

GEOLOGY OF THE TIN-TUNGSTEN DEPOSITS OF THE
ABERFOYLE AREA, BEN LOMOND QUADRANGLE
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INTRODUCTION

GENERAL.

In recent years, the Aberfoyle Mine has attained an economic importance unprecedented in its history and the important developments responsible, fully warrant a comprehensive geological survey. The objects of the present examination were to determine the effect of the main Aberfoyle fault on the vein system in depth, to determine whether the veins were cut off by the fault in depth or whether the fault was responsible for repetition of the veins within the mine area; and to acquire all possible information bearing upon the genesis of the lodes, their structural features, the distribution of the mineral contents, the probable extensions and any evidence pertinent to the question of ore deposition.

This geological survey was commenced in the winter of 1938, but circumstances prevented the completion of it, at that time. Last year, Aberfoyle Tin No Liability again requested that the work be completed, so field work was resumed in January last.

A geological and a structure contour map have been prepared. The geological map shows the physical features, geology, and position of the Aberfoyle Tin Mine and surrounding prospects, while the structure contour plan shows the elevation and "lay" of the base of the Permian.

Mineral lease corner pegs were used as the main control in mapping and detail was located by means of plane-table and telescopic alidade. The assumed datum of 2,200 feet at the collar of Spier's shaft, is based on aneroid readings from the Avoca Railway Station, reduced level 653 feet above sea level.

The Aberfoyle Mine area is situated on the southeastern slopes of Ben Lomond in Quadrangle No. 48. It is connected by motor road to the nearest railhead, Avoca, some 1,500 feet below and 14 miles distant and to Fingal, via Mangana, a distance of 19 miles.

The area under review is one of generally low relief consisting as it does of a down faulted block or senkungsfeld through which the Storeys Creek and the Aberfoyle Rivulet have deeply entrenched themselves through prolonged erosion and are still grading their courses.

The drainage pattern reveals the influence of the strike of the Silurian (?) rocks.

The physiographic features are due primarily to differential block faulting probably contemporaneous with the doleritic intrusions in late Jurassic times and/or the basaltic extrusions in the Tertiary.

PREVIOUS LITERATURE.

Although official literature relating to the Avoca-Ben Lomond area is fairly extensive, relatively little detail is available of the particular area under discussion.

The following is a list of published reports of the Geological Survey of Tasmania which bear on the geology and mineral deposits of the Aberfoyle district :-

G. Thureau	1881	The St. Paul's River Tin Deposit.	House of Assembly Paper No. 108.
G. Thureau	1881	Report on the Ben Lomond Tin Deposits.	House of Assembly Paper No. 108
A. Montgomery	1892	Report on the Ben Lomond District.	Secretary for Mines, 1891-2.
	1892	Report on the Discoveries of Tin Ore on the Brookstead Estate.	
	1893	Report on the Roy Hill Tin Mine.	
	1893	Second Report on the Brookstead Estate Tin Lodes.	
W.H. Twelvetrees	1899	Report on Some Tin Mines in the St. Paul's River Valley near Avoca.	Secretary for Mines, 1899.
G.A. Waller	June 1901	Report on the Tin Mining District of Ben Lomond.	
W.H. Twelvetrees	1905	On Coal at Mt. Rex	
Loftus Hills	1915	Tungsten and Molybdenum	Mineral Resources of Tasmania No.1 Part 1.
Geological Survey	1922	The Coal Resources of Tasmania.	Mineral Resources of Tasmania No. 7.
P.B. Nye	1926	The Campbell Town - Conara - St. Marys District.	Underground Water-supply Paper No.4.
A.M. Reid & Q.J. Henderson.	1929	The Avoca Mineral District.	Bulletin No.40.

The following brief summary indicates the available data recorded in unpublished reports contained in the files of the Geological Survey.

- (1) P.B. Nye, July 1926. Report on J.J. Goodall's Prospecting Area.

This is a one page type-written report on an area, half a mile south-east of the Storey Creek Mine, in which occur narrow veins of a sandy or clayey material with individual shoots of limited size, impregnated with cassiterate. It is questionable whether they can be economically sought and mined owing to the small size and value of the shoots and their infrequency of occurrence.

- (2) P.B. Nye, August, 1926 Report on Section 9223/M, 80 acres, Aberfoyle Creek.

This report describes the working on this, the original section of the Aberfoyle Tin Mine. These consisted largely of trenches and shallow excavations over a length of 200

feet with two shafts less than 20 feet deep. All the deeper trenches and shafts were full of water and could not be examined. Nye concluded that the above workings exposed a series of quartz veins in which the mineralised zone had appreciable extent; and as exposed at surface were too small to be of commercial importance.

The Aberfoyle fault system was unsuspected at this stage.

- (3) J.B. Scott, December, 1927. Mineral Lease No. 10183, charted in the name of Lutwyche and Richards, Storeys Creek District.

This report described the vein system occurring on this section and concluded that although tin bearing veins were distributed over fairly wide area they were in a totally undeveloped state.

- (4) J.B. Scott, June, 1928. Aberfoyle Tin No Liability.

The mine workings at that time are described. Two shafts (Searle's Workings) had been sunk to a depth of 60 feet and connected by crosscut, the eastern one, an underlay shaft following a 20 inch vein and the western or main shaft, a vertical one. Only 60 feet of driving had been done. Scott expressed the opinion that the series of veins represented branches from a much larger parent vein. This idea was based on the fact that the most westerly of the group was at a much higher angle than its neighbours and the most easterly was at a lower angle than any. Further sinking was recommended.

A five head battery and concentrating mill with a steam power unit was in the course of erection and Scott pointed out that the general character of the ore mined was such that a more unsuitable method of milling could not be devised, and suggested simple box sluicing until such times as ore production warranted a complete concentrating plant.

He concluded that at that stage the Company had little to show for its heavy outlay of capital and the long time taken to bring the mine to its then immature state of development.

- (5) J.B. Scott, August, 1928 Notes on the Aberfoyle Mine, Avoca.

Two months later Scott again visited the area to examine the developments exposed by surface trenching under the direction of (the late) W.E. Hitchcock. Some interesting geological features were observed. It was found that horizontally bedded shales exposed in the western end of the trenches abutted against the highly inclined mineralised belt constituting the ore channel.

This is the first record of the existence of the Aberfoyle fault system and although the full significance of its implications was not then fully realised, sufficient was known to indicate the importance of draining the flat swamp lands occupied by pebbly mudstone prior to shaft sinking.

- (6) Q.J. Henderson, October, 1937. The Ivanhoe Mine.

The writer examined this prospect for the purpose of determining if the grade of ore exposed by sluicing operations was high enough to warrant bulk mining. At least four narrow greisen veins striking generally north-west were exposed. Sampling indicated an average grade of 0.02 per cent tin, with 0.54 per cent for 3'6" greisen material.

HISTORY OF MINING

Prospecting operations in the Aberfoyle Mine area commenced about 1927 and consisted of the sinking of a small vertical shaft 60' deep and connecting by crosscut to a prospecting underlay shaft. Within a distance of 57 feet, seven tin-bearing veins had been exposed as a result of surface prospecting and it was decided to sink a new shaft, purchase additional mining equipment and erect a concentrating mill.

During 1928 operations were of an uncertain nature until towards the end of the year, when a definite policy of exploration and development was instituted and the project of sinking a main underlie shaft abandoned and the erection of the mill temporarily suspended.

Operations on the ore veins exposed in the vertical shaft workings were discontinued; and a commencement made in driving the low level adit crosscut from western slope of Aberfoyle Rivulet gorge. The adit, 6' x 8' in the clear, with an estimated distance of 894 feet would attain a vertical depth of 224 feet below collar of shaft or approximately 184 feet below the shaft workings.

Not only would this prospect the veins at depth and reveal the character and extent of the ore, but would also explore the zone of mineralisation east of the shaft workings.

In 1929, the adit was continued to 1,050 feet from datum point and passed through the ore vein system exposed in the vertical shaft workings. Several small tin-bearing veins occurring easterly from these workings were also revealed by the adit.

Additional prospecting established the persistence of the vein system over a distance of 600 feet. Although the veins were not individually large nor characteristically regular, their persistence and frequency between 900 and 1,042 offered scope for collective and sectional mining, but not as individual veins.

Developmental work and the installation of mine equipment, necessary for productive operations continued and successful mining and marketing of finished products was established in 1932.

Exploratory drives on major veins at 125 level of the vertical shaft workings were advanced, and an active developmental campaign was then entered upon, the companion drives at 26 feet and 50 feet on the major veins being driven north and south, stoping sections were blocked out and productive operations permanently established at this level. A drainage drive was turned away from the main adit and advanced in the footwall country to ultimately connect with the shaft workings and make a second lift of workings available for production.

In 1933 a vigorous policy of mine development and milling innovations was undertaken. North and south drives were advanced on the major veins of the ore-vein system at the 125 feet and intermediate levels of the shaft workings; and exploratory driving and crosscutting were undertaken to determine the economic possibilities of other sections of the ore zone.

Concurrently with the stoping of the major veins of the ore-vein system from and above No. 1 level, the Company maintained a vigorous policy of exploration and development throughout 1934. The shaft was deepened to 230 feet and the No. 2 level opened out at 222 feet and the development of the vein system commenced at this level.

A prospecting shaft was sunk to 85 feet and cross-cutting commenced to explore the vein system 970 feet south from the main shaft.

In 1935, consequent upon the gradual depleting the major veins in the developed area above No. 1 level, developmental and stoping operations were vigorously undertaken on "26", "40" and "50" lodes on No. 2 level which satisfied immediate and future productive requirements. The results justified the progressive policy of the Company and preparations were made for the driving of a low level adit approximately 3,000 feet to prospect and develop the ore zone, 172 feet below No. 2 level.

Total production and sale of concentrates were a progressive advance on the previous year.

During 1936, stoping was continued on the "26" "40" and "50" lodes and associated veins on Nos. 1 and 2 levels and the eastern lode was opened up in both levels. Developmental operations in the southern part of the No. 2 level, further enhanced the prospects of the mine. The No. 2 low level adit was commenced and had reached a distance of 941 feet by the end of the year.

In 1937, general electrification of the operating plant, the further development of the ore vein system on producing levels and the driving of the No. 2 adit another 1,519 feet marked further progress in the Company's developmental policy.

On the No. 1 level, the eastern lode was driven for 139 feet in a southerly direction and in a northerly direction for 151 feet with an average vein-width of eleven inches.

The main crosscut on No. 2 level was extended to the eastern lode, which was driven on northerly for 125 feet and 214 feet southerly, the average width in the north end being 14 inches and in the south end 20 inches. North and south drives on the 26 lode showed average widths of 25 and 21 inches respectively. The south drive on the 40 lode was extended for 137 feet, the ore width averaging 17 inches.

The No. 2 adit was continued to 2,957 feet during 1938 and from 2,829 feet to 2,948 feet, 18 tin-wolfram veins, ranging in width from three to nine inches, were passed through, the aggregate width of these veins being 92 inches. Work in the No. 2 adit was suspended pending a connection being made with the upper workings. This was made by means of the No. 2 shaft (Brandon's) which is located 435 south of the No. 1 main shaft (Spier's) and was completed between No. 2 level and the surface by rising and sinking. It was anticipated that the shaft would provide hoisting facilities about the region of the No. 2 adit.

In 1939 the major developmental work was the completion of the No. 2 main shaft (Brandon's) to 408 feet from the surface and the connection to the No. 2 adit. Plats were also cut on Nos. 1 and 2 levels. The shaft was equipped with steel head frame and an electric hoist. In the ore treatment process, rod-milling and flotation was adopted in place of roasting and re-dressing of seconds.

The main operations underground in 1940 were the development of the vein system on No. 4 level from No. 2 shaft by drives and crosscuts. Sinking the No. 1 main shaft from No. 2 level to connect with No. 4 level was commenced, the vertical distance to connect being 170 feet. In stopping an attempt was made to reduce mill feed dilution and increase grade by a better separation of ore and gangue.

On surface, a new steel head frame and an electric hoist were installed. In the mill, a flotation unit was installed for retreatment of tin concentrates for the purpose of stripping sulphide impurities.

In 1941, the sinking of the main or Spier's shaft to No. 4 level and connecting it with the working at that level was completed. On the surface a new change house was provided. The grinding and flotation units for sulphide elimination were completed and placed in use. It was now possible to produce a high-grade tin concentrate.

Productive operations were maintained during 1942 (and some prospect drilling undertaken) although the stopes on the upper levels were approaching depletion and those on the lower levels were in the early stages of development. Several important innovations in milling equipment were commenced such as an improved return water scheme and the provision for simultaneous operations of the compressors on the existing power transformers.

Additions to surface plant and underground development work, including the sinking of the main shaft and driving No. 5 and 6 levels, marked the steady advance of a progressive developmental policy until last year when a completely re-organised 250 ton capacity mill was installed. The mill is designed to obtain maximum recovery at coarse sizing to obviate oversliming of tin which causes a sharp decline in recovery.

PRODUCTION STATISTICS.

The total recorded value of production since the inception of milling operations to December, 1945, is £817,560 made up of 2,855.825 tons of metallic tin valued at £679,313 and 515.712 tons of tungstic tri-oxide valued at £138,147.

The annual value of production reached its peak in 1943 with £95,924 and since then has declined.

The only other mine with sufficient production to warrant recording is McDonald's west of Storeys Creek. The figures given below for McDonald's production may not be complete because in some years production would be so little that it would be included in "sundries" in the annual reports.

ABERFOYLE TIN NO LIABILITY.

See table on next page.

ABERFOYLE TIN NO LIABILITY.

Year	Ore Milled	Mettalic Tin	£	W03	£
Inception to 1932	4092.5	32.840	4,980		
1933	11410.5	174.000	33,441	14.00	873
1934	10269	149.160	34,256	21.25	3,132
1935	14487	220.921	50,860	24.38	2,943
1936		182.664	37,968	25.20	3,609
1937	13489	161.647	38,405	45.72	12,220
1938	14355	157.915	29,879	36.087	7,712
1939	15267	192.725	43,356	24.976	4,600
1940	16653	318.180	81,346	20.00	3,698
1941	16185	252.800	66,107	28.48	3,235
1942	16699	278.550	72,283	62.25	19,700
1943	16462	251.999	65,393	84.58	30,531
1944	18021	237.725	68,801	68.536	24,285
1945	20213	244.719	52,238	60.293	19,609
	Totals	2,855,845	£679,313	515.712	£138,147

MCDONALD, ROSSARDEN.

Year	Tons	Mettalic Tin	£
1939	5.813	4.225	953
1940		.540	140
1941		1.720	451
1942	.720	.450	116
1943	.280	.201	53
Totals		7.136	£1,713

GEOLOGY

GENERAL

Geologically, the Aberfoyle district consists of gently folded and faulted Permian pebbly mudstones, sandstones and mudstones unconformably overlying steeply dipping Upper Silurian (?) quartzites, slates and tuffs. The latter, in the southern part of the area, are intruded by Devonian (?) acidic rocks, consisting of granite, graphic granite, aplite and greisens. The acidic rocks are of great importance in that they are genetically connected with the occurrence of the tin and wolfram.

SEDIMENTARY ROCKS

Silurian (?)

The complete failure to locate any fossiles in the older series of rocks makes a definite statement of their geological age impossible. Any provisional age assigned to this rock series must rest upon such evidence as lithological characters and continuity with or proximity to rocks of known age. Lithologically these sediments consisting predominately of quartzites appear to me to be very similar to the Mathinna Series, which were previously correlated with the Dundas Series as Cambro-Ordovician in age. Since then the age of the Dundas Series has been established as Middle Cambrian on the evidence of fossil dendroids.¹

In 1934, during a survey of the Warrentinna gold fields, F. Blake, Field Geologist, discovered some plant remains in a railway cutting near Mara Siding. These were examined and described by Dr. Isabel C. Cookson² in 1936, who compares them with the smooth branched axes of the type known as Hostimella. If this determination is accepted, the Mathinna Series can scarcely be older than Upper Silurian so the earlier correlation with the Dundas Series now known to be Cambrian must be invalid.

The Aberfoyle quartzites are lithologically similar to quartzites occurring in the Mathinna Series throughout the north-eastern part of the State and it seems reasonable to assign to them provisionally an Upper Silurian age on the evidence of the Warrentinna plant remains.

The quartzites may be light or dark in colour and generally contain mica along the bedding planes. The general strike is about 130° , with a south-westerly dip from 60° - 90° .

The most prominent structural feature of this series is a pronounced cleavage. The strike of the cleavage-planes varies from N. 15° W to N. 40° W., and the dip is generally to the south-west at angles ranging from 45° to 80° , though the steeper angles are the more common.

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1. Some Fossils from the Dundas Series, Dundas. D.E. Thomas and Q.J. Henderson. Papers and Proc. of the Royal Society of Tasmania, 1944, P. 1.
 2. Fossil Plants at Warrentinna, Tasmania. I.C. Cookson. Papers and Proc. of the Royal Society of Tas, 1936, p. 73-7.

In the majority of surface and underground exposures within the mine area the cleavage almost completely masks the bedding. In some places the bedding can be followed fairly closely where there is a lithological difference such as a slate band in the quartzite or different coloured bands in thin-bedded slates. The strike of the bedding-planes varies from N. 10° W. to N. 50° W., but N. 40° W. is the most commonly observed strike.

The rocks constitute the eastern limb of a synclorium. Minor puckerings and drag folds in the vicinity of faults occur.

Permian.

Owing to the lack of complete sections shewing the Permian succession in this area, it is possible to give only a tentative correlation.

Basal Conglomerate:

This is very thin, probably not more than two or three feet and is found only at the lowest elevation of the oldest rocks. At higher elevations other members rest directly upon the bed rock.

It is doubtful just where the base of the Permian occurs on the eastern side of the No. 3 Aberfoyle fault, but the evidence suggests that the Risdon sandstones transgress in that area, and that the Lindisfarne pebbly mudstones are absent.

Lindisfarne Mudstones:

The basal conglomerate as exposed in the mine workings is conformably overlain by pebbly mudstones 230 feet thick. There are occasional pebbly bands possibly of glacial origin. In the type area the uppermost beds of the Lindisfarne mudstones below the Risdon sandstone are fossiliferous, but as a small outcrop in one place is the only exposure, the failure to locate any fossils is readily understood.

Risdon Sandstone:

The Lindisfarne mudstones are conformably succeeded by a coarse sandstone not less than 120 feet thick which tends to be pebbly towards the base.

Fern Tree Mudstones:

Conformably overlying the Risdon sandstone is a white siliceous mudstone similar to the Lindisfarne mudstone but lacking the pebbles so common in the latter; a thickness of at least 200 feet remains.

IGNEOUS ROCKS

Granite:

The granite is intrusive into Upper Silurian (?) strata and abundant boulders of it occur in the basal conglomerate of the Permian which rests on its eroded surface. Hence it has been assumed to be of Devonian age. However, there is no evidence to preclude its correlation with either the Devonian or Lower Carboniferous epochs of injection of Eastern Australia.

The granite is similar to the "tin granites" so widely distributed throughout the State.

The granite is somewhat variable in texture and composition. Macroscopically the rock is a light-coloured biotite granite. It is predominately porphyritic with phenocrysts of white orthoclase. The constituents of the normal granite are orthoclase, plagioclase, quartz and biotite in that order of relative abundance.

The granite exhibits the characteristics of a discordant or subsequent batholith. It is massive with an irregularly domed roof and irregular outcrop in plan. The boundaries are mostly sharp and transgress the strike of the sediments. There is little evidence of a contact aureole and inclusions are angular and not orientated. There is some local concordance with the enclosing strata which is only moderately folded. No peripheral lenses were observed but dyke and sill apophyses are present. Pegmatites are scarce while fine grained aplites are common. Some complementary lamprophyric sill occur.

Wherever tin deposits accompany a batholithic intrusion of granite, it has been found that the deposits occupy positions at or near the summit of the batholith. Hence the extent to which the granite has been eroded is a very significant factor.

The width of the metamorphic aureole is roughly proportional to the flatness of the dip of the contact surface so that in this case the almost total absence of a metamorphic aureole is indicative of a batholith with steeply dipping sides. The virtual absence of tin deposits in the centre of the granitic outcrop and the marginal distribution of the known deposits further supports the contention that considerable erosion of the summit of the batholith has taken place.

Assuming the contact surface of the granite was dipping at 60° and probably this is not an unreasonable figure, the depth to the granite in the vicinity of Spier's shaft would be of the order of 2,500 feet.

Complementary Diaschistic Sills.

Two small, almost completely decomposed basic igneous sills, occur in the Aberfoyle Mine, one in the extreme northern end of No. 1 level and the other in the southern end of that level, just north of Brandon's shaft.

Similar sills occur in close relationship to many ore deposits in north-eastern Tasmania. At Mathinna, they are associated with gold-quartz veins. Similar material occurs in the Storeys Creek Mine.

It is not possible to identify this rock but it is in all probability connected with the Devonian (?) period of igneous activity and intimately associated from point of time with the ore deposition.

The following analyses compare similar material from the Aberfoyle and Storeys Creek Mines :-

	1	11
SiO ₂	49.2	60.60
Al ₂ O ₃	16.38	24.57
CaO	2.0	0.48
MgO	3.5	0.80
K ₂ O	3.45	1.82
Na ₂ O	0.12	0.63
FeO	9.48	N.D.
Fe ₂ O ₃	1.43	1.43
MnO	0.50	Tr.
TiO ₂	0.88	1.28
P ₂ O ₅	0.8	0.40
FeS	0.71	S 0.05
Ignition Loss	11.80	8.68
	<hr/>	<hr/>
	100.25	100.74
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1. Sample No. 4. Reg. No. 1570 (1938). Dyke rock, No. 2 level Aberfoyle; W. St. C. Manson, Analyst.
11. Sample No. 3. Reg. No. 1569 (1938). Dyke rock, No. 4 adit Storeys Creek; W. St. C. Manson, Analyst.

STRUCTURE:

A structure contour map (Plate 11) has been prepared which shows the behaviour of the base of the Permian, and hence depicts all known Post-Permian dislocation and deformation of the ore bearing rocks. The contour interval is 20'.

Post-Permian Folding.

There is little evidence of systematic folding of the Permian strata, for although the Permian beds are for the most part gently dipping at angles of 3° to 6°, the deformation is of the nature of warping and buckling as a result of the block faulting and uplifts which have affected the region, rather than normal folding. However, the structure contours reveal that there is a trough like depression in the Permian rocks which tends roughly east and west about three quarters of a mile south of the Aberfoyle Mine. South of the trough the Permian strata have general north-north-easterly dips, while north of this trough the Permian dips gently to the south-east. The convergence of these strikes causes the trough to pitch gently to the east, with a swing to the south-east in the eastern part of the area.

Post-Permian Faulting.

Aberfoyle Senkungsfeld:

The Aberfoyle area lies in a senkungsfeld between the Burns Marsh fault, which throws down not less than 240 feet, and the Aberfoyle fault system which throws down about 480 feet.

In this senkungsfeld Permian strata have been preserved whereas on the bordering blocks the Permian has for the most part been removed except an outlier of Permian strata on high ground between the Aberfoyle fault and the Aberfoyle rivulet.

Aberfoyle Fault System:

The Aberfoyle fault system consists of three faults en echelon - each throwing down to the west. In the northern part of the area the whole throw of the system (nearly 500 feet) appears to be carried by Aberfoyle fault No. 1. As the mine area is approached the downthrown side of the fault remains at the same general level as does also the main part of the upthrown block, but a slice from the upthrown block drops down steadily along Aberfoyle fault No. 2 until the strip between the No. 1 and No. 2 faults reaches the same level as the main downthrown block, whereupon No. 1 fault cuts out. As a result of this the throw of the No. 1 Aberfoyle fault in the vicinity of Spier's shaft is only about 90 feet and at the South Prospect is less than 40 feet.

Meanwhile another fault (Aberfoyle No. 3) starts to drop another slice off the upthrown block, so that No. 2 fault also rapidly dies out and the whole throw of nearly 500 feet is then carried by No. 3 fault.

Field Exposures of Faults:

The No. 1 Aberfoyle fault is exposed on all levels in the Aberfoyle Mine, in both the Nos. 1 and 2 adits and as far north as the Spartan lease, where it is exposed in a trench between the main shaft and the underlay shaft. Some 30 feet south of the trench a prospect shaft has been sunk on it.

Apart from the No. 2 adit, the No. 2 Aberfoyle fault is exposed in one other place only, in some shallow adit workings approximately 12 chains, east of the Aberfoyle south prospect shaft.

The No. 3 Aberfoyle fault has been mapped on the surface from the No. 2 adit south to Archer Creek. Throughout, this distance it throws strata against Silurian (?) strata and intrusive granites, both of which rise topographically above the flatly dipping Permian beds.

Effect of the Aberfoyle Faults System on the Lodes:

The structural analysis has shown that although all three faults cross the No. 1 and No. 2 adits, only No. 1 Aberfoyle faults closely approached to the lodes. Further, within the limits of the mine workings the throw of this fault varies from about 120 feet at the northern end to about 40 feet at the southern end, the downthrow being to the west.

Since the Aberfoyle No. 1 fault is in the footwall of the system and dips at a flatter angle it is of economic importance to decide whether the fault intersects the lodes and what then would be the effect on the lodes. This problem presents no difficulty. The angle of convergence of the fault and lodes is of the order of 5° to 10° . Hence when fault meets lode, the lode will reappear in the footwall at about 20 feet into the footwall (throw x sine of angle of convergence) at the extreme north end of the mine, and at progressively less than 20 feet into the footwall further south in the mine. Hence the Aberfoyle fault will have no disadvantageous consequences on the lodes but will result in a duplication of each lode in turn for a vertical range equal to the throw, thus resulting in slightly increased total potential production within practicable mining depth.

Pre-Permian Faulting.

The fracture system which now forms the lode channels is Pre-Permian and Post-Silurian in age; it was without doubt developed during the diastrophism responsible for the granite injection. Although previously assigned loosely to the Devonian, there is no definite evidence to define its age to any lower limits than the close of the Silurian on the one hand and the end of the Carboniferous on the other. Three major epochs of diastrophism in Eastern Australia fall within these limits, and of the three, that occurring at the close of the Lower Carboniferous has most in common with the epoch here considered.

It is evident that lode formation was going on concurrently with the fault movements. Thus for example on No. 2 level near the western fault, small mineralised veins on either side of the main 66 footwall lode are displaced while the 66 lode is undisturbed. A certain amount of post-ore movement has taken place along many of the vein channels for greasy heads faced with clay frequently extend along the whole of the lode channel; in some cases these appear to have affected slight displacements in the veins but in others they have had no effect whatsoever. Frequently there is a smooth striated wall, with a selvage of soft clayey material containing irregular lenses and fragments of quartz.

MINERAL DEPOSITS.

All known mineral prospects in the area are shown on the geological map which accompanies this report (Plate 1). Where no ore of consequence has been produced, the prospect is shown merely as a small circle filled in with red to indicate tin, or purple to indicate tungsten. Where ore has been produced the diameter of the circle has been drawn in proportion to the total production, in accordance with the scale in the legend. From this map it is apparent that the only workings of consequence is the Aberfoyle Mine, with tin production considerably in excess of its tungsten. McDonald's show has also produced a little tin ore, but all other shows in the area are no more than prospects.

All important production from the Aberfoyle district has been from primary lodes. Secondary deposits are virtually absent, because conditions are unfavourable for their accumulation. Eluvial accumulations overlying or lying near ore bodies occur in several places. These have been sluiced for their tin content in a number of places, without any notable return.

The primary deposits are of three types :-

- (1) quartz-mica veins
- (2) greisen veins
- (3) replacement deposits.

(1) The quartz-mica veins are by far the most important within the area examined. Of this type the Aberfoyle vein system is the only one upon which active mining operations are being undertaken, at present. They occur also at the Spartan, being the northern continuation of the Aberfoyle vein system, at Johnson's Prospect, the Lutwyche's Prospect and at the south-eastern continuation of the Eastern Hill series of veins.

In the Aberfoyle Mine, the veins are of thin tabular form, characteristic of simple fissure fillings; the contacts with the country rock are sharp and well defined. Angular fragments of the walls broken off and lodged in the veins are but little altered. Cavities with crusted banding and well formed crystals pointing to the centre is good evidence of deposition in open fissures. The ore minerals present in the veins are cassiterite, wolfram, galena, marmatite (iron rich sphalerite), chalcopyrite, arsenopyrite, pyrite, stannite and scheelite while the gangue minerals are predominately quartz with lesser amounts of calcite, manganese-siderite, triplite, fluorite, apatite and pinite, a pale green waxy mineral, which is essentially a hydrous silicate of aluminium and potassium corresponding to muscovite in composition.

Quartz practically fills the fissures while the cassiterite occurs as blebs and massive aggregates with the sulphides. The wolfram is present in bunches of heavy dark brown to black sub-metallic crystals in columnar masses. The wolfram and cassiterite usually occur in completely separate aggregates, little or no inter-growth of the two minerals being observed.

These hydrothermal tin-bearing veins are unique in that the tin has also been deposited in the unusual form of stannite.

The following is an analysis of a representative sample of wolfram specimens (Column 1) :-

Lab. Reg. No. 1574 (1938) Sample No. 8.

	1	11
WO ₃	75.40	76.5
FeO	10.21	9.5
MnO	13.27	14.0
Cu	0.11	-
Fe	0.26	-
S	0.29	-
Acid Insoluble	0.50	-
Lead, Bismuth and Tin	Nil.	-

The WO₃ content is about 1.1% low, on account of the presence of copper iron sulphide. The analysis corresponds to a Fe: Mn ratio of 2 : 3, the theoretical analysis of which is given in Column 11. This is a common form of wolframite.

Some secondary galena has been deposited in fractures in the lodes on the hanging wall side of strike faults. The galena is soft, bluish-grey, with metallic lustre and easy cubical cleavage. The actual source of the galena is uncertain but it is probably derived from primary lead deposits in the vicinity of the Aberfoyle fault system, south of the mine area.

An analysis of the galena shows that it is low both in lead and silver and suggests that some silica has also been precipitated :-

Lab. Reg. No. 1571 (1938) Sample No. 5

Pb	81.70
S	13.02
Fe	1.17
As	0.98
Ag	46.5 oz. per ton
Acid Insoluble	3.02
Cu, Bi and Zn	Nil.

Sphalerite occurs in the iron rich variety marmatite and an analysis of the mineral collected from the Eastern lode on No. 2 level shows its grade.

Lab. Reg. No. 1572 (1938) Sample No. 6

Zn	50.70
Fe	12.95
S	32.80
Cu	0.25
Bi	0.27
Mn	0.91
Acid Insoluble	0.45

The occurrences of triplite, an iron-manganese fluo-phosphate, not previously recorded in Tasmania, was first observed by the writer in the eastern lode on the No. 2 level in 1938. Triplite is a massive to imperfectly crystalline, reddish brown mineral.

An analysis of the mineral is given below :-

Lab. Reg. No. 1568. Sample No. 2.

P ₂ O ₅	32.0
FeO	13.90
MnO	43.34
Al ₂ O ₃	3.93
TiO ₂	0.12
CaO	0.80
MgO	1.16
Alkalies (including Li if present)	0.30
F	7.40
Acid Insoluble	0.20

103.15

(2) Greisen veins consisting essentially of quartz, muscovite and green coloured tourmaline occur at the Dalrymple and Ivanhoe prospects.

(3) Replacement deposits representing the metasomatic replacement of tuffaceous beds occur at McDonald's prospect and in the vicinity of Tiger and Tasmania Creeks.

The Aberfoyle Mine.

The strike of the ore veins in the Aberfoyle Mine closely parallels the Aberfoyle fault in the north end of the mine workings but deviates slightly from it in a southerly direction, while the dip is west at angles between 45° and nearly vertical. Vein widths vary from a fraction of an inch to at least seven feet.

The whole of the country penetrated by the two low level drainage adits is mineralised, but although the veins are not individually large nor characteristically regular their persistence and frequency over a zone of approximately 100 feet in width constituted an economic concentration. The veins are worked in four main groups in which the total vein width would range from ten to fifty inches and would average 22 inches.

Many veins are of complex structure and properly may be called lodes.

Lutwyche Prospects

North of Johnson's 11455/M mineral lease a fairly continuous line of mineralization occurs in a general north-westerly direction. It is characterised by sporadic occurrences of quartz in the form of irregular veins and bunches. Tin oxide occurs as small, well developed crystals usually confined to the edges of the veins and sometimes as veinlets of cassiterite.

These veins, of which there are several, are well defined and reach a maximum width of ten inches in one place.

About nine chains north-north-easterly from the north-east angle of mineral lease 11455/M an adit has been driven 160 feet in a direction south 38° west without disclosing any prospects. This adit was driven, over 20 years ago, for the purpose of testing the quartz veins occurring along the ridge above; but was not sufficiently advanced to intersect the downward extension of those veins.

About ten chains north of the north-east angle of 11455/M, a shaft has been sunk to a depth of 14 feet. In the side of the shaft three veins can be seen striking 145° and dipping south-west at 75° , but as the shaft was filled with water the veins could not be examined. It is reported³ that "at the bottom of the shaft the veins widen to four inches; they carry fair prospects of tin. A bulk sample of the vein material mixed with a proportion of country rock as excavated from the shaft when sinking assayed 0.75 per cent tin, samples of the vein stone 1.8 per cent."

Two trenches have been cut across the mineralised zone, the first, 100 feet north-west of the shaft and the second 50 feet farther on. At the north-east end of the first trench an underlay shaft has been sunk on a fault which approximates to the strike of the veins. These workings were not accessible for examination at the time of the survey but it is reported that a zone of quartz veins and stringers was exposed over a distance of 20 feet.

Another trench has been cut across the formation approximately 300 feet north-west of the second trench, but beyond this no further prospecting is apparent although the same conditions exist along the line of outcrop for at least 15 chains.

Tin-bearing veins are spread over a fairly wide zone for at least 2,000 feet and although no prospects have been disclosed of sufficient merit to warrant a comprehensive scheme of development the present undeveloped state is due primarily to insufficient prospecting to demonstrate whether the veins are continuous or of sporadic occurrence. This zone fully warrants a comprehensive drilling campaign.

McDonald's Prospect

The workings consist of two shafts, some underhand stopes and shallow trenches and sluiced areas. These workings have been abandoned for several years and cannot be examined because the shaft workings are full of water and the underhand stopes have partially collapsed.

In 1939, a flat make of high grade tin ore, being a metasomatic replacement of a tuffaceous bed, was stoped from a lode formation at the 50 foot level in the shaft workings. The ore was hand picked and dressed for a return of 7.83 tons of tin oxide (5.61 tons metallic tin).

A light two head stamper battery was installed with the intention of testing the lower grade formation by crushing and concentrating but proved abortive.

Johnson's Prospect

Although for over a period of 20 years prospecting operations have been carried on intermittently there are only a few shallow excavations, on a series of parallel tin bearing quartz veins, which strike approximately north 20° east and dip north west, and an adit about 300 feet long. This adit, about 120 feet below the plateau level, has been driven on a bearing of 267° for 304 feet. Several narrow veins were intersected and at 210 feet a short drive ten feet long has been driven north on a fault which strikes 310° and dips north-east. A two inch quartz vein occurs east of the fault; it strikes north 10° west and dips east at 70° .

Egan's Prospect

North-west from mineral lease 10108/M strike veins apparently the southern continuation of the Eastern Hill vein system are exposed in shallow trenches. Little can be seen at the present time. It should be noted that there are several closely spaced parallel veins contained in the main ore channel. Although they are narrow at the surface insufficient prospecting has been done to show whether the occurrence is a sporadic or continuous one.

CONCLUSION AND RECOMMENDATIONS

The study of the Aberfoyle fault system has shown that the No. 1 Aberfoyle fault (main Aberfoyle fault), of the Aberfoyle fault system, occurring in the mine area is one of relatively small magnitude with a displacement of 40 feet at the southern end increasing to over 100 feet at the northern end of the workings.

The fault will intersect the lodes in depth if the observed dips continue, but the displaced lodes will reappear in the footwall with a horizontal shift of less than 20 feet, with duplication of the lode system over a vertical range equal to the throw. There is thus no danger of failing to locate the displaced portion provided the footwall is adequately explored.

The Aberfoyle vein system has been developed only to 600 feet and at that level shows no diminution in average grade. The evidence suggests that a depth of the order of 2,000 feet may be required to reach the granite. However, the roof of this type of batholith is liable to be erratic and hence this prediction could easily be substantially in error. The veins should continue down to the batholith.

Since the early days of the discovery of tin ore in this district, the several veins outcropping have received the attentions of prospectors and the results of their work may be seen in the numerous long trenches, excavations and pits that expose the veins.

Little prospecting work has been undertaken for many years and it is therefore difficult to obtain additional information regarding the extent and mineral content of known prospects. Such excavations as are available for examination are quite small and have never sufficed to reveal the nature and extent of the shoots of ore which were being prospected.

Apparently the veins were not regarded as being very promising owing to their narrowness at outcrops but that reason does not appear to be quite sound in view of the fact that the veins in both the Aberfoyle and Storeys Creek Mines improved in size and mineral content at depth so that there is every encouragement to prospect the various veins at depth.

Three areas exist which offer sufficiently encouraging prospects to warrant prospecting by diamond drill.

(1) The extension northward of the Aberfoyle vein system through the Spartan lease. This area is covered by a thin veneer of Permian beds which is probably less than 20 feet thick throughout.

Northwards it may be found that the ore shoots gradually cut out because the roof of the batholith probably plunges in this direction and although the tin wolfram mineralisation has considerable vertical range its upper limit must eventually be reached and this will plunge down in conformity with the granite.

So far as the Aberfoyle mineralised zone has been observed in the area its trend is approximately meridional. In view of the trend of other mineralised zones in the district, a swing in trend towards the north-west is not unlikely and should be watched for in the course of the diamond drilling.

(2) The extension southward of the Aberfoyle vein system towards Archer Creek. This area is also entirely under cover of the Permian beds which however are probably everywhere less than 100 feet thick.

(3) Lutwyche's prospects: Numerous small prospecting adits, shafts and trenches have been put down in this area. These, however, do not adequately test this zone. Evidence of mineralisation exists over a strike distance of 30 chains. Since this zone is further from the nearest granite outcrop it may represent the upper limit of an important mineralised belt, and in view of the fact that both the Aberfoyle and Storeys Creek vein system improved in depth, a thorough investigation of this zone by fairly deep diamond drilling is warranted.

Q.J. Henderson,
FIELD GEOLOGIST.

Hobart.

June, 1946.

LOCALITY INDEX

<u>Name</u>	<u>Quadrangle</u>	<u>Latitude</u> <u>S.</u>	<u>Longitude</u> <u>E.</u>
Aberfoyle Tin N.L.	Ben Lomond 48.	41°51'	147°46'
Aberfoyle Rivt.	Ben Lomond 48.	41°43'	147°43'
Archer Ck.	Ben Lomond 48.	41°51'	147°46'
Avoca	Snow Hill 55	41°47'	147°43'
Bedelph Workings	Ben Lomond 48.	41°53'	147°46'
Ben Lomond Mt.	Ben Lomond 48.	41°37'	147°41'
Brandon's Shaft. (Aberfoyle)	Ben Lomond 48.	41°51'	147°46'
Brookstead Estate	Snow Hill 55.	41°48'	147°53'
Burn's Marsh	Ben Lomond 48.	41°51'	146°45'
Campbell Town	Lake River 54.	41°54'	147°30'
Conara	Lake River 54.	41°50'	147°26'
Dalrymple Prospect		o	o
Dundas	Zeehan 50.	41°53'	145°28'
Eastern Ck.	St. Helens 41.	41°26'	148°13'
Eastern Hill	Ben Lomond 48.	41°50'	147°45'
Egan's Prospect	Ben Lomond 48.	41°42'	147°40'
Fern Tree	Hobart 82.	42°55'	147°15'
Fingal	Ben Lomond 48.	41°38'	147°59'
Goodall's Prospect	Ben Lomond 48.	41°50'	147°45'
Ivanhoe Mine	Ben Lomond 48.	41°53'	147°45'
Johnson's Prospect	Ben Lomond 48.	41°50'	147°46'
Lindisfarne	Hobart 82.	40°50'	147°22'
Lutwyche's Prospect	Ben Lomond	41°50'	147°46'
McDonald's Mine	Ben Lomond 48.	41°51'	147°45'
Mangana	Ben Lomond 48.	41°36'	147°53'
Mara Siding	Ringarooma 32.	41°9'	147°48'
Mathinna	Alberton 40.	41°20'	147°52'
Mt. Rex Mine	Ben Lomond 48.	41°43'	148°10'
Risdon	Hobart 82.	42°50'	147°22'
Roy Hill Tin Mine	Snow Hill 55.	41°50'	147°50'
Searles Workings	Ben Lomond 48.	41°51'	147°46'

<u>Name</u>	<u>Quadrangle</u>	<u>Latitude</u> <u>S</u>	<u>Longitude</u> <u>E</u>
South Prospect. (Aberfoyle)	Ben Lomond 48	41°51'	147°46'
Spier's Shaft (Aberfoyle)	Ben Lomond 48	41°51'	147°46'
Storeys Creek	Ben Lomond 48	41°37'	147°43'
St. Marys	St. Marys 49	41°17'	148°12'
Spartan Lease	Ben Lomond 48	41°51'	147°46'
St. Pauls Riv.	Snow Hill, Bicheno 56	41°49'	148°
Tasmania Ck.	Ben Lomond 48	41°52'	147°45'
Tiger Creek	Ben Lomond 48	41°52'	147°45'
Warrentinna, gold field	Ringarooma 32	41° 6'	147°43'