Tasmania

DEPARTMENT OF MINES

GEOLOGICAL SURVEY MINERAL RESOURCES

No. 1

Tungsten and Molybdenum

Part I.

NORTH-EASTERN AND EASTERN TASMANIA

BY

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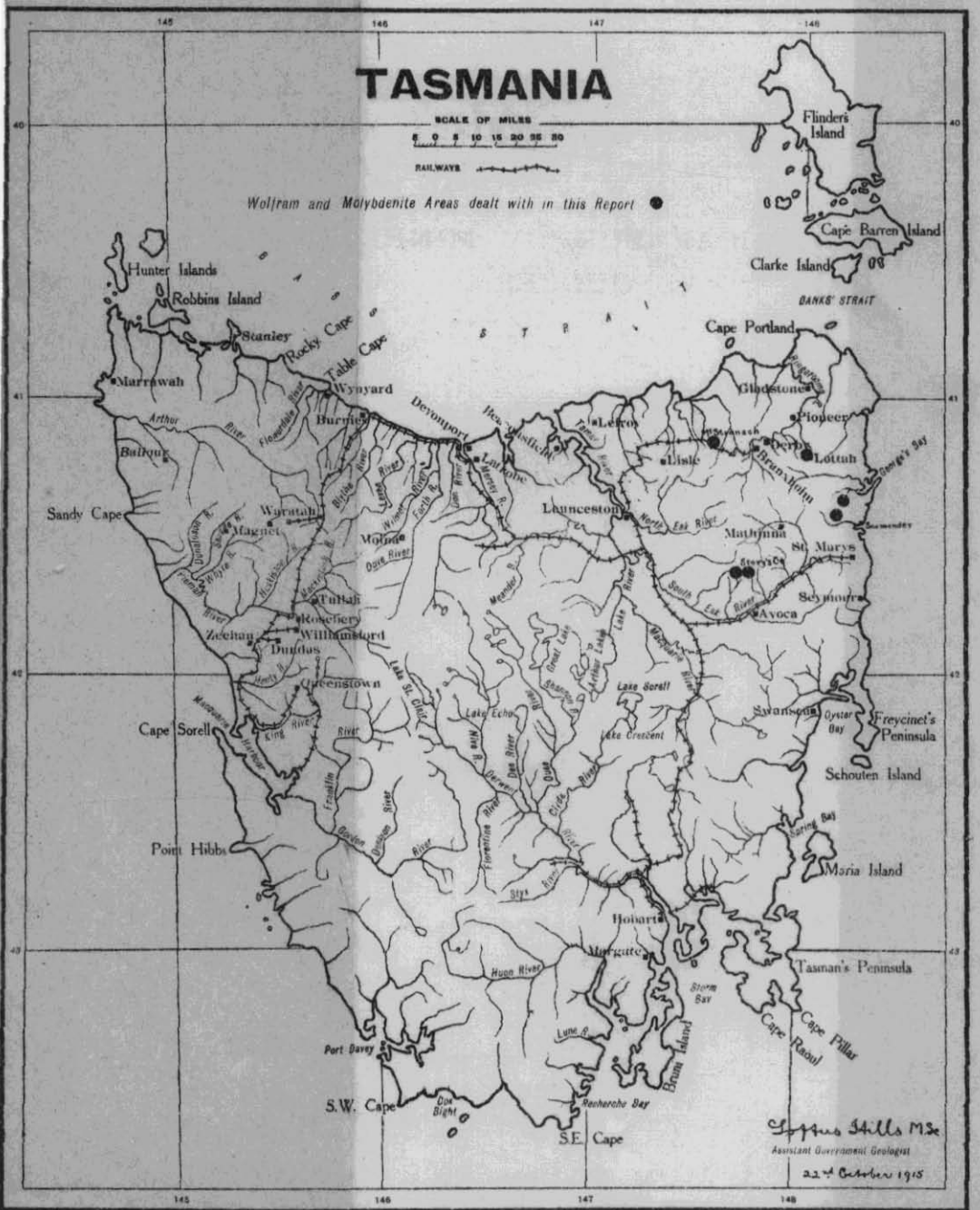

LOCALITY MAP

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Part I.

NORTH-EASTERN AND EASTERN TASMANIA.

I.—INTRODUCTION.

THE circumstances under which the investigations described in this report have been undertaken are exceptional, and therefore the examinations and the character of the publication both differ from the ordinary work of the Geological Survey. The great demand for the steel-hardening metals, tungsten and molybdenum, brought about by the great European war, increased the price of the minerals wolfram, scheelite, and molybdenite, until the Imperial Government commandeered the whole output, and fixed the purchase-price. That price is high enough to warrant attention being paid to deposits which were previously unprofitable, and much activity in prospecting has resulted; but the extreme necessity of obtaining greater supplies of these minerals has become so apparent that it was suggested by the Northern Tasmanian Science Sub-committee of the State Munitions Committee that the Geological Survey should investigate the resources of the State in regard to these metals, with the object of determining whether the output could be increased.

Accordingly, the writer was instructed to visit the localities in the north-eastern portion of Tasmania known to contain deposits of these minerals. The results of such examinations are here presented in concise form. No attempt has been made to supply complete geological data, the object being to indicate quite clearly whether the occurrences are such as to warrant further prospecting, or, in the case of the mines already working, whether the output could be increased, and how. These descriptions and recommendations are preceded by a short account of the properties of the two minerals, wolfram and molydenite,

and their genesis and mode of occurrence, and the conditions under which they may be expected to occur are clearly indicated. In addition, a chapter is inserted describing the methods of concentrating such wolfram and molybdenite ores as occur in the district dealt with in this publication.

It has been decided to publish this report as the first of a new series of Geological Survey publications, to be termed "Mineral Resources." Each publication will deal with specific minerals or metals. In the case of the two metals, tungsten and molybdenum, which are treated of under the one head, it has been deemed desirable, in view of the urgency of the matter, to issue the publication dealing with them in several parts, as the investigations are completed in the various districts. Accordingly, this volume is Part I. of the "Tungsten and Molybdenum" portion of the "Mineral Resources" series of Geological Survey publications.

The writer wishes to record his appreciation of assistance of various kinds rendered by the following gentlemen during his field examinations:—Hon. A. W. Loone, Mr. H. Harvey, and Mr. T. Tucker, of Scottsdale; Mr. Simon Bakhap, at Lottah; Mr. W. A. Rattray and Mr. M. Hartnett, at St. Helens; Mr. Chas. Cheshire, at Scamander; Mr. S. J. Dunn, at Gipps Creek; Mr. J. Miller and Mr. D. MacLeod, at Story's Creek.

II.—GENERAL CHARACTER, GENESIS, AND MODE OF OCCURRENCE OF WOLFRAM AND MOLYBDENITE.

(1)—Physical and Chemical Characters.

(*a*) *Wolfram.*—Wolframite is a black, lustrous, opaque mineral, having a reddish-brown streak. Its habit is massive, sometimes, however, assuming a bladed radiating structure. A marked characteristic is the perfect cleavage in one direction, by which the mineral is broken into flat plates. Wolframite is brittle, while the hardness is about 5½. This accounts for the readiness with which wolfram is reduced to slime by crushing, a property which is of great importance in its concentration from accompanying gangue. The specific gravity averages about 7·3, which is approximately that of cassiterite or tin oxide. This fact is also of great significance in connection with concentration. Both of these two facts will be fully discussed in Chapter IV. of this report, together with the important fact that all wolfram is slightly paramagnetic.

Wolfram is a tungstate of iron and manganese represented by the formula $(Fe.Mn)WO_4$. It is an isomorphous mixture of the mineral hübnerite $MnWO_4$ and ferberite $FeWO_4$, both of which are known to occur as mineral species, but the whole of the occurrences dealt with in this report are the isomorphous mixture of the two, known as wolframite, or in its abbreviated form wolfram.

Wolfram is sold on the basis of its content of tungstic acid WO_3, the theoretical maximum being 76·5 per cent. The market quotations are on the basis of shillings per unit of WO_3. The assay results of wolfram concentrates are always given in terms of tungstic acid WO_3. The price per ton is, therefore, the WO_3 percentage multiplied by the quotation per unit. Thus, the price fixed by the Imperial Government at the present time for wolfram is 55s. per unit for a concentrate assaying not less than 65 per cent. WO_3. A ton of concentrates assaying 67 per cent. WO_3 would, therefore, be worth in London—

55s. × 67 = £184 5s. per ton.

A concentrate assaying 73 per cent. would be valued in London at—

55s. × 73 = £200 15s. per ton.

(*b*) *Molybdenite.*—This mineral is silver-white to lead-grey in colour, and possesses a marked metallic lustre. It occurs in foliæ (leaves), scales, and also in a granular form. The foliæ are often flat, tabular, hexagonal crystals. Molybdenite possesses a marked basal cleavage, the thin laminæ being very flexible, but not elastic. This mineral closely resembles graphite in its appearance, but the two minerals can be easily distinguished from each other by reason of the fact that molydenite when rubbed on porcelain leaves a greyish-green streak, and also by its chemical reactions for sulphur and molybdic acid.

Molybdenite has a greasy feel; it is sectile, and partially malleable. The result is that it is difficult to crush to a fine powder, although the hardness is only between 1 and 1·5, the mineral flattening out into flat plates which have a tendency to float upon water in spite of the fact that the specific gravity is 4·8. This will be further referred to in Chapter IV.

Molybdenite resists weathering to a marked degree being quite bright, while the enclosing rocks show much decomposition. At times, however, it alters on the surface to a yellow powder called molybdic ochre, which is the oxide of molybdenum.

Molybdenite is the sulphide of molybdenum MoS_2. It is sold as a concentrate, which must not contain less than 90 per cent. of molybdenum sulphide. The basis of sale is the content of MoS_2, which is regarded as the unit. The market quotations are in terms of shillings per unit of MoS_2. Thus, a concentrate assaying 91 per cent. MoS_2, at the purchase price fixed by the Imperial Government, is—

105s. × 91 = £477 15s. per ton;

and a concentrate which assays 97 per cent. MoS_2 is worth in London—

105s. × 97 = £509 5s. per ton.

(2) Genesis.

The two minerals, wolfram and molybdenite, are intimately associated as regards their genesis or mode of origin, and, therefore, the factors governing their deposition will be most appropriately described under the one head. No detailed description is attempted, the leading points being very concisely indicated.

The three minerals, cassiterite, wolfram, and molybdenite, are genetically connected wherever they occur in any

part of the world with granitic intrusions. That genetic association consists in the origin of both the granite and the three minerals mentioned above, along with their associated gangue minerals, from an igneous magma, which originally contained the component materials of them all. That magma, after being injected into a series of sedimentary rocks, began to cool, and a process of progressive differentiation was set up. That differentiation consisted in the segregation of the metallic portion containing the tin, tungsten, and molybdenum, together with non-metallic elements such as silicon, boron, fluorine, sulphur, &c., towards the centre of the massif. The remainder of the igneous material solidified as the granite rock, which, cooling and contracting along with the surrounding sedimentaries, ultimately provided passages for the escape of the enclosed metalliferous differentiate. In their passage along these open fractures in the granite and the surrounding sedimentary rocks, these metalliferous gases were subjected to a gradual decrease in temperature and pressure, becoming quickly condensed to liquid solutions, still, however, under high temperature and pressure. The constituents of these gases and solutions were deposited as the decrease in temperature and pressure gave rise to conditions suitable for their crystallisation. The first minerals to crystallise from the gaseous emanations were cassiterite, bismuthinite, wolframite, and molybdenite, together with the gangue minerals quartz, fluorite, tourmaline, &c. This part of the deposition of minerals from the magmatic emanations is known as the pneumatolytic phase. The lodes resulting from pneumatolytic processes are therefore confined to the outer margins of the granite massif and the immediately surrounding area of sedimentary rocks, and are characterised by the presence of the minerals cassiterite, bismuthinite, wolfram, and molybdenite, and the gangue minerals quartz and tourmaline.

It is thus seen that the geologic conditions under which wolfram and molybdenite occur are identical with those of cassiterite. In some cases, however, it has been demonstrated that wolfram in certain quartz lodes has been deposited from hot solutions, and not from gases. Thus, in Boulder Co., Colorado, U.S.A., the quartz lodes contain wolframite with no tin, in such positions relative to their original igneous source that the conclusion has been arrived at that they have been deposited from solutions in the deeper portion of the deep vein zone. In any

case, however, wolfram is never found far beyond the pneumatolytic zone.

The mineral molybdenite also has been reported from ore-formations in all zones successively to near the surface, but the fact still remains that the important molybdenite deposits are confined to the pneumatolytic, pegmatitic, or contact-metamorphic zones.

(3) Mode of Occurrence.

From what has now been described, it is obvious that tungsten and molybdenum ores will be found under, approximately, the same conditions as tin. Wolfram and molybdenite may therefore be looked for in granite country, and in the surrounding metamorphic aureole.

In regard to the form of the deposit which carries the minerals, it may be stated that many widely different forms are known. Perhaps the most usual is that of quartz veins in both the granite and the surrounding rocks filling the fractures along which the mineralising gases escaped. These quartz veins often persist for considerable distances, 1000 feet being quite usual, while occasionally much greater lengths are observed, as, for instance, 34 chains at Story's Creek, in the Ben Lomond district of this State. The width of the quartz lodes is not very great, the average being from 1 to 2 feet. The constituent minerals are wolframite, cassiterite, pyrite, bismuthinite, and molybdenite, in a gangue of quartz, sometimes with the additions of tourmaline, fluorite, &c. The several minerals occur as independent crystals or masses in the quartz, intimate intergrowth of any two of the minerals being almost unknown, although they may occur in contact. When one of these veins is followed along its strike, it is sometimes found that a preponderance of cassiterite occurring at one locality gives place to an excess of wolfram at another. The occurrence of the wolfram in patches and bunches is characteristic of this type of deposit, so much so that in many cases the exploitation of wolfram-bearing lodes has been discontinued under the belief that the cessation of one patch of wolfram represented the complete disappearance of the wolfram values of the lode. Cases have been known in which a few feet more driving along the lode after such abandonment revealed bunches of solid wolfram. It must be borne in mind by those exploiting wolfram lodes that this bunchy and patchy occurrence is

wholly characteristic, and that the secret of keeping up a continuous output of wolfram from such lodes is to keep sufficient stoping length of the lodes in work. So also in prospecting, there is no justification for discouragement when a patch of wolfram peters out, for search should be made along the lode for a recurrence of an ore-shoot. It must be noted that this alternation of rich patches and barren zones is characteristic along the dip, as well as along the strike.

Another type of deposit is that of pegmatite veins or dykes, which consist of coarse aggregates of quartz and felspar, carrying the metallic minerals in blebs and patches, each mineral species generally occurring in separate crystalline aggregates. This class of vein or dyke is, in reality, a variant of the quartz lode, and possesses the same general characteristics in regard to the distribution of the metallic minerals. The pegmatite dykes are rock differentiates from the original magma, carrying a concentration of the metallic components, and therefore are related to the quartz-porphyry dykes, which themselves carry tin in the form of cassiterite, and occasionally wolfram.

A third form in which these deposits occur is that of "pipes" of siliceous material, which do not occupy any well-defined fissures. These siliceous ore-bearing bodies have been followed down from small outcrops as irregular pipes of ore. These pipes of siliceous material are surrounded on all sides by granite, the whole of the lode being taken out in the width of an ordinary shaft. There is no sign of any fissure along which the mineral-bearing solutions might have been introduced, or which might be followed in the anticipation of striking other bodies of ore. The minerals molybdenite and wolfram occur in these pipes as bunches and patches, and, being very coarse-grained, are usually picked by hand after knapping. Such are the molybdenite and bismuth bearing pipes at Kingsgate, near Glen Innes, New South Wales, and the wolfram and molybdenite pipes at Wolfram Camp, Queensland.

Finally, it remains to mention a rather exceptional occurrence of molybdenite in normal biotite granite as an original constituent, crystallising from the magma along with the quartz felspar and mica of the normal granite. The molybdenite in this case occurs as small patches in the granite, intergrown with the other components, and very sparsely scattered throughout the granite mass. Such is

the mode of occurrence on the greater part of the western slopes of Mt. Stronach, near Scottsdale, in this State. It does not seem as if this class of occurrence is of any economic importance, the molybdenite being scattered throughout too large an amount of rock.

Having now briefly indicated the general modes of occurrence of wolfram and molybdenite, the particular occurrences in north-eastern and eastern Tasmania examined during this investigation will be separately described.

III.—OCCURRENCES OF WOLFRAM AND MOLYBDENITE IN NORTH-EASTERN AND EASTERN TASMANIA.

(1) Molybdenite at Mt. Stronach.

Mt. Stronach is situated about 3 miles east of the Scottsdale railway-station. It is reached by means of the main-road, from which a branch road leads to the foot of the mountain at 1½ mile from the township. A foot track is available to the summit of the mountain.

The whole of the mountain is composed of varying facies of Devonian granite. The occurrences of molybdenite are situated on the higher parts of the mountain and the western fall, no molybdenite having been observed on the eastern side.

There is only one mineral section held for molybdenite in this district, and that is a reward section granted to G. L. Meredith, numbered 6948-M, with an area of 37 acres. It is situated on the western fall of the mountain, in the vicinity of the track leading to the summit. The only work done has consisted of a few shots put on a rather steep, smooth face of granite showing occasional splashes of molybdenite. These splashes vary in size from mere specks to masses a little more than half-an-inch in diameter. It is observed that wherever the molybdenite occurs in the granite at this point it has a reddish tinge, although both the rock carrying the molybdenite and that free from it are normal biotite granites. The molybdenite occurs as a primary constituent of the rock, no sign of any variation in the rock accompanying the appearance of the molybdenite. Its occurrence in the rock is identical with that of the mica, with which at times it is confused. One sample collected from the locality shows quite clearly an intergrowth of felspar and molybdenite. There occur in this vicinity small irregular veins of pegmatite, but these do not seem to carry appreciable molybdenite, only one sample found by the writer showing that mineral. However, so little work has been done that no definite opinion on the matter can be expressed, for it is in these veins that workable deposits of molybdenite may be found. To indicate the approximate contents of molybdenite in the granite on this section as visible on the surface, an area

of 9 square feet, which showed the most plentiful molybdenite, was found to carry not more than 1 square inch of that mineral. That is equivalent to, approximately, 0·09 per cent. MoS_2, which represents a gross value of about 9s. per ton, a value which is obviously unpayable.

Further up the mountain, a little to the west of the track, and on Crown land, occurs a well-defined pegmatite dyke, showing large felspar and mica crystals. This is known locally as "The Blow." Molybdenite occurs here, not in the pegmatite, but in the granite surrounding it. A few shots put in show the mineral to be well disseminated, but again nothing approaching a payable deposit can be seen. It is remarkable that the pegmatite contains no molybdenite, but it seems as if in this case also the latter is an original constituent of the biotite granite, and is not connected with the subsequent intrusion of the pegmatite.

On the summit of the mountain there is an area of about 5 acres, which carries splashes of molybdenite, some of appreciable size, up to about ¾-inch, but there is no one spot where the general average is exceeded. The percentage would be somewhat less than that described on G. L. Meredith's Reward Section. Here, again, it is an original constituent of the granite, and no definite concentration of it exists.

Going southwards round the mountain from G. L. Meredith's section, the bare cliff-like face of granite is found to be continuous, and splashes of molydenite occur constantly, but in no place more than that on the section described. It may, therefore, be regarded as unpayable, and not warranting further attention.

On the western slope of the mountain immediately west of the pinnacle, on a vacant block of land 69a. 2r. 39p. in area situated north of the rifle range, is what is known as Harvey's show. At this point some work has been done under a prospecting licence, but no mineral area has been taken up to include the locality. There occurred at this point an outcrop, showing a few splashes of molybdenite. A few shots put in disclosed siliceous granite carrying chalcopyrite, pyrite, and molybdenite, the latter occurring in a prominent seam 1 inch to 2 inches wide in the centre of the formation. This was sunk on for about 10 feet, which showed the siliceous and pyritic formation to be widening, with no walls showing, the molybdenite seam still persisting. In the south side of the cut there can now be seen two well-defined vertical "heads" or fractures in normal granite, striking N. 30° W., 4 feet apar

The granite for a few inches on either side of these fractures shows some alteration, indicating clearly that they have been passages for solutions. The surrounding rock is the normal granite. There has not been sufficient work done to clearly show what the formation is, but it looks as if there exists at this point a pipe-like mass of siliceous material consisting of quartz and felspar, of undetermined dimensions, carrying appreciable values in molybdenite, copper, and silver. Samples submitted to the Government Assayer at the time the deposit was opened up gave the following results:—

	Copper. per cent.	Silver. oz.	Gold
Sample No. 1	4·1	6·5	Trace
Sample No. 2	3·3	6·0	Trace

These figures cannot be taken, of course, to represent the value of the deposit as a whole, but there is no doubt that the values in molybdenite alone are sufficient to warrant further work being done. The copper and silver values will be additional to the molybdenite, but their presence entails additional metallurgical treatment, which, however, as will be shown in Chapter IV., cannot be regarded as insuperable.

Finally, therefore, in connection with the occurrences of molybdenite on Mt. Stronach, it may be stated that with the exception of one occurrence, there is no deposit which would justify further attention, and although there is a considerable amount of molybdenite scattered over the western slopes of the mountain, yet the obtaining of the whole of it would involve the removal of most of the mountain, an obviously unprofitable undertaking. The one exception referred to is Harvey's show, which decidedly warrants further attention, and the writer would recommend that it be opened up by approaching it from lower down the slope. The extent and exact character of the formation will thus be seen, and the value determined sufficiently closely to decide the future policy. It is certainly the only occurrence on the mountain which warrants present attention.

(2) Molybdenite and Wolfram in the Vicinity of Lottah.

It is known that several splashes of molybdenite occurred in quartz and pegmatite veins encountered while driving the old Lottah Mine tunnel, situated above the Lottah

township, near the road to Poimena. That tunnel, however, is inaccessible, having fallen in some distance from the approach, but specimens gathered on the tip show the occurrences to have been very sporadic. No more can be said concerning this occurrence

North of the Lottah Mine there are reported to occur occasional splashes of molybdenite, but no definite formations have been observed, and no work done.

At the old Liberator Mine, 3 miles to the west of Lottah, splashes of molybdenite occur in tin-bearing porphyry exposed in the open cuts. Some large splashes occur up to 1 inch in size, but these are very few in number, small disseminations being the characteristic. The molybdenite at this locality invariably occurs associated with quartz in small stringers or blebs, but there is no definite formation of any size which could be worked as a source of molybdenite. The Liberator cannot be regarded as a potential source of molybdenite.

On the Liberator section, now held by Mr. Simon Bakhap, on the opposite side of the road to the open-cut, there occurs a lode-formation about 15 feet wide carrying several inches of ore containing both wolfram and cassiterite. This has only been surface-stripped for a few chains but not enough to disclose the nature of the deposit or its value. Sufficient can be seen, however, to warrant the conclusion that justification for further work on this formation exists. It looks as if the presence of wolfram with the tin acted as a deterrent when the deposit was first investigated, but the admixture of the two minerals in a concentrate presents no difficulty at the present time, as will be seen in Chapter IV. As a mixed tin and wolfram proposition, this occurrence ought to be looked into.

(3) Wolfram and Molybdenite at Constable's Creek and Upper Scamander.

There exists an area lying in the hinterland of Scamander and St. Helens, about 6 miles from the coast, characterised by the occurrence of lodes carrying wolfram and molybdenite. The country-rock consists of slates and quartzites of Pre-Silurian age, but to the west occurs Devonian granite. Nearer the granite contact, the sedimentary rocks have been converted into quartz mica schists, and it is in the contact-metamorphic aureole and the granite itself that the lodes to be now described are found.

All these lodes on which any work has been done are confined to the sedimentary rocks. This wolfram-molybdenite belt or zone is about 4 miles long in a north-south direction; the width is undetermined, but is certainly greater than 1 mile at the southern end of the belt, although it appears to be narrower at the northern end.

The belt we are now discussing constitutes part of the tin-tungsten zone described by Mr. W. H. Twelvetrees, Government Geologist, in his bulletin on the Scamander Mineral District (Geological Survey Bulletin No. 9). They are genetically connected with the Devonian granite lying to the west, and represent the pneumatolytic phase of the mineralisation which has given rise to the copper and silver deposits further east. Mr. Twelvetrees has described the occurrences on the Upper Scamander, but he did not visit the northern extension of the belt. The reader is referred to the publication quoted above for general geological details.

The northern end of the belt is best reached from St. Helens, for a good road is available to within 2 miles, whence the northernmost occurrence can be reached by means of a foot-track. The northernmost series of outcrops occur on an old 40-acre section numbered 4189-M, and shown on the Scamander mineral chart, which has recently been taken up by H. T. Roach and M. Hartnett as Section 7204-M. The country-rock on this section is a micaceous quartzite, representing the contact-metamorphic facies of the slates and sandstones, being not very far from the granite-contact. The strike of the quartzites is, approximately, north-west, south-east. The lodes strike nearly due north and south, and are almost vertical. They consist of quartz, with blebs and patches of wolfram and molybdenite, with some arsenopyrite. The width varies from about 1 foot upwards, one bulge 6 feet wide having been disclosed. The average width, as far as present work has shown, is, perhaps, 1 foot 6 inches to 2 feet, but so little work has been done that no definite figure can be given. What work has been done consists of a few shots and pot-holes at isolated points, and a little trenching. In one place a small open cut on the 6-feet bulge of lode referred to gave half a ton of wolfram, by hand-picking. This constitutes the total output from this section.

An examination of the exposed portions of the lodes, of which there appear to be at least two parallel to each other, shows that the values of wolfram and molybdenite are

persistent and appreciable. Particularly is the percentage of molybdenite noteworthy. No figures of percentages can be given, but from the amount of the two minerals visible the lodes could be mined, and the minerals concentrated at a profit if a sufficient length of lode is found to exist. Not only is the molybdenite present in the quartz lode-filling, but it occurs also in the quartzitic wall-rock adjacent to the lode. The wolfram does not appear to occur under the same conditions, but is confined to the quartz-filling, and is often intimately associated with the molybdenite.

There is a very steep fall from the outcrops southwards and westwards to Constable's Creek, amounting to about 200 feet from the uppermost outcrop. An adit driven northwards from Constable's Creek would be vertically 200 feet below the outcrops, with between 300 and 400 feet of driving. This would be along the course of the lodes, and crosscutting would be necessary.

Finally, in regard to this section the writer would express the opinion that it deserves and warrants the expenditure of capital. It has a good prospect (if the lodes are at all persistent in length) of developing into a payable wolfram and molybdenite proposition.

The other sections in this belt on which any work has been done are situated in the Upper Scamander district, the country intervening between these and Hartnett's section being unprospected. These sections can at present be reached from the Upper Scamander Ford, which is in communication with Scamander Bridge (Yarmouth) by means of a good road, by a foot-track some 4 miles in length, which, however, is of rather a steep grade. There are six sections held in this locality for wolfram and molybdenite at the present time, five being in the name of D. MacLeod, and one in the names of Greaves and Rubenach. These sections have been previously described in two official reports—one by Mr. G. A. Waller (then Assistant Government Geologist), dated 4th June, 1901; and the other by Mr. W. H. Twelvetrees (Government Geologist), in Geological Survey Bulletin No. 9, dated 18th October, 1910.

The country-rock on these sections consists of slates and quartzites, striking north-west and south-east, but there are less signs of contact-metamorphism than on Hartnett's show, the granite being further away to the west.

On Section 7176-M (D. MacLeod) there are numerous small veins of quartz carrying wolfram on a steep northerly

slope of a spur running westwards from the West Pinnacle. These veins coincide in strike with the bedding-planes of the slates, and seem to have been formed along them. They have been opened up by several small open-cuts, which have served to indicate that the veins are rather small and inconstant. In one lode, about 1 foot wide, with several parallel veins, there occurs associated with the wolfram several splashes of molybdenite. Not enough work has been done at this point however, to show the true character of the lode. It would be as well to drive a short distance along the course of the lode to determine its size and the molybdenite content. With the exception of a quartz lode about 9 inches wide and striking north-east to south-west seen in the creek at the foot of this slope, and which carries a few splashes of molybdenite, no other lode observed in this locality is known to contain that mineral. The most promising lode on this section, however, is one recently disclosed by Mr. C. Cheshire, which carries good wolfram values. It is 5 feet wide where exposed, and seems to be a more defined lode than any others visible in the immediate neighbourhood It is situated a few feet west of the wolfram-molybdenite veins referred to above. It is worth further attention.

On Section 7177-M (D. MacLeod), situated to the north of the previous section on the hill to the north of the creek referred to above, there occur a number of quartz lodes carrying wolfram. On the southern slope of this hill is a promising-looking lode. The strike is north-east to south-west, and the fracture thus cuts across the country, in contrast to the veins on the lastmentioned section. The lode is nearly vertical, with a slight inclination towards the west. It has been trenched along its strike for about 40 feet, which shows a well-defined lode averaging about 18 inches with one bulge up to 3 feet. The quartz shows nice bunches of coarse wolfram occurring in the patchy manner so characteristic of that mineral. Excellent facilities for driving an adit to cut this lode exist, up to 200 feet of backs being obtainable. This lode is worth attention, as the metallic contents visible are certainly payable.

On the summit and northern slopes of this hill, still within Section 7177-M, are the old workings of the Carson De Beers Wolfram Mining Company, described by Mr. G. A. Waller in the report above referred to. Several wolfram-bearing lodes were more or less opened up by this

Company, but operations ceased for two reasons—firstly, the price of wolfram was so low at the time (1900) that the values disclosed would be unprofitable; and secondly, owing to the directors becoming disheartened because several rich patches of wolfram did not continue, an expectation which, in view of the characteristics of wolfram lodes, was quite unjustifiable. Therefore, the reasons which were responsible for the cessation of operations 15 years ago do not apply at the present day.

On the 80-acres section held by D. MacLeod, numbered 7181-M, and which lies to the west of the two preceding sections, there occur two lodes about 5 chains apart. These are on the eastern slope of a third hill, and good facilities for adit-driving therefore exist. The eastern lode is only 6 inches wide, but the other is larger, and of more importance. It is about 1 foot in width, and has been opened up, and underhand stoped down to 15 feet for a length of 60 feet, and ½ ton of wolfram taken out, which was obtained by hand-picking. The lode is well defined, and is certainly worth further attention.

The writer wishes to definitely remove a misconception which seems to exist in regard to the wolfram occurring in this field. It has been stated that the wolfram is very low in tungstic acid. This is absolutely wrong, as the picked wolfram from this field is as high as that from any other field in the Commonwealth. Wolfram is wolfram wherever it occurs, and the percentage of WO_3 in clean samples will vary by only a few units.

Finally, in regard to this wolfram-molybdenite belt, it may be stated that work in the directions indicated above is quite justified under present conditions, and prospecting for other lodes between Hartnett's show and the Upper Scamander, and also west of the latter, should be at once undertaken. The discoveries already made are certainly not the only lodes existing in the belt.

(4) Wolfram at Gipp's Creek.

Gipp's Creek is situated in the Ben Lomond district, lying in the southern footwalls of that mountain. It is reached by road from Avoca, from which it is distant about 15 miles. The road is in good order, except in one or two places, where the failure to provide proper table-drains has caused several wash-outs. The grade is, on the whole, steep, but in no way excessive.

Mining has been carried out in this district for many years, but always in a small and rather primitive fashion. It was reported on by Mr. A. Montgomery, at that time Government Geologist, in May, 1892, and again by Mr. G. A. Waller in June, 1901. In both of these reports the occurrences of wolfram were regarded as quite subordinate to the tin. The present position, however, is that the wolfram is the more important mineral in the district.

The country-rock is granite, through which run quartz lodes and greisenised bands carrying the minerals wolfram and cassiterite. The length over which these lodes extend is, approximately, 1 mile, and they have been more or less worked for, practically, the whole of this distance.

On the northern end of the belt, on a section now worked by Mr. S. J. Dunn, a considerable amount of alluvial ground has been worked, which carries mixed tin and wolfram, the former predominating. Some of this alluvial still remains to be worked, and to this Mr. Dunn is devoting his attention. On the eastern side of this section, however, there occur two parallel quartz lodes about 8 chains apart, striking a little west of north and dipping to the east at about 45°. The lode on the east is just out of S. J. Dunn's section, and averages about 9 inches in width, carrying nice tin values, with occasional bunches of wolfram. The other lode is within Dunn's section, and is about 4 inches wide, but splits into stringers.

These two lodes can be traced southwards into ground held by parties of working miners, and another lode lying to the east of them makes its appearance. These three parallel lodes in this locality carry predominant wolfram with only a little tin and, together with three additional parallel lodes lying nearer Gipp's Creek to the west, have all been worked from the surface in very crude fashion to varying depths reaching a maximum of 40 feet, but averaging not more than 15 feet. Work in this primitive fashion, which mainly consists of underhand stoping until the water becomes too plentiful, is still continuing, but it seems as if this method of hand-to-mouth work is nearing its natural end, and something more systematic will soon be needed to allow operations to be continued. The width of the lodes varies greatly, the average being in the neighbourhood of 1 foot. The wolfram values are patchy as usual, but the persistent length of the lodes is the saving feature from the systematic mining point of view, the

centre lode of the first group of three having been traced practically continuously for nearly 40 chains.

Traced southwards these lodes seem to peter out as they approach the steep fall to the eastern bend of Gipp's Creek. On the south bank of the creek at this locality occur the workings of the old Tungsten Mining Company, which were abandoned by that Company as unpayable, but which were taken up by Mr. T. Briggs and worked with very profitable results until his death about 12 months ago. The property is now being worked by tribute. There is one lode at this point which is of the same nature as those already referred to, and in granite country, but the pronounced characteristic is the remarkable flat dip to the east. That dip measures from 10° to 15°, but in some places is quite horizontal. The average width is about 18 inches, and the wolfram values distributed in patches. It was mainly because a zone barren of wolfram was reached that the old company ceased operations. The fallacy of concluding that the wolfram values had completely disappeared has been abundantly demonstrated by subsequent work. At present a short adit is being driven a few feet above the creek-level to cut the lode on the dip which will give a few feet of backs. The lode should be followed southwards from the stoped ground above this level, as in several places work was stopped when barren patches were met with going south. This will open up more ground to be stoped above creek level, below which sinking will have to be resorted to.

There is practically no tin in the old Tungsten Company's lode, and it is a noteworthy fact that the amount of wolfram present in lodes in this belt increases progressively in relation to the tin contents from north (where tin is the main constituent) to south (where wolfram is the predominating mineral).

In regard to the lodes northwards of the Tungsten workings, an adit can be driven northwards from Gipp's Creek, near the tungsten workings, along the course of the lodes, by which means up to 150 feet of backs can be obtained. The lodes can be penetrated by crosscutting from the main drive. The time has come for the exploitation of these wolfram deposits on systematic lines, and it is by such means of attack, combined with efficient treatment methods, that an output commensurate with the size of the deposits can be obtained.

(5) Wolfram at Story's Creek.

Story's Creek lies to the north-east of Gipp's Creek, being distant therefrom about 5 miles. It is reached by road from Avoca, the first 9 miles of which coincides with the Gipp's Creek-road. From the turn-off to Story's Creek (7 miles) the road, although of good grade, is in very poor order, there being many boggy patches. A few tons of metal would convert it into a good road. If machinery is to be carted over this road to Story's Creek, such attention is absolutely essential.

It may be at once stated that this district is decidedly the most important wolfram producer in north-eastern Tasmania.

The country-rock consists of dark slates and quartzites striking north-west to south-east, and dipping to the west at from 70° to 80°.

The mining properties are situated on the western side of Story's Creek, the southern continuation of certain of the lodes, however, crossing the creek. The whole of the ground is now held in the name of D. MacLeod, with the exception of three sections, aggregating 18 acres in area, held by W. Greaves, R. Byatt, and E. L. Egan, and situated on the south-eastern corner of the mineralised belt.

There are two main lodes, one striking N. 25° W., called the main lode, and the other called the No. 1 lode, striking N. 10° W. Both of these lodes dip to the west, the main lode having a dip of 37°, and the No. 1 a dip of 20°, which varies, however, at different points, being almost horizontal in places. Both lodes are of the same general character, namely, fissure-fillings of quartz carrying wolfram in bunches, blebs and massive aggregates, cassiterite, and some pyrite. There is often, although not always, a seam of "pug" or "flucan" between the quartz and the country-rock. The wolfram and cassiterite occur in completely separate aggregates, no intergrowth of the two minerals being observed. The wolfram occurs sometimes in large patches and bunches, from which cwts., and even tons, of clean ore have been extracted. Specimens weighing nearly 1 cwt. are quite common. The tin appears to be more plentiful on the hanging-wall of the lodes, but is by no means confined thereto. The pyrite also occurs in bunches in the quartz, and there is no intimate association with the other minerals. Both the wolfram and the cassiterite are invariably crystalline,

although complete crystals of the former are very seldom seen.

These lodes were first reported on by Mr. A. Montgomery in 1892, in his report, mentioned under "Gipp's Creek," and again by Mr. G. A. Waller in 1901, but both of these gentlemen regarded the proposition as a tin-mining one, and refer to the wolfram as a contamination, or as an unimportant constituent. Mr. Montgomery refers, for instance, to the lode (No. 1) penetrated by Miers' tunnel as "carrying very little tin, but plentiful wolfram." At that time, also, very little work had been done, and the true size of the lodes was unrevealed.

Since that time parties of working miners have held the ground and made handsome profits in mining for wolfram, or "mixed ore," as the mixed concentrate of tin and wolfram is called. Their work on the surface, mainly consisting of underhand stoping, has served to demonstrate the length of the lodes, with the result that the No. 1 lode is seen to be 34 chains in length, averaging over this length for the depth worked fully 2 feet. This lode is sometimes split into two or more branches, but these unite to form the main lode, and the persistency of both the lode and its values is quite remarkable. Likewise, the main lode has been worked for about 5 chains continuously past where it crosses No. 1 lode, in Section 1571-M, but southwards of this it is split into many quartz leaders, all of which carry wolfram and tin, and most of which have been worked on more or less. It is on a continuation of these quartz lodes that Greaves is now working, on the other side of Story's Creek.

For the last 34 years parties of working miners have owned and worked the lodes in this district until the difficulties which developed as increased depth was attained caused dissension, and the syndicate which now holds the greater part of the district stepped in, and are now initiating that systematic working of the lodes which they fully warrant. The wonder is how such a promising mining proposition has been allowed to be neglected by capitalists.

Since taking charge of operations, the present owners have driven a low-level adit and cut both No. 1 and the main lodes.

No. 1 lode has been driven on for 150 feet. It is split into two veins, aggregating 3 feet, where cut by the adit, but is further split at both ends of the drive. On the surface there were more branches, which came together at this

level, and the dip of the two branches here observable should allow them to unite a few feet deeper. The average width of the No. 1 lode for the 150 feet is 2 feet 6 inches, and shows nice values in wolfram and tin.

There are several cross-faults in this part of the workings, striking nearly east and west, which displaces the lodes a few feet. The fault-line generally carries a foot or more of soft, puggy material, and serves a very useful purpose in crosscutting. One such fault was followed by the low-level adit, and another can be seen at the south end of the south drive on No. 1 lode.

The main lode, where cut, measures 4 feet, and shows high values. It is certainly a nice-looking lode. It has only been driven on for a few feet. When cut it gives a depth corresponding to 150 feet of lode for stoping.

Miers' tunnel, situated on the southern fall to the creek, about 15 chains south of the main adit, and approximately on the same level, has been driven along No. 1 lode, which is here also in two branches, showing good values, and providing a very convenient means of attacking the southern portion of the lode. The crosscut from this tunnel, if continued for a few feet, will emerge a few feet above the level of the tramline, not many yards away from the mill-site.

Stoping is in progress on No. 1 lode, but none has yet been done on the main lode.

The material stoped is at present being treated in a very crude manner by hand, as will be described in the succeeding chapter. Steps are now being taken, however, to provide a suitable concentrating plant. A site has been chosen further down the creek, and a tramway already formed to connect with the low-level adit, below which future mining will have to be carried on by shaft-sinking. A haulage-line from the mill-site to the top of the ridge has been cleared and formed where it is proposed to erect an electro-magnetic separator plant. The capacity of the proposed concentrating mill will be 50 tons of crude ore per 24 hours. The motive power proposed is a suction gas plant, water-power not being available above about five horsepower, although there is sufficient for dressing purposes.

The present output is 5 tons of concentrates per fortnight, the extraction by the crude methods employed varying from 2 to 5 per cent. The concentrates consist of, approximately, equal quantities of wolfram and tin

ore. Since the present owners took charge, the output of mixed tin and wolfram concentrates has been 79 tons. The two minerals present in these concentrates are present in about equal proportions.

The number of men employed is 45, and two shifts are worked. The manager is Mr. J. Miller.

Such is the present position of affairs, and there is no doubt that there are here the elements of a successful mining proposition. The large length of lode available on two distinct lode systems, the average width of nearly 3 feet on both lodes already proved, and the metal contents proved by the extraction obtained by very crude methods, are all very satisfactory indeed. As a matter of fact, the 34 chains proven length of one lode, and the certainly much greater length than 5 chains of the other, taken in conjunction with the very flat dip of both, warrant the entry of two separate companies to exploit them, although most of the ground (330 acres in area) is now controlled by the one syndicate. The writer would certainly recommend, in view of the great need of wolfram at the present time, either the provision of sufficient capital by the one company to enable it to work the southern end in addition to the northern, or the flotation of a new company to operate that portion of the lodes. In either case, there seems to be assured a long term of profitable operations. When it is remembered that the S. & M. Mine, in the Middlesex district, has been worked at a profit for eight years on four parallel lodes averaging not more than 1 foot in width, with metal contents (tin, wolfram, and bismuth) of about 1½ per cent., and extending over a maximum length of 1200 feet, it is very clearly seen what an attractive proposition the Story's Creek mine really is. It is, in the writer's opinion, destined to prove the largest producer of wolfram in Tasmania, and, as previously remarked, it is remarkable that its potentialities have not before been realised.

In addition to the possibilities in regard to these two lode systems there exists the likelihood of locating other lodes between them and the granite-contact nearly a mile away to the west.

As regards the persistence of the lodes in depth, it will be seen from the explanation given in Chapter II. that both the lodes and their values may be expected to continue into the underlying granite. A considerable depth therefore, is available for future exploitation.

IV.—CONCENTRATION OF WOLFRAM AND MOLYBDENITE ORES.

In the Ben Lomond district (which provides the only present output of wolfram) the methods of treatment are very crude indeed. At Gipp's Creek, the ore is mined, and the coarse wolfram knapped out and picked by hand. The rejects are built into a kiln with wood, and burnt. This causes the breaking up of the quartz at the junction with the wolfram, freeing the latter, which is picked by hand, and the fine portion streamed.

At Story's Creek, the ore, as mined, is passed over a grizzly, and the coarse portion stacked for future treatment. The fines are treated in streaming-boxes, and a mixed tin and wolfram concentrate obtained, which is sent to Launceston for electro-magnetic treatment, by which clean wolfram, assaying up to 74 per cent WO_3, and clean tin concentrates, are obtained. Advantage is taken in mining of keeping separate from the remaining ore any rich patches of wolfram encountered. These are subjected to hand-picking, and sent away as clean wolfram.

Such are the methods at present employed, and which have served a useful purpose in the past, but it is now necessary to replace this crude treatment by more efficient methods of concentration. It will be best to consider the different classes of ore under separate headings.

The Wolfram and Tin-Wolfram Lodes of Gipp's and Story's Creeks.—As previously pointed out, the lode-material in these districts consists of separate crystalline aggregates of wolfram and cassiterite in quartz, together with some pyrite. The masses of both wolfram and tin are sometimes large, and there is no finely disseminated mineral intimately associated with the quartz. The problem of treatment is, therefore, a special one, and must be dealt with accordingly.

It may be stated without any equivocation or hesitation that the crushing of the material by stamps is sure to end in failure. As pointed out when describing the properties of wolframite, that mineral is very easily converted into slime when subjected to crushing, and the pounding of wolfram-bearing material in boxes until the whole of it will pass a certain screen is sure to convert a great part of the wolfram into fine slime, which, of course, is to be avoided.

The object to be attained is to merely free the minerals from the gangue, and this can be easily accomplished by taking advantage of the crystalline character of the cassiterite and wolfram, which allows of their separation from quartz at their junction when subjected to sufficient pressure. This is best accomplished by rolls, which simply "nip" the material, and do not "grind" it. In this way, the cassiterite and wolfram are freed from the quartz.

The reduction appliances must therefore consist of rock-breaker (reciprocating jaw type) and rolls. The mills should be of the gradual reduction type, and the concentration of ore, as soon as it is freed from the gangue, and without further crushing, should be the characteristic. In fact, the mill should be designed on the same general lines as that at the S. & M. Mine, Middlesex, which treats a tin-wolfram-bismuth ore, from lodes of the same general character as these. This mill is described in detail in Bulletin No. 14 of the Geological Survey, pages 52 to 57 inclusive. The mills to be erected on this field should be on the same general lines.

The present method of keeping bunches of wolfram separate from the ordinary lode-material as it is mined, should be continued, and bags should always be kept in the stopes for the reception of such picked material.

An electro-magnetic separation plant is an essential adjunct to such a mill as that indicated above. Particulars of such a plant are given in an article prepared by the writer, and published in Geological Survey Bulletin No. 14, pages 58 to 73 inclusive. The provision of such a plant at Story's Creek is rendered necessary by the fact that the plant already operating in Launceston is working at its utmost capacity, apart from the consideration of other economic factors. The plant should be on the same lines as that in Launceston, including the rolls and screens. The latter appliances are rendered necessary by reason of the fact that the coarsest jig product from the mill will be about ½-inch in diameter, while the coarsest size treatable by the electro-magnetic separator is one-seventh of an inch in diameter. It is inadvisable to design the mill to make the coarsest product of the latter diameter, for the reason given above, that the minerals should be separated from the gangue in as coarse a state as possible, to avoid sliming of the wolfram. In designing the mill this object should be kept in view, leaving the magnetic separation

to take care of itself. Accurate sizing is also an essential to successful magnetic separation.

The product from the concentrating mill will contain some pyrite, as it does at present, and the amount will certainly increase as depth is attained. A stage will soon be reached when it will be advisable to remove this pyrite, from a "seconds" product produced in the milling operations. This will have to be done by first submitting the concentrate to magnetic separation, by which clean wolfram will be obtained, and a pyritic tin concentrate. The latter must be given a slight roast and again passed through the separator, when an iron product, which can be dumped, and a clean tin concentrate, will be produced. It would be a mistake to roast the mixed tin and wolfram concentrate before separation, as this would result in a loss of wolfram in the iron product, as well as a contamination of the wolfram product with iron.

The Wolfram and Wolfram-Molybdenite Lodes of Constable's Creek and Upper Scamander.—The lodes in this belt, which carry only wolfram with neither tin nor molybdenite, will have to be dealt with in a mill designed on the same lines as that indicated above, *i.e.*, gradual reduction, but there will be no need for the electro-magnetic separator-plant. The concentrates produced in the mill itself will be at once marketable as high-grade wolfram.

In those lodes, however, which carry molybdenite in addition to the wolfram, the treatment will be more complicated. The only method in general use in treating molybdenite ores up to quite recently has been hand-picking the coarse flakes, the finer material being reserved for future treatment. Concentrating by water is impossible with this mineral owing to its tendency to float. Quite recently, however, the application of the flotation process has been successful in treating molybdenite ores. The following extract indicates the general outline of these processes:—([1])

"In the case of molybdenite ores, large scale results are obtained without the use of either acid or oil, the antagonism of the surface of the mineral itself to wetting action being sufficiently pronounced to enable it to be floated off under the conditions prevailing in practice. Even after having been crushed wet and passed through

([1]) "The Concentration of Molybdenite Ores," Mining and Engineering Review, May 6, 1912.

an ordinary wet concentration mill, it may still be floated by bringing it in a suitable manner upon a water surface. Thus at Wolfram, Queensland, where the flotation process was first applied to the recovery of molybdenite in Australia, the tailings from a wolfram-bismuth concentrating mill, all passing 20 mesh and containing 2 per cent. to 4 per cent. of molybdenite, were treated by passing them over suitable flotation-boxes without the aid of acid or oil. The flotation-boxes there consisted of a series of cone-shaped boxes, with the usual overflow, the ore being fed on to the water surface by means of an inclined plane, the molybdenite in the form of a thin scum, passing over the overflow lip, while the tailings were discharged at the bottom of the box. The necessity for a rapid forward movement of the flotation surface involved the use of a somewhat large overflow of water, which was necessarily contaminated with the siliceous gangue of the ore, and this affected the molybdenite concentrate, and reduced its assay value. As a molybdenite concentrate to be saleable must contain at least 94 per cent. of MoS_2, it was necessary to reduce this contamination as much as possible, and several devices were tried with that purpose.

"In the 'Engineering and Mining Journal' for 27th January, Henry E. Wood describes what appears to be a practical method of overcoming this difficulty. The apparatus used consists essentially of the usual form of flotation-box, with a hopper feeding on to a vibrating plate, which serves to distribute the feed evenly over the width of the box. The ore—in this case, dry—is delivered from this vibrating plate on to a partially submerged revolving cylinder, which, while helping to moisten the gangue of the ore, allows the molybdenite to float forward towards the take-off belt, which is a novel feature of the apparatus. Instead of the molybdenite overflowing with the water, it is intercepted by the take-off belt, on to which it floats, and is carried up and over the overflow-lip, the water passing over the lip, being then free from molybdenite. The clean molybdenite is washed off the take-off belt into a suitable receptacle. The gangue, as usual, passes out at the bottom of the box.

"The same author's statement that the ore must be crushed dry is not, however, in accordance with Australian experience. Where the ore must be ground fine, in order to effect a complete separation of the sulphide from the gangue, the difficulty of completely wetting the finer par-

ticles of gangue, in order to allow it to sink, when it reaches the flotation-box, is considerable, and leads to much of the slime being carried over with the molybdenite. On the other hand, his advocacy of the ball mill, in one or other of its types, as a grinder for molybdenite ores is well justified, considerable experience with other crushing machines, both with and without screens, having shown the ball mill to be the most suitable machine for the purpose."

More recently, however, the Mineral Separation De Bavay's Proprietary Company Limited have carried out a considerable amount of research on the application of the flotation processes to molybdenite ores, and the results obtained have been very satisfactory. One of the difficulties encountered in the treatment of molybdenite ores by flotation is the grinding of the mineral to sufficient fineness, owing to the fact that it flattens into flakes, rather than breaking down to slime. In any scheme of treatment provision must be made for the separation of these coarser flakes, as they are too large to be floated.

Although the treatment of molybdenite ores is now successfully accomplished by flotation when the mineral is unassociated with others of value, the problem of treating a mixed wolfram and molybdenite ore presents certain difficulties. In the class of ore occurring on Hartnett's section, for instance, the requisite condition of treatment to recover the wolfram is gradual reduction, as previously explained; while the requirements in connection with the recovery of the molybdenite are fine grinding and sliming of the material. How are these two conditions to be compromised upon? If gradual reduction is decided upon the molybdenite will go partly in the concentrates and partly in the tailings, part of it being irretrievably lost in the dressing-water, unless provision is made to recover it. The tailings in this case could be submitted to flotation treatment. If the material is reduced to a fine state and first submitted to flotation, with subsequent concentration to recover the wolfram, much of the latter will be lost as slime. The recovery of a mixed wolfram and molybdenite concentrate cannot be regarded as undesirable, for these two minerals can be separated by electro-magnetic treatment. The exact method of treatment to be adopted will depend on the nature of the ore as it is disclosed in future operations, a great deal depending on the percentage and degree of coarseness or fineness of the molybdenite. When average samples of the ore are available, trial parcels can

be despatched for treatment, and the details of the latter decided upon. The difficulties can in no way be regarded as insuperable.

The following description by Mr. E. C. Andrews, of the Geological Survey of New South Wales, of the methods employed in that State in treating mixed molybdenite and bismuth ores will be useful in this connection:—

"Three plants are in use at Kingsgate in the concentration of molybdenite ores. The gangue is mainly clean quartz, the ores are molybdenite and bismuth, and the concentration is effected by means of shaking screens and tables.

"The capacity of one of these plants is about 5 tons a day, and the cost of the plant was about £900. The mill is worked by two men and one boy, under a general manager.

"The ore consists mainly of large clean flakes of molybdenite and small irregular pieces of bismuth in a siliceous gangue. As fed into the mill, the ore contains about 3 per cent. molybdenite and bismuth. This is fed by hand to a rock-breaker, and there crushed to about 1-inch gauge. Thence it passes by gravitation through two sets of rollers, each set having screens to pick up the large flakes of molybenite as oversize. This oversize is returned to the rolls, so as to reduce the gangue to smaller size without materially reducing the flakes of molybdenite. Underneath the second pair of rolls a shaking screen with holes 1/12th inch in diameter is placed, and the undersize from this screen passes on to a Wilfley table by means of a launder fed by jet of water. The tailings from the table are 'paddocked,' pending possible improvements in the treatment (such as the introduction of oil flotation).

"The oversize from the 1/12th-inch screen is carried to a third set of rollers crushing to 1/20th-inch gauge. Much of the oversize from this screening is cleaned by hand-sieving. The first of this oversize, however, is taken to a fourth set of rollers set close together, and after crushing the material, is passed through a 1/32nd-inch mesh. The oversize from this is a product containing 90 to 92 per cent. molybdenite. The undersize is a rich product, which is saved pending possible improvements in the treatment."

Molybdenite at Mt. Stronach.—As previously pointed out, the only occurrence on Mt. Stronach which deserves further attention is that known as Harvey's show. The

ore at this point carries chalcopyrite in addition to the molybdenite. The latter mineral occurs in flakes measuring, as far as can be seen at present, about ½-inch in diameter. By fine grinding and flotation a mixed concentrate of molybdenite and chalcopyrite could be obtained, which, after partial roasting, would give clean molybdenite and a high-grade copper-silver ore. It is quite possible, moreover, that a separation of the molybdenite from the chalcopyrite may be possible by means of differential flotation. Such a method of treatment can only be considered if considerable quantities of ore are subsequently exposed. It will probably be more expedient to adopt some such scheme of treatment as that outlined in the article by Mr. E. C. Andrews, quoted above, as the bismuth and chalcopyrite play about the same role in relation to molybdenite. If the occurrence develops into one of any size, there will be no difficulty in treating the ore.

V.—CONCLUSION.

(1) The Output from the District.

There has been no output of molybdenite from this district whatever up to the present date.

The output of wolfram is confined to that from the Ben Lomond (Avoca) district, and a few parcels from the Upper Scamander. The exact amount is impossible of estimation, but may be put down at about 400 tons of mixed concentrates from the former district, which corresponds to, approximately, 250 tons of clean wolfram. The output from the Upper Scamander has been only about 5 tons of hand-picked wolfram.

The present output is confined to that from Story's and Gipp's Creeks, which may be put down at, approximately, 12 tons of mixed tin and wolfram concentrates per month, equivalent to about 7 tons of wolfram per month.

(2) General Recommendations.

It now remains to briefly summarise the conclusions arrived at in the preceding pages in connection with the various occurrences. The recommendations in regard to future procedure are naturally influenced by the consideration of the desirability of obtaining the maximum supply of the metals tungsten and molybdenum, which the deposits are capable of producing, as soon as possible. The *resumé* of the recommendations are presented under the headings of the various localities.

Mt. Stronach.—The occurrence known as Harvey's show is the only one deserving of further attention, and prospecting of this occurrence is recommended. If an appreciable body of ore is disclosed, then the consideration of treatment on the lines indicated in the preceding pages can be entered upon. The other deposits of molybdenite in this locality are quite unpayable, but search for definite pegmatitic dykes can be made which may carry payable molybdenite.

Lottah.—The molybdenite occurrences observable in this district are unpayable. The tin-wolfram deposit on the section held by Mr. Simon Bakhap in the vicinity of the old Liberator Mine deserves further prospecting. Such investigation is recommended.

Constable's Creek and Upper Scamander.—The wolfram-molybdenite lodes on Hartnett's Section 7204-M on Constable's Creek show good values in both minerals, and active prospecting is recommended.

The lodes on the sections at Upper Scamander are essentially wolfram deposits, molybdenite being only sparsely distributed, as far as at present observable; but from what can be seen with the very limited amount of work done, at least three of the wolfram lodes ought to be payable at the present market price. The investigation of these lodes to start with is recommended.

In addition, general prospecting between these sections and Hartnett's, and also to the westward, is recommended.

To enable such prospecting to be carried out, it will be necessary to construct a road to the Upper Scamander sections. The route for this road will be from the present end of the Scamander Road up the Scamander River to Fitzgerald's Creek, following the course of the latter for about 1 mile, then turning northwards towards the flat ground on Section 7179-M. This seems to be the only practical route. Such a road is essential if these deposits are to be worked.

Gipp's Creek.—The systematic exploitation of a series of six parallel tin-wolfram lodes from a few inches to 2 feet in width, extending over about 1 mile of country, is decidedly justified, and is strongly recommended. The output possible from the present crude system of working is very small, whereas the deposits are capable of providing an appreciable output if worked on systematic lines.

Story's Creek.—This is certainly the most important district examined, producing, as it does, about 6 tons of high-grade wolfram per month, and being capable of greatly increasing that output. Two lode-systems, averaging about 3 feet in width—one being 34 chains in length, and the other over 5 chains, with several offshoots to the southwards—give potentialities which indicate an output exceeding any other wolfram-producing district in Tasmania. The plant now proposed to be erected to treat the ore from D. MacLeod's sections is designed to produce about 4 tons of wolfram (assaying over 70 per cent. WO_3) per week. The accumulated coarse rejects from the present crude methods, amounting to upwards of 1000 tons, and the development work already done, and that contemplated on lodes already proved on the surface, will

be sufficient to keep such a plant going for an indefinite period. In addition to this, there is room for such another company or syndicate to operate the southern continuation of the No. 1 and main lodes, or, preferably, the duplication of the proposed plant to deal with this portion of the lodes. An electro-magnetic separator plant should be erected to treat the mixed tin and wolfram concentrates.

It is thus seen that the Story's Creek deposits can be made to produce from 8 to 10 tons of clean wolfram per week. In fact, the deposits, after being known for 34 years, are only now receiving that attention by capitalists which, by virtue of their being the largest wolfram lodes in Tasmania, they fully justify.

It is evident, therefore, that with proper handling and treatment, the output of wolfram from north-eastern and eastern Tasmania can be materially increased, and there is a possibility of the production of molybdenite from the Stronach and Constable's Creek districts.

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