wolfram have been produced from time to time, but the limited extent of the gravels, and the fact that they have already been sluiced would preclude anything but small scale operations.

3. *Tiger Creek and Tasmania Creek.*

Deposits in Tiger Creek upstream from its confluence with Tasmania Creek have been worked. About ¼-mile south of the junction, Tiger Creek cuts through basal Permian grits and coarse arkosic sandstones which are overlain by gravels of late Tertiary or Recent age. Both the Permian and the gravels have been worked for tin. Although it is known that the basal Permian grits and conglomerates contain detrital cassiterite, mineral content may be patchy and the beds may often be well-cemented and hard, thus making sluicing difficult.

Alluvial gravels are found downstream in Tasmania Creek as far as Story Creek.

The limited extent of mineral-bearing deposits in this area would hamper development.

4. *Archer Creek.*

A narrow strip of gravels occurs in Archer Creek, which flows from the granite on the upthrown side of the Aberfoyle Fault south of Rossarden, and joins Story Creek a short distance north of the road bridge. Although cassiterite may occur, the gravels are apparently thin and of low economic value.

REFERENCE.

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II. URANIUM PROSPECTS

TASMANIA UNITED URANIUM N.L.

In 1955, A. Chwalczyk discovered radioactivity in the granite country on the east bank of Story Creek, about two miles south of Rossarden. A shallow hole about 100 feet upstream revealed traces of secondary uranium minerals, and both places gave a calculated reading of 2,700 counts per minute (Noakes, 1955). Significant radioactivity appeared to be associated with a tongue of microgranite. A further opening in a fracture zone a little way downstream uncovered a black vein about 9 in. wide containing uranium minerals. In late 1956, the Tasmania United Uranium N.L. was formed to explore the deposits, and three vertical boreholes were cored by the Department of Mines in 1956 and 1957 to a maximum depth of 150 feet. A prospect adit was driven eastwards from the fracture zone on the east bank of Story Creek for 90 feet. When the area was visited on September 26th and October 8th, 1957, no work was being carried out, and the adit is now flooded. (See Fig. 20).

Location and access.

The Company holds Mineral Lease 10M/56 of 200 acres, about 1½ miles south-south-west of the bridge over Story Creek at Rossarden. A road two miles long was cut by the Department of mines to link the mine with Rossarden. The track is rough and now partly gullied, but passable. A number of steep gradients with loose gravel surfaces make the road difficult in places.

Topography.

The lease covers rugged granite country, with steep smooth cliffs and rounded tors, the slopes of which are strewn with a mantle of quartz gravels. Story Creek flows rapidly through gorges and over rapids. It is littered with large boulders of granite.

Geology.

The chief rock type in the vicinity is a coarse pink or pale grey porphyritic granite, with tongues and bands of pale grey microgranite. In places, the coarse granite contains blocks and small rounded lumps of porphyritic microgranite which could be altered xenoliths.

(i) *Coarse granite*. This rock is of medium to coarse texture and is composed of felspar, glassy anhedral quartz and subordinate muscovite with large phenocrysts of soda-orthoclase. The rock is generally hydrothermally altered and has been sheared. G. Everard, the Depart-

Fig. 19—Block of micrograite within coarse granite, Storý Creek.

5 cm

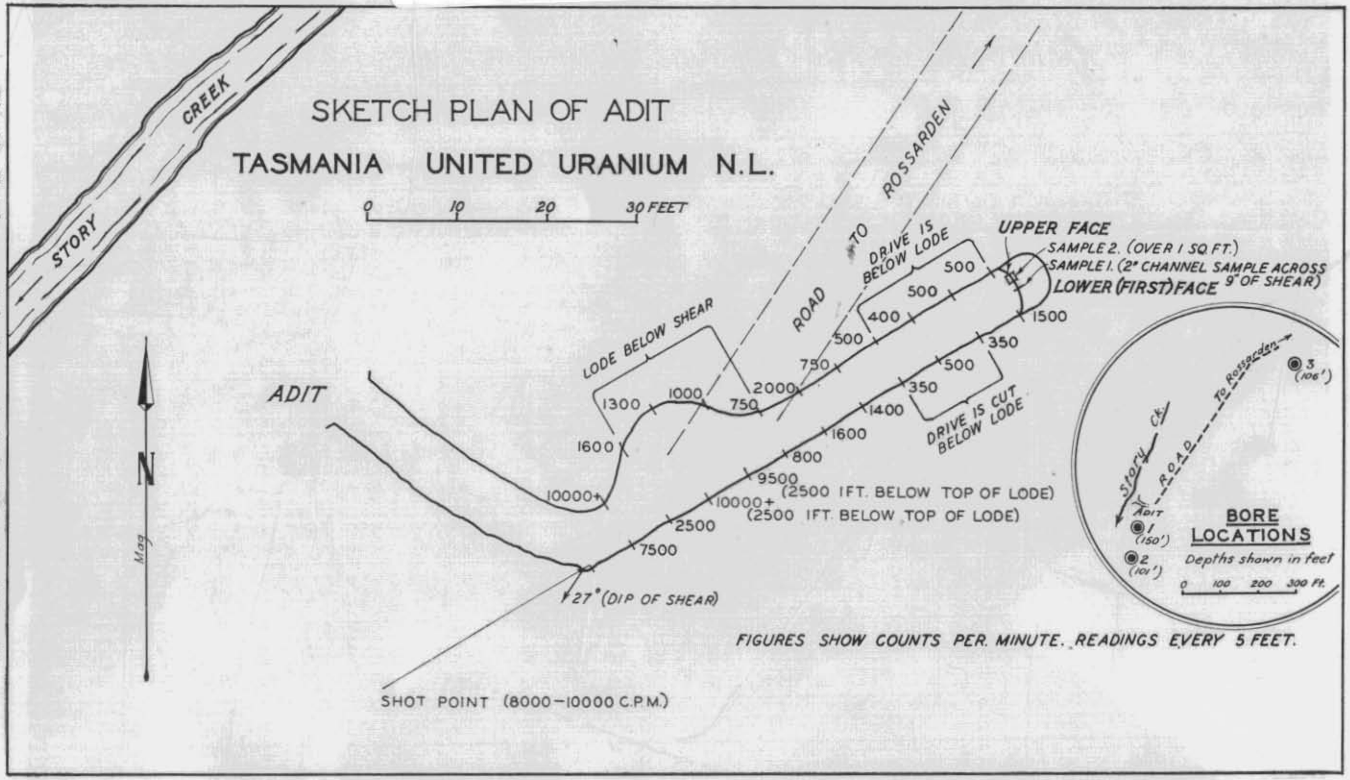

Fig. 20—Sketch map of the Tasmania United Uranium N.L. adit.

ment of Mines Petrologist, reports that albite is common and may occur as perthitic intergrowths with orthoclase. Small amounts of biotite are present, sometimes intergrown with muscovite. The potash felspar has been almost completely sericitised and the albite partly altered, while the quartz crystals are cracked and corroded. The groundmass is either sericitic and heavily stained by iron oxides, or a colourless, fine grained recrystallised quartz-felspar mosaic.

(ii) *Microgranite*. The rock is of fine pale grey granite which is sometimes porphyritic, with scattered phenocrysts of orthoclase and dark quartz. The quartz inclusions are often rounded and corroded. The micrograni̇te appears to form tongues and irregular bands within the coarse granite, and is sometimes intensely sheared. The contact between the two types is irregular and the micrograni̇te is apparently intrusive into the coarse granite.

G. Everard reports that in thin section, the micrograni̇te does not appear to tbe different mineralogically from the coarse type which the micrograni̇te seems to permeate. Micrograni̇te also occurs in the form of rounded masses, blocks or small nodules within the coarse granite. (See Fig. 19).

South of the mine on the west bank of Story Creek, rounded domes of granite were seen containing blocks of micrograni̇te, as well as small round nodules ranging from about 1½ inches to six inches in diameter. On the north wall of the adit, a rounded mass measuring four feet by two feet six inches was noted. One mass is a pale micrograni̇te with scattered phenocrysts of felspar and slightly rounded quartz. The contact with the coarse granite surrounding it is fairly sharp but irregular. Compared with the coarse granite, the micrograni̇te appears to be slightly poorer in CaO and richer in K_2O (see page 30).

Diamond drilling.

Three vertical holes were cored by the Department of Mines between December, 1956, and March, 1957. (See Fig. 20). No. 1 Bore was drilled to 150 feet, and evidence of shearing was reported from about 65 feet to 70 feet, with some pyrite in coarse granite at about 120 feet. No. 2 hole was sited approximately 80 feet south-south-west of No. 1 and was taken to 101 feet, with shearing recorded at about 90 feet. The third hole was drilled to 106 feet, about 560 feet north-east of the portal of the adit and above the east side of the road to Rossarden. The shear zone was reported to be between 30 and 35 feet.

A radiometric survey was made by the Geophysical Section of the Bureau of Mineral Resources, Geology and Geophysics in early 1957 (Langron, 1957). The log shows only weak radioactivity, the maximum recorded being 400 counts per minute. No sign of uranium mineralisation was seen in the cores, and there was no noticeable variation in radiation between the recorded shear zones and the rest of the granite. It was concluded that the drill holes did not intersect uranium mineralisation of commercial grade.

The following condensed log of No. 2 boring is typical of the granite in drill-holes:—

No. 2 Hole—Logged by K. Burns (Geologist, Dept. of Mines); (Longyear Junior Straightline No. 3 drill).

From.	*To.*	*Description.*
0	12′ 0″	No core.
12′ 0″	15′ 4″	Weathered granite, with pink felspar. Vertical joint from 12′ 6″ to 14′ 0″.
15′ 4″	28′ 1½″	Uniform coarse granite. ½″ shear at 20′ 2″ dipping 45°. 2″ shear at 26′ 4½″ dipping 15°.
28′ 1½″	34′ 7″	Porphyritic granite (boundaries transitional). Scattered quartz and clumps of orthoclase in a fine grained matrix.
34′ 7″	67′ 0″	Coarse granite. Transitional top; sharp contact at base dipping at 20°.
67′ 0″	70′ 6″	Porphyritic granite. Sharp contact at top; transition at base.
70′ 6″	70′ 8″	Coarse granite.
70′ 8″	74′ 3″	Porphyritic granite.
74′ 3″	76′ 8″	Coarse granite.
76′ 8″	78′ 3″	Porphyritic granite. Horizontal cracks infilled with reddish-brown mineral at 76′ 10″, 77′ 11″, and 78′ 2″.
78′ 3″	80′ 9″	Coarse granite with large flakes of brown mineral.
80′ 9″	83′ 4″	Fine grained porphyritic granite with numerous broken felspars, and brown mineral filling cracks.
83′ 4″	101′ 0″	Coarse granite. Felspars stained pink and cracked from 99′ 0″ to 99′ 9″.

Below about 43 feet, a brown mineral described as altered biotite, becomes common.

Mineralisation.

At the outcrop, near the entrance to the adit, flakes and patches of obscure secondary uranium minerals were revealed, apparently associated with an intrusive tongue of fine-grained granite. Flakes of this mineral were also found in a shallow hole dug about 100 feet upstream.

Noakes (1955) made field assays of radioactive material associated with microgranite in the first site discovered. A representative sample was also tested in the laboratory of the Geophysical Section of the Bureau of Mineral Resources with the following results:—

Field assay. eU_3O_8			**Laboratory Assay (Geophysical Section).**		
Ub%	**Ug%**	**Ratio**	**Ub%**	**Ug%**	**Ratio**
0.13	0.16	0.81	0.096	0.094	1.0

Thus, in this particular sample, the uranium is in equilibrium.

The adit was driven eastwards from the exposure of a 9 in. band on the east bank of Story Creek. G. Everard reports on the lode material as follows:—

"The specimen is weathered and shows strong rock cleavage. Oxidised radioactive minerals, and also a somewhat crumbly black substance which is seen on close inspection to consist of sulphides, mainly pyrite.

"Silicate minerals observed in thin section include quartz in clear colourless crystals, partly euhedral, with lines of bubbles and minute inclusions, biotite of pale yellowish-brown colour, and a groundmass of quartz-sericite mosaic. Some areas of the groundmass show a regular linear arrangement of the quartz and sericite grains and are relics of felspar crystals. The quartz grains may show corrosion and euhedral grains may be partly enclosed by biotite.

"Sulphides, mainly pyrite, but including a very small amount of galena and sphalerite, are scattered through the rock as euhedral crystals, grains and irregular masses. A black mineral is associated with pyrite and frequently encloses small grains. It also occurs as skeletal crystals, almost dendritic in form, and as strings of minute grains and in the interstices between grains of quartz. A little fluorite is also associated with the black mineral.

"While it is difficult to separate any portion of the rock, other than quartz fragments, which will not give a fluorescent sodium fluoride bead in ultra violet light, beads containing the black mineral are so much more strongly fluorescent that the radioactivity of the rock must be peculiarly associated with it.

"Secondary radioactive minerals are present and many account for the peculiar yellow-orange colour of the rock. This colour may be partly due to iron however, as the proportion of sulphur from analysis is not sufficient to convert all iron, lead and zinc to sulphide.

"The black mineral is evidently a primary uranium mineral introduced after the sulphides, at the hydrothermal stage of mineralisation".

The black mineral was later identified by D. Ostle of the United Kingdom Atomic Energy Authority as fine grained pitchblende and this determination was subsequently confirmed by X-ray powder photographs. A sample of the ore was analysed by the South Australian Department of Mines. It contained 2.2% U_3O_8 and the material was reported to consist of a highly altered silicified and ferruginous quartz-clay rock with about 2% fluorite, and lesser amounts (in order of abundance) of sphalerite, beta-uranophane, gummite, uranophane, autunite, meta-autunite, uraninite, haematite, pyrite, chalcopyrite and galena.

The Adit (see Fig. 20).

The adit was driven for about 30 feet south-east (117°) and then turned on a bearing of 60° for approximately 60 feet. The granite is sheared and at the bend in the adit, the shear plane dips at about 27°, slightly west of south. The black vein followed from the outcrop on the bank of Story Creek varies in thickness up to about one foot and in places on the north wall is hard and dense. The vein dips southwards at an angle less than that of the shear plane so that in the middle section of the adit, the vein is below the shear zone, on the north wall. Because of the southerly dips, the last 20 feet of the adit are cut below the vein and the shear. Readings were made every five feet with an Austronic counter Type **PRM 200.** The normal background count ranges to 200 counts per minute. Measurements were made on the vein, except for the last 20 feet where the adit is below the position of the vein and where readings were made near the roof. At the end of the drive, a short rise has been cut about four feet from the face and to a height of about nine feet from the floor. The vein was not visible in the rise, and readings were made in sheared microgranite at this point. Two samples were taken from the shear; a 2 in. channel sample across 9 in. of shear, and a representative sample over one square foot.

Readings made by Langron in 1957 indicated that radioactivity increased steadily along the adit up to the bend where a maximum of 12,600 c.p.m. were recorded on the north wall and the vein contained up to 4% of U_3O_8. However, the drive has since been widened northwards at this point and radioactivity in the vein drops abruptly to about 1,600 c.p.m. and except for one reading of 2,000 c.p.m. diminishes along the adit. On the south wall radiation increases, with a maximum of over 10,000 c.p.m. for about 20 feet from the bend but falls abruptly eastwards. The two samples from the shear zone near the end of the drive were assayed by the Dept. of Mines Laboratory, Launceston. The 2 in. channel sample contained 0.11% U_3O_8 and the sample over one square foot 0.08% U_3O_8.

Summary.

1. Uranium mineralisation occurs within the granite and is probably due to late stage hydrothermal action associated with microgranite intruded into earlier coarse granite.

2. Mineralisation is patchy and evidence to date suggests that the highest values are associated with shear and fracture zones within the granite. The main shear in the adit dips at a steeper angle than the vein, but it is likely that the latter represents the infilling of a fracture along which the mineralising fluids were introduced.

3. The fact that the three drill holes showed low grade mineralisation may imply that the deposit is merely a local concentration of limited extent, since radioactivity appears to diminish towards the end of the adit. The short rise near the face revealed only low grade uranium mineralisation.

Recommendations.

1. To determine the extent of mineralisation it would be necessary to follow the course of the vein in both directions, making frequent readings to be sure that the main mineralised zone is being followed and whether it occurs within the vein or within the shear zone. However there would be much difficulty with water southwards as the vein and shear will dip below the level of Story Creek. Northwards it is expected the vein and shear will rise.

2. The rise near the end of the adit should be continued upwards for about six feet to determine whether the shear sampled is the mineralised zone or whether further mineralisation occurs. Information from the rise would help to decide if it would be worthwhile driving at this horizon.

3. There appears to be no justification for extending the adit at its present level and direction.

4. The scintillometer survey now being planned by the Dept. of Mines over the whole of the Ben Lomond granite may give valuable information to guide any further prospecting round this area.

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HUGHES PROSPECT.

The Hughes Prospect, which was discovered in 1955, is on the west bank of Story Creek at an altitude of 1,780 feet about one mile due south of the adit driven by Tasmania United Uranium N.L. Hydrothermally altered and mineralised granite is exposed in cuts about 50 feet above the creek, and the maximum reading obtained with the Phillips Austronic counter was 700 counts per minute, or about five times background radiation. In 1955, one large specimen is reported to have given readings of 5,000 c.p.m., including beta and gamma radiation. Further south, several readings up to 600 c.p.m. were obtained. The normal coarse granite generally gives readings of between 150 and 200 c.p.m. or only slightly higher than the local background. The main granite in the area is a coarse pinkish granite, often with large felspar phenocrysts. It is apparently intruded in places by a porphyritic microgranite.

Noakes, Stevens and Roberts (1955) have described the mineralisation in detail. The body is exposed over a total length of 35 feet and is about 4 ft. 6 in. wide, with a northerly strike, and apparently dips steeply eastwards. The granite has been altered to a quartz-sericite rock with prominent sphalerite, and subordinate galena, chalcopyrite and pyrite.

Stevens (1955) states that the original felspar has been replaced by sericite and micropegmatitic quartz has been coarsely recrystallised to form large clear subhedral and euhedral crystals showing occasional relict stringers of fine sericite. Interstices between the quartz crystals are now filled with a deep red semi-opaque mineral shown by Roberts (1955) to be sphalerite, which may enclose subordinate pyrite, chalcopyrite, galena and pyrrhotite. Radioactivity is associated with a thin sericitic vein but in such small quantities that the mineral cannot be identified.

Noakes (1955) gives the following analyses of specimens:—

1. eU_3O_8	Ub%	Ug%	Ratio beta to gamma
Field test	.08	.07	1.14
Laboratory (Canberra)	.059	.053	1.0

2. Sample examined by South Australian Dept. of Mines—0.03% eU_3O_8.

3. Sample showing much sulphide mineralisation—0.19%.

Summary.

1. Small amounts of an unidentified radioactive mineral occur with sulphides introduced by late stage magmatic fluids which have hydrothermally altered the granite.

2. The mineralisation probably occurred by way of joint planes or fissures. Joint planes striking about 335° to 340° are well developed, as in the area round the Tasmania United Uranium N.L. lease, one mile to the north.

3. Mineralisation may be associated with a late intrusive microgranite, in a similar manner to orebodies in other parts of the Ben Lomond granite, for example Rex Hill and the Gipps Creek area.

4. Radioactivity is patchy and the deposit small. There is no apparent connection with the larger prospect one mile to the north. Further prospecting would be necessary to seek similar altered granites before any definite pattern of mineralisation can be worked out to indicate whether or not radioactivity is merely in the form of localised concentrations. A general systematic radioactivity survey would help to indicate the level of radiation, especially in areas away from Story Creek which are often mantled by a variable cover of granite gravel. A scintillometer survey is now being planned by the Tasmanian Department of Mines, to cover a large part of the Ben Lomond granite.

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CASTLE CAREY CREEK.

In the year 1956, two prospectors discovered radioactivity in black shales towards the base of the Permian succession in Prospect Creek.

Location.

The site is to the east of the main road from Avoca to Storeys Creek and Rossarden, and about six miles north of Avoca. The road lies about 200 feet above the confluence of the westward flowing Prospect Creek with Castle Carey Creek, which flows southwards within the Prospect Creek Fault Trough. Castle Carey Creek falls about 1,400 feet in four miles, and its tributary about 500 feet in less than half a mile. Radioactivity was observed about 100 yards up Prospect Creek.

Topography.

Castle Carey Creek is a youthful consequent stream imposed on the Fault Trough which has a gentle southerly tilt. The stream and its tributaries have cut deeply into the Permian rocks, and the underlying granite has been exposed in a small elongated patch north of the junction with Prospect Creek, the junction being 1,540 feet above sea level. Castle Carey Creek flows near the western boundary of the Fault Trough beyond which granite is upthrown, so that the western side of its valley is steeper than the eastern slope which exposes Permian strata up to an altitude of 2,050 feet, with granite on the upthrown side of the eastern boundary fault (see Fig. 11).

Geology.

Within the Prospect Creek Fault Trough, about 500 feet of indurated Permian rocks are exposed, dipping at about 6° to the south, or south-east. The basal beds include coarse grits and conglomerate bands, with up to about 10 feet of black shales developed locally. Radioactivity is confined to the black shales. On the western side of the trough, the upthrow to the west is about 500 feet; the throw on the eastern flank is greater, but unknown. Black shales appear to be absent from the basal Permian found at about 2,000 feet on the upthrown block to the west.

Mineralogy.

The radioactive material has not been definitely identified, but is probably a complex thucolitic hydrocarbon of syngenetic origin formed by erosion of the granite during Permian times. The black shales are carbonaceous with many small nodules of pyrite, indicating deposition in an anaerobic environment, probably in swamps or stagnant pools.

When the deposit was first discovered, readings of up to 600 counts per minute were measured in a hole near the creek, and up to 1,500 c.p.m. in a trench on its southern side. In the creek bed, analyses showed 0.014% U_3O_8 for four feet in a black siltstone at the base, followed by three feet of black shales containing 0.03% U_3O_8. However, in 1957, the maximum reading observed in the trench was 600 c.p.m. suggesting that leaching has taken place since the original report was written. Granite on the west side of the road gave readings of up to 200 c.p.m. against a background of 140 c.p.m. Similar black or dark grey shales were noted on the south side of the Mangana road, about two miles east of its junction with the old road from Storeys Creek. At this point the background was 125 c.p.m., and maximum readings of only 180 c.p.m. were found.

Conclusions.

1. In places, black shales occur towards the base of the Permian succession. In Prospect Creek the shales contain a local concentration of thucolitic hydrocarbons probably derived from the erosion of uranium-bearing granite during Permian sedimentation.

2. Investigations carried out so far suggest the concentration is too low and limited to be any more than of academic interest.

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III. COAL.

Brief visits were paid to the new Stanhope Colliery, the main operating coal mine of the district. This Company is working Triassic coal seams, south of the old Rex Hill Mine, where Triassic and Permian rocks have been preserved on the downthrow side of the Castle Carey Fault. Jurassic dolerite was injected into the upper part of the Triassic strata, possibly in the form of a thick transgressive sill. Erosion has since exposed the Triassic formations over much of this area, with dolerite remaining on the hills north and south of Stanhope and west of Buffalo Brook.

Twelvetrees recorded five coal seams, one of which is reported to be almost 12 feet thick, in the upper part of the Felspathic Sandstone (see p. 42). The Sandstone is about 400 feet thick and comprises thick pale grey felspathic sandstones, with some bands of conglomerate containing rounded pebbles of Mathinna quartzite. The coal seams usually rest on dark seatearth, and may have beds of dark carbonaceous mudstones or shales above.

History of Mining.

Mining started in 1904 and when Twelvetrees visited the area in 1905, a number of adits on the Mount Christie lease had already collapsed. He was unable to examine them. Between 1904 and 1922, the Mt. Christie mine had produced about 500 tons of coal, and production was running at the rate of 15 tons a week (Hills, 1922).

The mine was re-opened in 1940, and until its abandonment in 1947 had yielded about 6,000 tons of coal. Lease 82M/39 of 60 acres covering part of the area formerly worked by the Mt. Christie Mine is now held by N. & D. Fenton who have recently produced small amounts of coal.

Between 1932 and 1957, the Stanhope Mine produced approximately 153,000 tons of coal, part of which came from the New Stanhope Mine, after the closing of the old mine in June, 1957.

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FIG 21

GEOLOGICAL SKETCH MAP
ROSSARDEN & STORY CREEK AREA