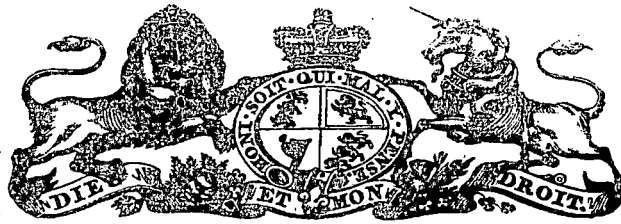


(No. 89.)



1884.

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PARLIAMENT OF TASMANIA.

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**WESTERN MINING DISTRICTS:**

**REPORT BY MR. G. THUREAU, F.G.S.**

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Presented to both Houses of Parliament by His Excellency's Command.



*REPORT on the present Condition of the Western Mining Districts, with special reference to their Mineral and Metalliferous Deposits; the Geological features observed, and other matters of interest.*

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*Launceston, June, 1884.*

My instructions included the examination and survey of the King River Goldfield, the Silver-Lead lode at Mount Zeehan, the country lying between Macquarie Harbour—inclusive of the Tin Mines at Mount Heemskirk—and the Pieman River, as well as the Corinna Goldfield extending towards Mount Bischoff.

The King River Goldfield could not be visited on this occasion on account of the track from Long Bay to Lynch's Camp being all but impassable, and for the want of horses, the police having prohibited further packing, as the horses were for a time incapacitated through having sore backs, &c. Consequently the only reliable information, obtained at Long Bay from storekeepers, miners, and the police, was communicated by letter to the Honorable Minister of Lands and Works on the 7th of May, from the Montagu Post Office.

The Silver-Lead Lode near Mount Zeehan likewise could not be examined on account of the bad state of the track at this advanced period of the year.

From the information obtained from various sources it appears, however, as very necessary that the whole district should be thoroughly examined in the coming more favourable season.

*The Mount Heemskirk Tin Mining District.*

Since my last official inspection in June, 1882, the development of these tin deposits has not, except in a very few instances, been carried on with great vigour, and in consequence the district still remains in an unexploited state, for without working the mines the deposits will never be proved to satisfaction. True, some proprietaries have extended their underground operations in a praiseworthy manner, but, as their neighbours have done but very little work, the isolated efforts of the former has left the question whether vein-mining will be remunerative and profitable much in the same state as it has been. It is, however, satisfactory to observe, that some companies having continued their operations below the surface, obtained proofs of not only their surface out-crops continuing in depth, but also that the ores occurred in other places along the course of the veins and lodes. With the exception of the Cumberland, West Cumberland, Champion, and Peripatetic Companies, no underground work of any magnitude was being carried on at the time of my inspection, and consequently most of the leases were *quasi* abandoned. In those mines where some work had been done since my last visit, I had to receive my information from persons left in charge as caretakers for what it is worth. Not less than four proprietaries were found to have erected complete crushing and concentrating machinery; three other similar plants were near completion, and one company had constructed a powerful steam winding and pumping plant, all the former employing exclusively water as their motive power, with the exception of the Orient Company, who work their battery also by steam power. It will thus be seen that a very considerable, if not excessive, amount of subscribed capital has been expended on mining machinery and general charges, and I think that a portion of such expenditure might very properly have been saved, as in some cases such was incurred where a limited number of days' crushing would totally exhaust the supply of ore made available by means of levels and their connecting winzes. To have proved the extent of the ore deposits along their strike in width and depth so as to have opened a very considerable height of "backs," and to continue the openings of more of such ground in advance of the stopes should have been the primary consideration; and then, when these were satisfactory for continuously supplying a given machinery power, steps should have been taken to erect suitable plants accordingly. As is now the case, trial crushings have been made of ores that had been raised previously in limited quantities, and there-

fore insufficient for keeping the reduction plant regularly employed, thereby creating dissatisfaction, in other instances not the slightest consideration had been shown in regard to whether the veins or lodes were embedded in soft or hard country, or the lodes themselves were of a soft or hard description. With the former description of vein-matter it was imperatively necessary to provide a very large extent of well secured ground properly opened up by levels and winzes in order to keep up the supplies for the reduction plant; and in hard lodes especially, the mode of level driving and stoping, &c. would have to be accelerated by the use of rock-drills, driven either by compressed air or water under great pressure.

Until the various Companies have opened their mines to a very much greater extent than what they have done, in order to enable them to *blend* their poorer with their richer ores, and thus average the same, I regard it merely as misleading to record from any part of a mine or mines what the per-centage per ton of vein-matter may be, because without any such averages being obtained for the purpose from *all* parts of the mine or mines, the hand or even battery tests of limited quantities cannot possibly be held as establishing the intrinsic value of that or the whole of such mines. The very peculiar way in which tests "on the shovel" are made do not give *reliable* results, because actually the results accruing thereby exhibit the contents of frequently three times the quantity of ore so manipulated.

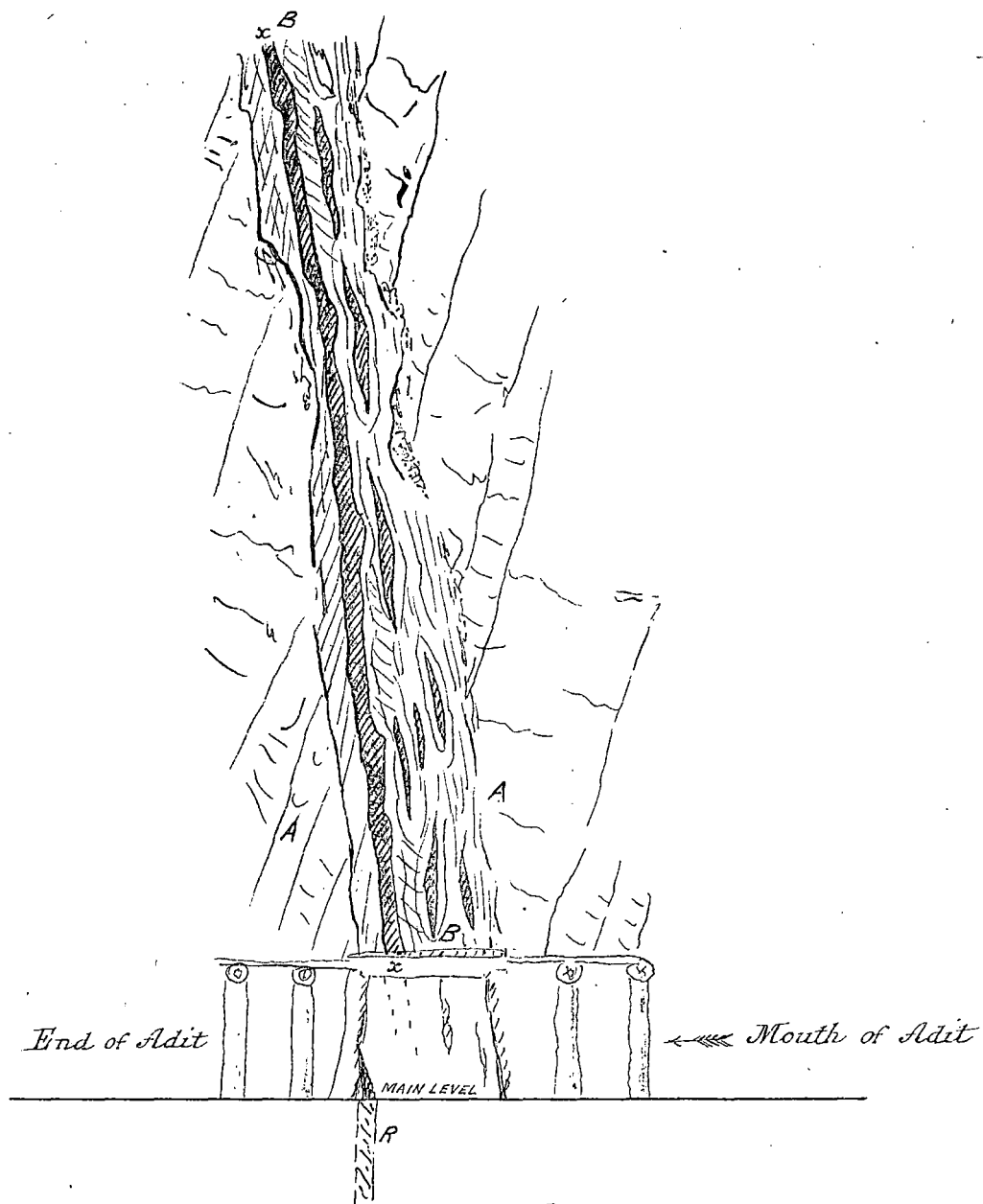
Vein tin-mining is no doubt very different from that of auriferous quartz reefs, where, after simply crushing, amalgamating, and the treatment of pyrites, the resulting gold, after retorting, has at once an economic value; it is also at variance with the manipulation of that immense deposit at the "Red Face" at Mt. Bischoff, which latter furnishes such almost unlimited supplies of ore, which, after a somewhat more intricate process, produces at per ton a uniform per-centage of metallic tin. The Heemskirk Mines are no exception to the old and recognised rule in mining geology,—viz, "That almost every mineral or metalliferous district present features, though similar on the whole, differ in themselves from each other even with the same kind or description of ore." This necessitates a modification of working and treatment almost at nearly every other mine, in order to facilitate the winning of cleansed ore by the processes or machines employed for that special purpose.

#### *Geological Features.*

With regard to these veins or lodes, and their exploitation, at Heemskirk, it would appear as if too strict an attention to an experience gained in working in deep tin mines in Europe, or also the theoretical guidance from text-books on the subject, had resulted in the carrying out of works that otherwise would not have been undertaken had the features of the local lodes been more closely studied. This view is borne out in one or two cases; for instance, it is a recorded fact that the Great Flat Lode, south of Redruth and Cranbourne, in the Duchy of Cornwall, occurs between the metamorphic clay-slates (killas) and the primary granite, and the tin ore is associated with "schörl," i.e., tourmaline. That lode has been wrought to over 140 fathoms in depth, and in some places to a width of from 40 to 50 feet; there is but one wall at the joint of the two rocks, and in the "killas" but very rarely deposits of tin ore have been found to occur. In the granite, however, the ore forms a band of altered rock which gradually disappears in same from the vicinity of the wall or joint. The name of "eurite," a species of porphyry, has been but lately adopted in connection with our tin lodes, but from the description given by Dr. C. Le Neve Foster, in 1878, it is clearly demonstrated that those euritic dykes occur as associated with tin lodes in Cornwall as they do in Tasmania, and that their compact "schörl rock" appears as favourable to the ores as our tourmaline does here; but at Heemskirk these tourmalines are frequently altered into chlorites and steatites. In comparison with the above there appears one instance that has come under my notice where too much attention was directed to the probable discovery—if possible, as in Cornwall, the continuation of tin deposits, veins, or lodes—*cropping out in the granite*, in the adjoining and, in some parts, overlying metamorphic clay-slate or killas, whereby a considerable amount of the working capital appears to have been dissipated without any corresponding favourable results. As it was, the original rich outcrops of ore occurring in the euritic porphyry dykes enclosed in the granite were not nearly so exhaustively tested as the richness of them warranted in those rocks, but, instead, numerous underground prospecting workings, carried out apparently for the purpose of ascertaining whether or not those and other deposits would continue from the granite into and traverse the clay-slates. This error of judgment involved, after the completion of a good crushing and concentration plant, sinking of shafts, driving of crosscuts from levels, &c., the cessation of all operations, owing partly to the unremunerative per-centage of tin in the ores raised, and the inability to raise sufficient quantities for manipulation. No doubt this failure produced, at a critical time, a prejudicial impression upon the owners of the surrounding leaseholds and the public also.

With regard to other veins and lodes in the course of exploitation or, for peculiar reasons, quasi-abandoned, it may be observed that I have this time had much better opportunities of forming an opinion than heretofore of the future prospects of the district, because in some of the mines a very considerable amount of work had been done, thus permitting closer and more careful examination. And, now that this has been done, there exist at the depths reached two classes of lodes, viz.; *soft* and *hard*, and that thus far the tin ores occur in either are differing as much as the greater or lesser density of the vein-matter itself.

# CROSS SECTION OF CUMBERLAND LODGE.



## EXPLANATION.

- A. A. Coarse Granitoid Rocks
- B. B. Lode Shaded parts
- Tin Ore ----- Deep black as pipe x. x. and  
in bunches, nests & &
- R. ----- Rich vein of ore beneath Adit Level

It is deemed necessary to refer to my former reports on this district in order to explain how far my views of *surface outcrops* of ore have been found to correspond with the lodes underground. With that view it may be observed that the numerous and, in many instances, rich outcrops of tinstone at Mt. Heemskirk, as first discovered in or before 1881, occurring either *in situ* or in close proximity to those lodes they come from, were since found to continue underground in the form of "shoots" and "pipes," or more irregular lenticular masses of ore. This explains the singular occurrence of so heavy fragments of ore (up to 50 lbs.) and the coarse angular gravels near those outcrops. These and other features demonstrate the prehistoric raising of the sea-beaches to their present altitude, and the gradual wearing down, by atmospherical and other influences, of the wall-rocks, leaving the denser and heavier ores almost where they occurred as lodes, shoots, pipes, &c. This view is confirmed by the occurrence on the plateau or foothills where most of the mines have been found of remnants of marine beds of rounded gravels and sands widely distributed to a considerable altitude above the present sea level. It was the discovery of these, so to speak, "*concentrated*" outcrops of pure tin ore that gave rise to so much prospecting—not always successful, as the outcrops were too far apart—and the subsequent, on account of encouraging results obtained, more systematic mining pursued ever since, as detailed below. It is, however, quite impossible to deduce from the extent, quantity, or richness of such outcrops any practically reliable basis for valuing the lode or lodes beneath such segregated deposits, thus confirming, in the main, the gist of my first report. Another reason for this view is that practically those outcrops represent really the aggregate results of accumulations of ore through denudation, &c., probably many vertical feet in height originally, and which do not account for the softer vein-matter that has now disappeared from the same process. The shoots of ore along the strike of lodes are therefore indicated by the "patches" and "nests" of ore at the surface, and the more and the closer they are together the better is the prospect for the output of ore from such a mine; and therefore it depends on these shoots how comprehensively and rapidly these mines should be worked in order to keep the crushing and concentrating machinery fully employed. As already stated, the occurrence of the ore varies within the walls, but it may be accepted as a fact that in "soft" lodes ore shoots are more frequent than in "hard," where they are more irregular in nests, pipes, bunches, &c., and that in some cases shoots of ore occur only where the porphyritic dykes exhibit "cross-joints."

The term "lode" has been adopted after the same manner as in England, where such applies to more or less vertical fissure veins as well as tabular masses of tinstone.

All kinds of mineral or metalliferous deposits—lodes especially—have been subjected after their formation to interruptions in their regular course known as "faults," "slides," and "crosscourses," &c., which render their working frequently a difficult matter, requiring *practically experienced mining managers* well versed in lode-mining to be able to recover, in such cases, the missing parts of a lode so faulted. As these interruptions differ in all mining countries, no rule can be applied, but close observation will render the search a, comparatively speaking, very simple matter indeed. At Heemskirk two of these faults were observed, viz., at the Cornwall and the Cliff Companies' mines, and probably at the Empress also. They are described further on in this report.

Having now dealt with the general aspects of and the geological features observed at the Mount Heemskirk mines, it appears requisite to refer in detail to each mine examined, and likewise to describe the means adopted by the several proprietaries engaged in mining operations. The various processes for manipulating and dressing the ore by those companies having erected ore-dressing machinery are also tabulated for comparison, in order to afford the fullest information on every point of interest in connection with those tin ore deposits.

#### 1. *The Cumberland Tin Mining Company.*

*The Mines.*—The principal veins and lodes, as indicated by the surface outcrops, have been fully described and delineated on plans with former reports. The mines have been opened by means of a commodious main adit, over 1000 feet in length, which is connected by means of a tramway (22 inches gauge) with their crushing and cleaning plant. At about 612 feet from the entrance to the tunnel a hard lode formation 6ft. 6in. wide was intersected, embedded between two soft granitoid walls, underlaying north, and striking nearly north by south. In an air shaft the same formation,—there 14ft. wide,—was again intersected. It carried a little ore, but showed in the air shaft no improvement. There are about 265 feet of "backs" open on this lode (?)—"a stanniferous and porphyritic dyke,"—but as no levels have been driven, which it would be difficult to make in so treacherous a stratum, its test is yet incomplete. At between 900 to 1000 feet "in" from the mouth of the adit another very hard lode formation, bearing north west by south west, was intersected. This is of a very much more promising description, and it exhibits all the characteristics of a true "fissure" lode, in which the vein-matter is represented by all those minerals so generally associated with tin ores proper. The veinstone is highly quartziferous, contains but little mica, and the chlorites, fluor-spar, fine radiated tourmalines are, in places, strongly impregnated with tinstone. There is a very marked difference between this formation and the coarse-grained porphyritic wall-rocks in which it occurs. The ore itself occurs, irregularly distributed, in the vein in the form of nests, impregnations, cuticular masses and pipes: of the latter a good example was seen in the "rise," where an oblong

stem of pure ore, not more than two feet in diameter, was followed to a height of over 40 feet embedded in chlorites and tourmalines. Beside that, "nests" and bunches were met with, and, at the bottom of the north-eastern level,—where the lode is nine feet wide,—the top or "cap" of a rich "shoot" of ore was found to extend for over 30 ft. in length by 12 inches in width, which presents a very fair prospect under foot. Altogether, this lode promises to be fairly productive as soon as the rise has been directly or indirectly connected with the surface, a height of 350 feet in the "backs." This lode, at the adit level, has been driven on along its course for only about 90 feet; consequently its full value as an ore-producing deposit cannot yet be estimated, but the indications are, so far, favourable to its becoming so.

It would be judicious for this company to consider the propriety of introducing rock-borers, driven by means of compressed air, for the more speedy opening of this lode and of their mine generally. As it is, the work in the "rise" is much retarded through slow ventilation. A rock-borer would aid the latter both by its exhaust air during boring and by opening the valves in order to drive out the powder-smoke, which renders the work—manual labour—as exceedingly unhealthy and protracted, considering the large amount of work yet to be performed in opening this lode.

The ore itself resembles a great deal that of Fawknor's lode, which furnished so heavy an out-crop of coarse and very pure lumps of ore.

*The Crushing and Concentrating Machinery.*—With regard to this part of my report, which is second in importance only to that of the occurrence of vein and lode tinstone at Mount Heemskirk, the subjoined tables will afford every information of the treatment of the veinstone to its final separation of concentrated tin ore obtained, and the waste rejected as valueless.

This company, it may be stated, has, in conjunction with the Montagu Tin Mining Company, which latter is located about 800 feet below the former, secured a more than sufficiently copious water supply by constructing an excellent dam across the outlet of that extensive "upland basin," in which most of the Cumberland Company's mines are situated. A string of wrought iron pipes, riveted together with cast-iron flange joints, leads to the battery below, and, by means of a very considerable amount of water pressure, the motor,—a horizontal turbine of a somewhat novel construction and of great power,—operates the whole of the crushing and dressing machinery. This consists of ten heads, two classifiers, two two-storied Lewis's buddlers, one slime buddle, a series of settling boxes, two sizing boxes, and a set of tubs, in which the sands in gyrating are made to deposit the finer slime tin, the whole process ending with strakes of blankets.

## 2. The Montagu Tin Mining Company.

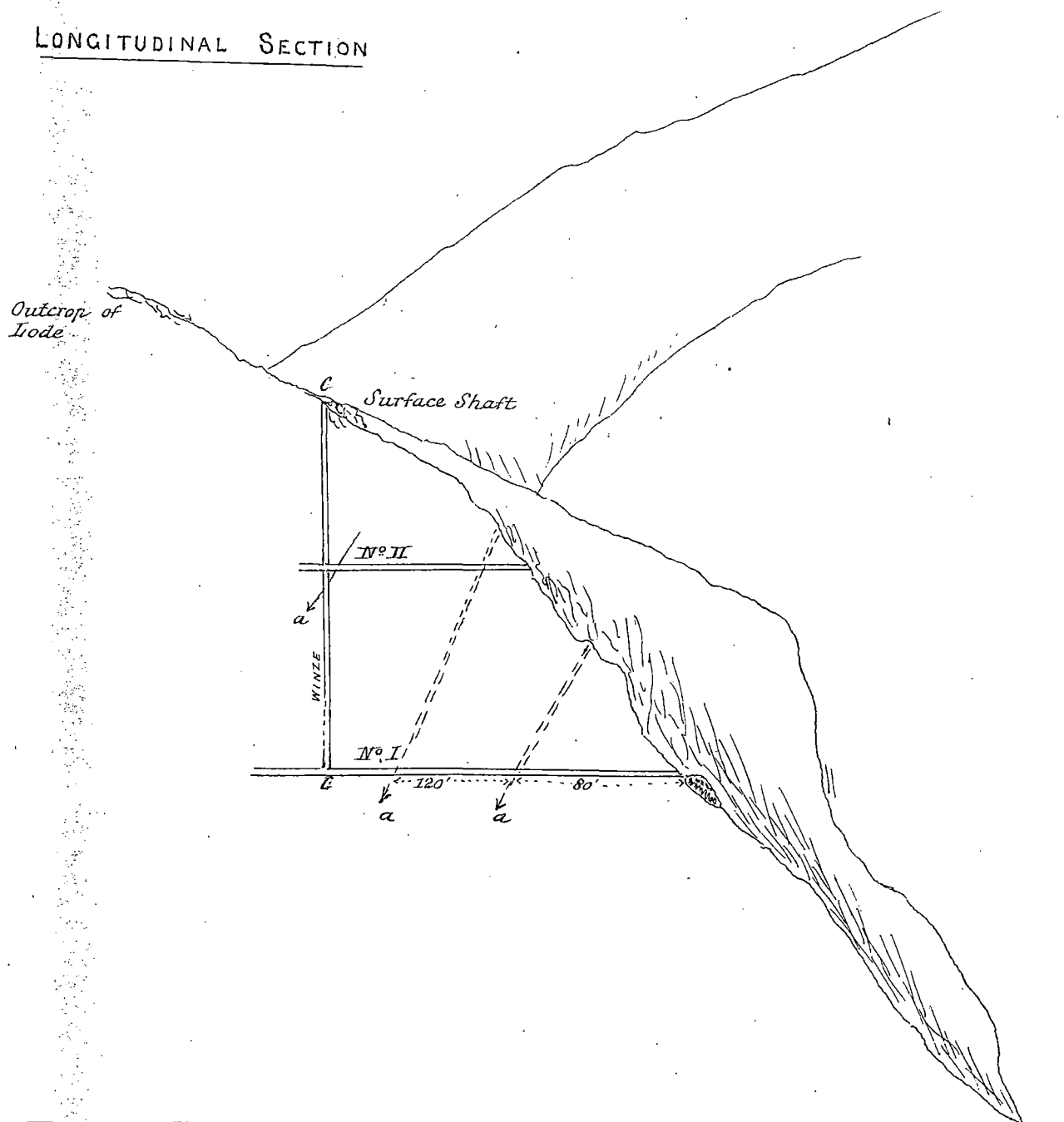
*The Mines.*—At the time of my second visit to Heemskirk, in June and July, 1882, this mine was flooded, rendering inspection impossible. At this present visit the same state of affairs prevail, with exactly the same result.

*The Crushing and Concentrating Machinery.*—As already stated, this Company undertook to construct, at joint expense, the large high-level reservoir, together with a string of pipes for supplying both the Cumberland batteries, &c. and this Company's plant, now almost complete. A branch of pipes from the main supplies a smaller service reservoir constructed about 200 feet below the former. From the bottom of a "clearing" tank, filled from the smaller reservoir, another string of pipes has been laid (partly on the surface and partly on trestles), tapering from 9 to 5 inches in diameter, giving a head of water of 560 feet vertical, thus conveying at present the largest and most powerful available water pressure for motive power in Tasmania. The lower five-inch wrought iron pipes connect direct with one of Leffel's (American) "vertical" turbines, 4 feet 6 inches in diameter at the outer rim, and 3 feet diameter for the working part. By means of a pulley and gear an endless Manila rope, working in five grooved pulleys, instead of a belt, works the main gearing 60 feet distant. The present plant, which, with the almost unlimited water-power secured by this Company, can be considerably added to, consists of fifteen heads of stampers (with provision for five more), six classifiers, twelve of Sterry Hunt's (American) double-acting jiggers, two rotating and two slime tables ditto, or buddles (cemented bottoms), sizing boxes, labyrinth ditto, gyrating tubs and strakes, and other fixed ore dressing appliances.

## 3. West Cumberland Tin Mining Company.

*The Mines.*—The two principal lodes are the M'Williams' and Riddoch's. The former, bearing N. East by S. West, has been followed on its course by means of adits (at various levels) 165 feet and 270 feet in length respectively, averaging from 14 inches to over 2 feet in width. A shaft sunk from the surface to the upper adit gives 52 feet of backs, and in continuation to the lower adit 120 feet will be available for stopping. On Riddoch's lode the upper adit measures 55 feet and the lower 150 feet in length, and a winze of 70 feet in depth, from one to the other, gives the height of backs open for ore extraction. These two lodes, with some others not yet

# LONGITUDINAL SECTION



EXPLANATION. *West Cumberland T.M.C.*

*a. a. a Ore Shoots (3). N° I and II Adits C.C. Winze*

sufficiently opened up, though tin ore has been found on Hadley's lode also, represent in the aggregate a height of stopes of over two hundred feet, if the "backs" at each lode are added together. Altogether, since October, 1881, there have been over fifteen hundred lineal feet of chiefly ore ground opened up in this mine, presenting a very marked contrast to the, in too many cases, display of want of energy and vigour at Mount Heemskirk, without which, it is almost needless to say, no mineral region, however rich and endowed with the greatest natural facilities, can possibly progress or give satisfaction to those interested therein. The character of the ore and its peculiar mode of occurrence, as chiefly in soft euritic dykes of porphyry, present interesting features, having a decided bearing on the future treatment of same on the dressing floors; the tinstone ranges from the very finest powder to a somewhat coarser kind, and it occurs principally in the form of "shoots" dipping easterly. So far, one of these shoots has been proved to exist on Riddoch's, and three on M. Williams' lodes. Generally speaking, the ore occurs in a fine slimey-like form, dispersed throughout the soft and decomposed vein-matter, and prospects taken at random, from No. II. especially, washed during my visit, were very satisfactory, and so were others, to a minor degree, from the other workings. At the same time, owing to the great fineness of grain, the *stamping* of same does not appear as necessary, as by it still more impalpable slimes are produced. Careful manipulation after passing through sets of sieves—revolving—so as to obtain uniform sizes of grain, and subsequent concentration on machines like the Frue's Vanning Concentrator, would in all probability give higher results than any other process extant. The coarser fragments not passing through the sieving machines should be fed to the stampers in the ordinary way.

So far, there have been no acidic minerals, such as fluorspar, &c. found as associated with the ore, but a kind of greenish micaceous mineral—most probably altered chlorites—appears to indicate the richer deposits when such are associated with arsenical and iron pyrites, both frequently transmuted, through decomposition, into a heavy black powder. From the surface the following features were successively observed, viz.:—1, rich outcrops of tin ores; 2, "floors" of micaceous iron ores, i.e., decomposed iron pyrites; 3, good tinstones—"cassiterites"; 4, "floors" of pure pyrites. In the bottom of the winze now in course of sinking between No. I. and No. II., in very soft whitish red vein-matter—"kaolin"—tin ore occurs of a reddish hue (ruby) in a very fine-grained slimey form. The character of the lodes change into a very hard quartzose matrix with the east and west lodes, in which the more abundant association with tourmalines appears greatly to displace those micaceous iron floors mentioned above. These lodes (east by west) are at times approached by a north-and-south lode, causing the latter to become very irregular, and to a degree they disappear altogether after driving a few feet on their course. The change mentioned of the soft "*gangue*" into the harder matrix is similar to that at the Peripatetic Company, but it remains yet unproven whether this alteration in density is favourable or otherwise to the future economic value of those repositories at a greater depth.

*The Crushing and Concentrating Machinery.*—Owing to the adits for mining the tin ore deposits being located at a vertical height of 370 feet above the dressing-floors, a self-acting single tramway 900 feet in length, and a more level continuation of same, connects the mines, with their reduction machinery. At the same time it may be stated that so far those mines have opened up satisfactorily, and that if that very fine grained ore can be saved or collected by the appliances adopted, the output of ore should be satisfactory in proportion to the capabilities of that machinery, which is rather circumscribed at present.

Water, by gravitation, as supplied from a reservoir constructed in a narrow glen above their crushing plant, is to be used as a motor; this embankment has been built chiefly of a decomposed gritty granite, faced in and outside with squared sods of peat. So far as could be seen, the material had no coherence, it being simply used to make up the bulk of the embankment without any ramming or puddling to give it resistant qualities to the pressure and percolation of water. Insufficient batter was also given to the in and outside walls, and as the discharging or supplying culvert for the wheel, together with the sectional capacities of the bye-wash, were restricted to limited deliveries only, it appears as doubtful whether the bank, if the reservoir was filled suddenly by the so very frequent local mountain freshets, would stand the pressure or prevent serious leakages. In case of any such mishap the plant below would most likely be very seriously damaged by the rush of water thus released suddenly. A well designed overshot water-wheel 20 feet in diameter drives a five-head battery, and the crushed material is then conveyed on to a couple of "*centre head buddles*," also known, it is believed, as "Borlase's"; these buddles are fed with the sands from the battery at the top of a truncated cone 3 feet in diameter by 4 feet at the base, by means of which the material will be equally distributed all round the base; the four revolving arms are furnished with strips of bagging or reeds, the action of which causes the resulting "water" to be discharged at the bottom of the depressed outer periphery. In this manner the concentrated ores will collect at the base of the central cone exclusively for removal at certain periods. A revolving slime-table or cleaning-buddle, to be followed by a couple of automatically acting "*Dead Frames*" will be eventually constructed, thus constituting a very simple series of apparatus for the proposed collection of tin ores and slimes.

#### *The Peripatetic Tin Mining Company.*

*The Mines.*—These are situate nearly ten miles north north-west of the Montagu Post Office. A considerable amount of work has been done in the way of testing and opening their tinstone deposits



to advantage. Those characteristically intrusive dykes of euritic porphyry enclose here also those ores, the metalliferous bands of which are enclosed in the coarser primary granite. The various workings have, in the first instance, followed the ore deposits from the surface outcrops in their peculiar manner of deposition; and secondly, with the practical knowledge thus obtained, the more permanent opening of the mines has been proceeded with in order to prepare for stoping the "backs" thereby disclosed. The matrix near the surface is soft and friable, chiefly feldspathic, and is very considerably associated with chlorites and tourmalines, with very fine and coarsish tin ores enclosed. The enclosing dykes bear to the north east, and at 23 feet from the surface, beneath a rich surface outcrop of ore, in an adit, a stanniferous formation was found underlying west. Near the blacksmith's shop good tin ore also occurs at a depth of but 21 feet from the surface in a chloritic vein ranging from 18 inches to 6 feet in width; it was here noticed that the ore is found in "shoots," in each of which the character of the ore varies from fine to coarse, as the case might be, though the vein or lode itself evidently belongs to the same formation. The dip of these "shoots" along the course of strike of the lode is evidently due to the inclination of "cross-joints" in the euritic wall-rocks.

#### *Explanation of Diagrams.*

*Plan, a a*, granite; *b b*, eurite; *c*, hanging-wall of lode; *d*, lode, consisting of streaks of ore and chlorites, parallel bands of coarsely crystalline iron pyrites and nests of tourmaline.

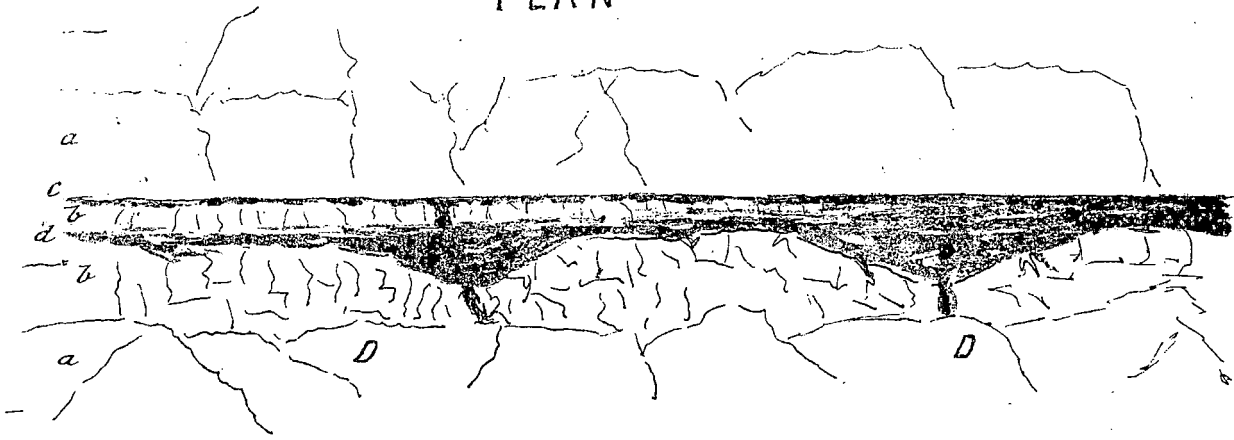
*D D*, cross-joints where the best tin ore occurs (as shown on longitudinal section) separated by eurites where the lode becomes narrower, and the ore more sparsely distributed. *C* shows the winze, which after passing through the centre of shoot has now entered the eurite again in the bottom, leaving the lower portion of the shoot intact. The distance between these shoots varies, and has been found to exceed 70 feet; the intervening spaces are still tin-bearing, but not so rich as those shoots. The underground workings or levels follow the narrow streaks of ore from north to south, and in No. 2 winze very good hard ore is exhibited in a feldspathic matrix with iron pyrites. The so-called "Mainstay" lode, disclosed in a still lower adit, belongs apparently to the same formation as those higher up, but it is more regular, richer, and the tinstones in regular veins alternate with parallel veins of iron pyrites, and not "floors" as described elsewhere. At the lowest adit in No. 1. winze, diagram *C*, a hard quartziferous formation on a cross-joint is being exploited. This shoot of very strong tin ore dips also to the west, and the steatitic matrix is heavily charged with crystalline iron pyrites. The winze in question has evidently been sunk at near the lower end of the shoot, and by sinking vertically that aggregation of valuable ores has passed, at a depth according to its inclination, out of the winze. The several "ends" of the levels and workings still continue indications for the existence of other shoots of similarly rich ore, and altogether these deposits rank among the best and most promising on the West Coast. The working of these mines is much facilitated by the soft nature of the enclosing wall-rocks and the vein-matter within the same, so that as soon as a regular supply of water for dressing purposes has been secured the winning of ore can be commenced without any delay. It is contemplated to resume the sinking of the main engine shaft, now nearly 20 feet in depth, and located west of the lodes, as soon as the ores raised from the other parts of the mine have been thoroughly tested with the plant for ore-dressing now in the course of erection.

*The Crushing and Concentrating Machinery.*—A reservoir had been formed in a creek below the mines, and the material used for the construction of the embankment was found to be precisely the same or, rather, similar to that at the dam of the West Cumberland Co., also faced with squared sods of peat, &c. A sudden freshet in the creek from the mountains had carried it away on the day before my inspection, whilst also doing very considerable damage to the machinery partly erected lower down on the same creek. And so far as the uninjured parts of that plant would permit one to see, the battery (10 head), water-wheel, four Cornish buddles (Borlase's), &c. were on the same pattern as those in course of erection at the West Cumberland Co.'s mine. As the ore in both of these mines is of a very similar description, the results may be anticipated as proportionately of like character.

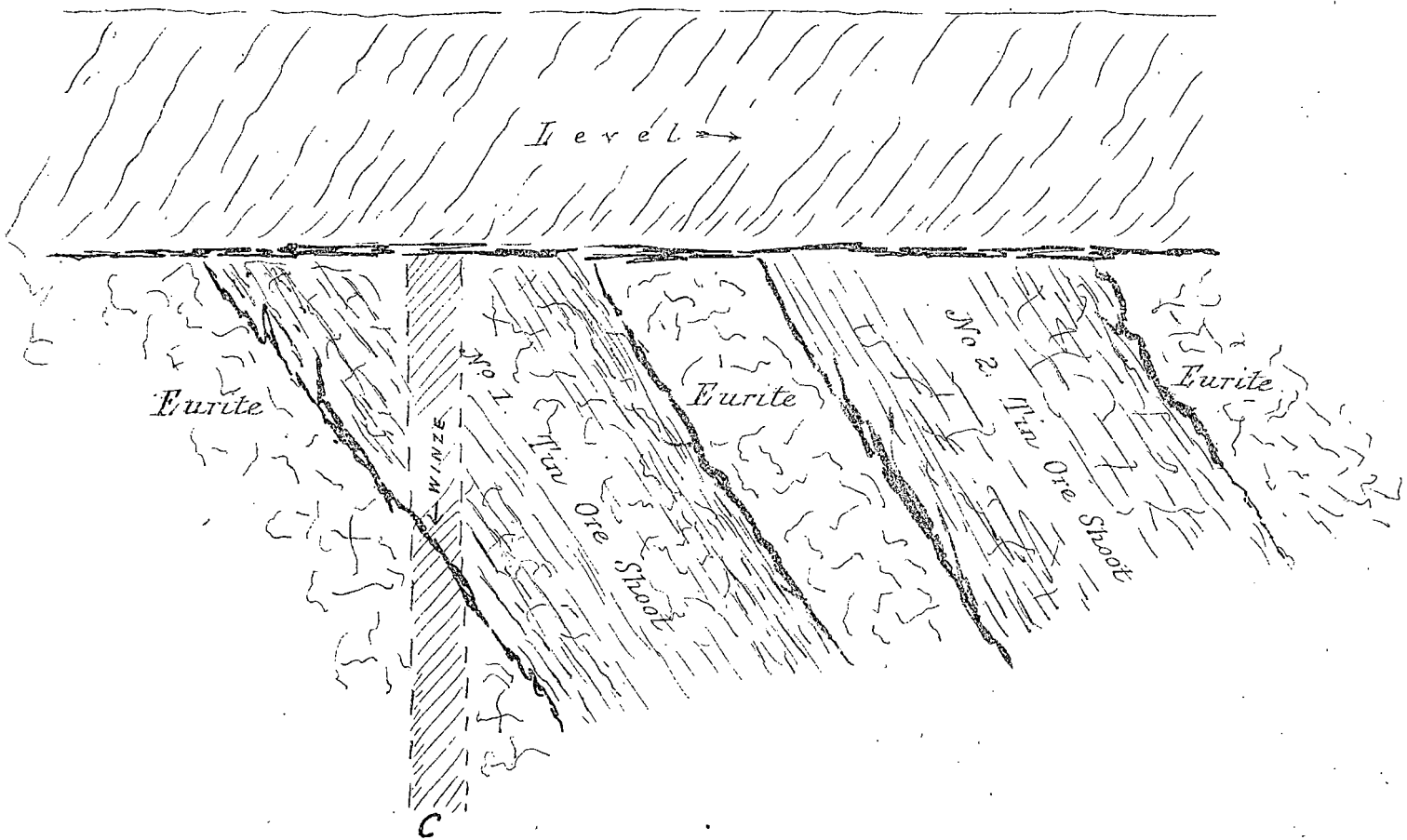
#### *The Champion Tin Mining Company.*

The *Mines* are located at North Mt. Heemskirk, about four miles easterly from those of the Peripatetic Co. An outcrop of ore having been discovered high up the range from a creek, the top adit below the former was driven for a length of 331 feet, and the tin-bearing vein again intersected gave so encouraging prospects as to induce the owners to come still lower down the range and drive another, or their present main adit, which had reached a total length of 280 feet, leaving only some 30 feet before the tinstone would again be intersected. Their main lode, and another near the mouth of the adit, have a south-easterly course, and in the upper adit, at 320 feet, a branch of good tin ore carrying vein-matter was found from 18 inches to 2 feet in width. The whole country consists of a very dense and extremely hard *porphyrite*, here and there containing nests and pockets of tourmaline, copper, iron pyrites, and some fluor spar. A prospect taken from the vein in the upper adit gave on washing both ruby and black tin ore. Owing to the excessive hardness of the strata, it is doubtful whether these tin ore deposits will pay for working in the ordinary way of remunerating the miners on this West Coast, though it is quite possible that at this and several other mines the tribute system would prove beneficial alike to employees and employers. No reduction machinery has been erected at this mine, but both water supply and sites are favourable for the same.

# PLAN



# LONGITUDINAL SECTION



*The Cornwall Tin Mining Company.*

*The Mines.*—Since my last inspection, in June, 1882, the mining operations have had but very little attention bestowed upon them, and it is reported that the ore saved for crushing, from a vein on the east side of Packers' Creek, after passing through their crushing and dressing plant (also erected since), did yield but very little ore. After that, a discovery was made on the western side of Packers' Creek, and several tons of ore were saved by the concentrating machinery, and shipped to Melbourne. That deposit, however, was soon after abandoned, I am informed, on account of the ore, at but very few feet from the surface, being found to rest upon and being cut off by a hard floor of granite. On examination of the old workings it was discovered that that floor was covered by a vein of unctuous greyish clay, and that this seam dipped to the north; there was every indication, besides, of the upper portion of this deposit—now removed—having been displaced in a northerly direction through or by means of a "fault" or a "slide." It would take but little trouble to prove whether this is, or not, the correct view, especially as the ore was very rich, I am informed; in any case, so promising a deposit should deserve a further trial. Previous to any more permanent work being undertaken, such as for instance, a main adit from near the crushing-plant, the exact angle of "dip" of that "fault" or slide should be ascertained, in order to be able to plan the future operations with every possible accuracy.

*The Crushing and Concentrating Machinery.*—This powerful and comprehensive plant has been unfortunately placed in an almost inaccessible position on the sea coast, whereas as good and better sites could have been found inland on Packers' Creek, which stream even now supplies the water as motive power, necessitating however the construction of a large tunnel through which it is led in a circuitous manner to the head sluice at the waterwheel. The plant has been completed since my last inspection, and it was observed that it evidently required better care and attention as regards cleanliness, &c. An overshot waterwheel 40 feet in diameter, 4 feet breast, works a 10-head battery, from which the crushed ore is fed to two *Frue's Vanning Concentrators*, which were fully described in my Report for 1882 as Inspector of Mines, and of which the mining manager has given testimony that they have afforded the greatest satisfaction. The thereby impoverished sands are then supplied to two of Borlase's buddles, the four arms of which are furnished with split canes instead of bagging or iron scrapers, and finally, cleansing the ore and of slimes are effected on a third Borlase's or slime table, followed by a treatment in a hydraulic "cleaner" and a series of settling-boxes. The ores were strongly impregnated by tourmalines, and therefore offered, on the buddles principally, and not on the *Frue's Concentrators*, very considerable difficulties in separating that fibrous mineral from the ores, as it formed a kind of dense matting, which, on a firm bottom like that of the buddles, became as solid as a concrete. On the *Frue's Concentrators*, I am informed, no such matting could possibly take place, as there was not such a solid, but an ever vibrating resistless bottom on their endless and revolving wide India rubber belts.

*The Cliff Tin Mining Company.*

*The Mines.*—But very little work had been done here; and that extensive deposit or lode, the outcrop of which I traced in 1881 for over one thousand feet in length, had scarcely been touched at all. A few tons of surface tinstone had been removed for crushing, and a shaft had been sunk to less than 20 feet in depth. Notwithstanding the very favourable indications on that lode, more attention has been devoted to two other lodes nearer the sea coast. My informant showed me what has been termed the "junction lode," which bore nearly north by south, and the whole of it for a length of about 75 feet by a width not exceeding two feet, as well as its rich surface shavings, had been sent to the battery. Very good ore was traced here to a depth of about 25 feet, when an interruption to its regular course took place, in precisely the same manner as at the Cornwall Company's mine, by a "slide" likewise dipping to the north; after sinking six or seven feet only on this slide, no further attempt was made to trace same to the missing part of the deeper lode. From the description given me of the angle at which the slide dipped, and as the inclination of the upper part of the lode was still in view, the continuation of that deeper lode should be sought for beneath the Cliff Creek, to the north of these present workings. The other, or east-and-west lode, a few chains nearer the coast line, although differing in its lines of strike, may, as well as the north-and-south lode, be taken as the one lode only, as it appears quite likely that a strong dyke of euristic porphyry occurring about midway between the two, and crossing their strike, has caused their disconnection; in both the vein-matter is similar, though at the surface the east-and-west lode produced the richest ore as embedded in chlorites. However that may be, this last lode was very rich to about 17 feet from the surface, I am informed, when it was also cut off by a "slide" or a fault, and has not been, so far, traced to a greater depth. At its outcrop a vertical shaft was sunk to a depth of about 70 feet, but, as both the lode and the fault trend to the north, the shaft has been of no use whatever in exploiting the mine, because, with increasing depth, the greater the distance would be from the lode in question.

*The Crushing and Concentrating Machinery.*—Like the Cornwall Company, this proprietary, without in the least regarding the future supply of ore for treatment in the dressing-sheds, as will be seen from the fact that they had but 17 feet in one place and about 25 feet of backs on another lode

in sight, on shoots of ore not exceeding 75 feet in length each, have also erected a crushing and concentration plant. They are very badly situated for water, the supply of same for motive-power being very limited, as their gathering area is small, and the shallow creek draining same is very frequently quite dry. Not less than three dams have been built across this creek, of which, however, two were soon destroyed on account of the faulty design adopted, and of the unsuitable material used in their construction. They were about 10 feet wide on top, with an inside batter of but 2 feet in 12; outside batter, 3 feet in 14 feet. A kind of puddle trench was formed throughout their length in the centre, but as the clay used, instead of being impervious to water, was of a gritty and sandy character, these two (upper) dams were soon demolished by the sudden freshets so characteristic of Mount Heemskirk. The lower (remaining) dam, of an improved design, alone remains for the use of the plant, which consists of an overshot waterwheel 18 feet in diameter, 4 feet breast, which works five heads of stampers—provision made for another five. The crushed ores are discharged into three connected Cornish tyes, thence into three similar strakes, which feed two of Borlase's buddles, constructed on the same principle as those at the West Cumberland and Peripatetic Companies' mines. The slimy residues, after collecting the coarser ores at the base of the truncated cones, are then treated on automatic "dead frames," hand-dressing tables, and finally in "tossing-tubs."

*The Empress Tin Mining Company.*

*The Mines.*—Of this, as well as that of the Montagu and Montagu Extended, nothing positive can be said, because of their workings being filled with water; and in giving the following statements—as I have in this Report of also the Cornwall, Cliff, and Montagu mines—it should be borne in mind that, as they were not working or accessible for inspection, those statements are only iterations of explanations and descriptions given to me, and noted at the time in my field-book, by the Mining Managers or the persons left in charge as caretakers. In doing this, the completion of this Report was principally kept in view, and I cannot vouch for the correctness or otherwise of their statements.

This Company has erected the only steam winding and pumping plant on the West Coast, being supplied with steam from a Cornish flue boiler—multitubular—for a horizontal 12-inch cylinder engine, driving a double winding-gear and pumping-gear with seven-inch lifts.

The shaft has been sunk to a depth of 111 feet, and has been opened out at the 105 feet level. Water stood at the time of my visit at the 53 feet or adit level, operations having ceased for some time previously. I was informed by the Mining Manager left in charge that the last tin ore beneath their rich surface outcrop had been met with at a depth of only 27 feet in their main shaft, and that from that point the "lode" had been followed vertically without meeting any more ore. It would thus be seen that ore occurred from the surface down to 27 feet; none from there to the adit level (53 feet); and none to and at the bottom level (105 feet); but that the Mining Manager anticipated, for some occult reason or other, to strike ore again at still greater depth in the "lode" followed. The lode below the 27 feet level is described as nearly vertical, with an underlay of 1 in 3, and levels had been driven on its east-by-west course for a total length of 160 feet at 105 feet from the surface. In these levels, at 36 feet "in" from the shaft, the supposed lode was found to be of the same size, measuring from the hanging-wall, as at the adit or 53 feet level; and that, in the soft country to the north, the anticipated junction with the north-and-south lode had not been met with. After very close examination by means of very powerful lenses of the upper or really tin-carrying stone, and that from the lower continuation (supposed) of same below the 27 feet level, I found a remarkable difference. The upper *tin-bearing* lodestone is embedded in a foliated euritic porphyry, with orthoclase predominating, and very little quartz. The supposed lodestone beneath the 27 feet level exhibits, instead, a highly quartzose porphyry, charged in places heavily with arsenical, iron, and copper pyrites, with tourmalines, and is therefore (from a mineralogical point of view) decidedly different from the former. As the shaft was timbered up I could not very well make a closer examination, but would suggest that that Company should cause the shaft to be opened out at the 30 feet level and ascertain whether, as I have good reason to believe, a fault, so prevalent on that line of country, has not displaced the lode from its original course, and that the continuation of same does not exist, as averred, in the lower metalliferous porphyritic dyke most probably mistaken for the "lode." If such assumption be correct, then the present shaft could be utilised without adding to its present depth, as is, I understand, contemplated.

*The Orient Tin Mining Company.*

*The Mines.*—It may be stated that a very considerable amount of prospecting and other "dead work" has been done here since my last visit, without, however, it is to be regretted, leading to the discovery of productive or remunerative tin ore deposits. As regards the work done, the measurements given me by the mining manager are as follows:—"Shafts sunk, 110 feet; cross-cuts driven, 1120 feet; driven on the course of veins and lodes, 615 feet,—or a total of 1845 feet: and that 360 tons of ore gave 55 bags or 2 tons 15 cwt. of cleaned ore." The original outcrop (Thorne's) has not had so much attention given to it at or near the surface as it undoubtedly deserved, and the

numerous shafts, air-shafts, levels, cross-cuts, and adits, all excavated some distance away from that outcrop, constitute quite a large mining concern. It is not deemed necessary for the purposes of this report to describe every one of these workings, but to state the result of my very careful examination of the various deposits and of the close inspection of all the workings, with a view of connecting same with the opinion formed as to future prospects. In doing this, the percentage of ore said to have been obtained from the various ore bodies and particularised by the mining manager are discarded, for the reason that they do not, in my opinion, convey a correct idea of the value of such ores; and that without stoping, and taking quite a series of such tests systematically and for a considerable length of time, they are more apt to mislead than to guide.

In the 50 feet adit a shoot of tinstone was, near the entrance, met with, having a general trend towards Thorne's outcrop; but instead of driving on its course in that direction, the adit has been made to cross same obliquely, and, consequently, is driven *beyond* and *away* from it. This will be better understood by stating the bearings of the lode at N. 42 E., and of the adit at N. 58 E. As that ore-shoot contained a little tin, dipped and trended towards Thorne's, it would have been but reasonably judicious to follow it, or its continuations from that or other points, so as to get beneath that rich outcrop. As it is, I am informed, the only other place where Thorne's is supposed to have been met with is in a cross-cut in the 85 feet level below, where a similar vein has been intersected, but not tin-bearing, which is not an unusual circumstance by any means in that district.

In the strictly granitoid country traversed by intrusive eurites several poor veins of tinstone have been found, and traced severally for considerable distances. No appreciable results followed, only it was observed that they, so to speak, "*thickened*" at irregular intervals, thus forming shoots, which generally led up to *very* moderate increase of ore at those parts. In one or two instances these were proved to dip beneath the bottom of those levels.

In the metamorphic clayslates, "*killas*," (south of the 50 feet adit), at the 85 feet level, three or four air-shafts tend to ventilate a main drive, from which four crosscuts have been driven easterly on as many veins, of which the first two consist all of pyrites, the third of quartz and pyrites, and the fourth the same, with a fair prospect of tin ore; but as that vein is only from 6 to 8 inches thick, and the others even less, they cannot be worked with any prospect of profit. Those narrow veins underlaying at various angles are likely to join at a depth the No. 3 vein, but the fact appears to be that there are too many of these narrow veins in the slate country to render such a junction sufficiently extensive or rich to sink deeper, so far as present appearances indicate. Singularly enough, in a level driven west from No. 3 shaft for a distance of 60 feet through slate, the granite country was met with, and a fairly promising deposit of ore was found to exist within the contact lines between the primary and secondary rocks. This may be considered a favourable indication to follow up, and to test further by means of a prospecting level, keeping those two rocks at either side and the "*joint*" in the centre, because it is quite possible that some of these or other veins occurring in either rocks may have formed ore deposits there, and it is just as likely that such, if intelligently followed, may lead to the discovery of stronger lodes thereabouts. Experience has taught miners that it is more judicious for them to *follow* any real ore deposit than propound theories which, though may be successful in one district, are not likely to be so always in other mineral regions, although with the same kind of ore.

Their deep adit, which has been started considerably below the hoppers at the battery, has been driven for a distance of 300 feet, and it will eventually give 50 feet under the present bottom of the whim shaft in this drive. Thorne's lode, it is believed, was cut at 250 feet, very regular and fairly tin-bearing; further on the Wheel Lode, which was exposed when making room at the hillside for the ore-crushing and dressing machinery, was intersected at 250 feet in from the entrance, for a width of 12 feet, carrying a little tin-ore, but not at all tested further. Another small lode, one foot wide, designated the Dam Lode, also somewhat stanniferous, and at the end of this adit promising spurs three inches thick were discovered. Having now briefly described all their tin-bearing deposits, there remains nothing but to draw attention to a feature which is likely to have a direct bearing on the future prospect of this mine, if the indications observed are accepted as a guide. In the southern portion of these leaseholds all the spurs, veins, and outcrops underlay to the west, and in the northern ground they underlay east, thus forming an extensive synclinal section, the Wheel Lode being the exception, as that is very nearly vertical; that lode must, therefore, from all appearances come into contact with those northern and southern poor tin-bearing veins at either side of the former. It is quite possible also that where that Wheel Lode comes into contact with the granite there may be a fair deposit of ore, and under any circumstances with the evidence to hand it would be judicious to test the "*joint*" between those two formations in a thorough manner. It should be mentioned that the Wheel Lode, where intersected in the deep adit, though greatly decomposed and containing much soft argillaceous vein-matter, it still yielded fair prospects of ore; the outcrop of same close to the water-wheel had also a good appearance, consisting principally of euritic porphyry with chlorites, and the whole being interspersed with attenuated quartz-veins, and it has been proved tin-bearing there also.

**The Crushing and Concentrating Machinery.**—These consist of ten heads of stampers driven by a portable 13 h.p.-engine with two cylinders of 8½ inches in diameter each, by means of a belt to the pulley on the crank-shaft.

The ore-dressing appliances are worked by means of a water-wheel 10 feet in diameter, with a breast of 2 feet 4 inches; first there are two of Munday's Patent Buddles, which empty themselves at the top of a channel lined with bagging for the interception of fine tin-ores encircling their outer periphery; the ore is then collected by means of trap-doors worked by screws and levers. The second quality of ore-sands is then conducted to two similar outside buddles, where the process is repeated; from there they are fed into a hydraulic concentrator with a sieve in the bottom, worked with fifty feet (or head of) pressure per square inch. The whole works are supplied with water from a reservoir constructed at an elevation above the batteries; they are well housed in, and though it must have cost a very considerable amount of money to excavate the site for same out of the hill-side, the whole are well arranged with a view of saving manual labour.

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The above are the mines, the proprietaries of which have, under considerable difficulties, persisted in the development of their respective ore deposits, and they have, in some instances, somewhat prematurely erected winding, pumping, and ore-reduction machinery.

So far as my examination of these tin-bearing repositories above described is concerned, I can see no reason to depart from what I stated in my first Report, No. 82, 1881; viz.:—“*Without the slightest doubt Heemskirk will, in the course of time, if the mines are continuously and efficiently worked, become a place of importance to this Colony;*” and in the concluding portion of that Report, speaking of these deposits, viz.:—“*They possess features which have shaped my opinion to be very favourable to their future behaviour when properly and systematically mined at lower levels than reached hitherto,*” &c.

Three years have elapsed since that was written, and it cannot, I submit, be said with any degree of truth that either of those conditions have been carried out to the extent required. There were in 1881 over 150 miners engaged in *mining proper and in prospecting* the very large number of leases taken up by capitalists and speculators; and it is questionable now whether the *seven* companies mentioned in this Report employ more than 50 men—not, as then, for mining exclusively, however, but as mining managers, engineers, ore-dressers, carpenters, caretakers, stamper-feeders, &c., so that the mines are being, even now, developed by a small minority of the former, thereby retarding the most important works underground. It is to be hoped, now that the production of tin ore is about to commence, that this will be materially altered, and that all those deposits will again receive renewed attention, if not on the wages', then on the tribute system, which latter works so well elsewhere. There cannot be any doubt that, as also stated in my Report of 1881, “the pernicious system of holding a large number of sections . . . for speculative purposes only,” &c., has had, in combination with the unsupported statements by unscrupulous speculators of dividends (?) accruing shortly to holders of Heemskirk stocks, &c., a very depressing effect generally, resulting in the cessation of mining operations in many cases.

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With regard to the various ore-dressing processes now tabulated, it may be observed that vein-stuffs, of whatever character, require more care and attention in treatment than is generally believed. Some of these Heemskirk lodes contain minerals possessing almost the same specific gravity as the tinstones (“cassiterites”), thus presenting great difficulties in separating same from each other. Then, again, at the lower levels, sulphides or pyrites appear to become largely associated with those ores, which will add considerably to the difficulties in separating and collecting the pure tin ores. For these reasons, any ordinary, or, it may be observed, any less scientific manipulation must necessarily eventuate in the loss of considerable percentages of ore, because proper classification as to “*size of grain*” and the collection of cleaned ores at *successive stages* during the concentration processes, is not included in the former. The object of separating or classifying progressively the coarser from the finer sands, and ultimately of the slimes also, is in the first instance to obtain successively the coarser and purer ores with every size of grain, until each class of reduced size of grain has been made to give up, as it were, by the action of proper machinery, its pure concentrated ore. With the cruder processes the crushed ores are treated for the tin they may contain as a *whole*, without classification of grain as to size, consequently some considerable portions have to be treated over and over again, and the mingled coarse and fine sands subjected together to the same hydraulic processes cause the finer and more valuable slimes to be lost together.

From the tables now submitted it will be perceived that some companies have adopted the more simple and ancient method for cleaning their ores; others, again, have introduced more elaborate systems of treatment by means of machinery which may be, as yet, regarded in the light of expensive experiments, and the importance of classification of grain has been recognised by but one company. In the first case, so to speak, a misplaced desire for economy and an objection to stepping outside of an old observed groove, now almost obsolete, has resulted in the adoption of designs and the erection of very simply constructed machinery defective from a technical point of view; and in another instance the other extreme has been reached by the adoption of too cumbersome and too complicated appliances, requiring, at the expense of excessive motive power, (happily no obstacle in this particular case,) constant, and laborious attention, together with continuous regulation of parts, and expensive repairs.

With a district like Mount Heemskirk, where the output of tin ore, by means of the appliances described, is an event of paramount interest to the public at large, matters must now be allowed to take their course, as most of the necessary machinery has been nearly completed; at the same time it is as well to draw attention to these matters so that they may be remedied at some future time, because, after all, the economic value of the Mount Heemskirk tin ore deposits can only be correctly gauged by the resulting output of pure ores, and any augmentation of same by means of more effective "cleansing" apparatus or appliances, becomes, doubtless, under the circumstances, most desirable.

Bearing in mind the undeveloped state of most of the Heemskirk mines, there is now more than sufficient machinery for all purposes erected to serve the purpose for a considerable time to come, unless new and extensive discoveries should be made.

G. THUREAU, F.G.S.

**COMPARATIVE TABLE** showing the various Methods adopted at Mount Heemskirk for Dressing Vein Tin Ores.

NOTE.—In the following the manipulations or cleaning processes are shown for a five-head battery only.

**THE CUMBERLAND COMPANY.**

*Turbines.*—One (horizontal). *Actual No. of Heads.*—Ten. (Provision made for other five heads.) *Gratings* (holes per square inch).—80 to 100.

*Process.*—Crushed sands on to splash-boards, into rotating and concentrating tubs; coarser sands to two-storied buddle (a). Slimes to rotary slime table (b) and pyramidal sizing boxes. Clean tin into settling boxes, residues into gyrating tubs and strakes lined with bagging, into tossing tubs. Clean tin (c)—Wastes.

**THE MONTAGU COMPANY.**

*Turbines.*—One (vertical). *Actual No. of Heads.*—Fifteen. (Provision made for other five heads.) *Gratings* (holes per square inch).—80 to 120.

*Process.*—Crushed sands on to splash-boards supplying St. Arnaud Classifier (two), to Sterry Hunt's American double acting jiggers, producing—No. I., coarse sand (clean) (a) enough for tubbing; No. II., fine slimes—into pyramidal sizing box and No. I. rotating table or buddle; thence into three labyrinth settling boxes: No. I., part "clean tin," (b), No. II., part to hand-buddles, residues to No. II. rotating table for slimes. These empty into two labyrinth settling boxes—clean tin (c)—overflows and residues into gyrating tubs, in which, by means of a jet of water striking the inner circumference (on the top of the water) of the tub obliquely, a gyrating motion to the sands suspended in the water is given, tending to effectually settle all heavier mineral particles in the centre.—Clean tin. Residues over strakes (d) lined with bagging—Wastes.

**THE WEST CUMBERLAND COMPANY.**

*Water-wheels.*—One. *Actual No. of Heads.*—Five.

*Process.*—Crushed sands on to splash-boards direct on to "centre-head buddle" (17in. diameter), thence on to second "centre-head buddle;" to be followed by a "dead frame" for cleaning the ore. The latter works continuously and automatically, and is intended for collecting finest tin. Clean tin—Wastes.

**THE PERIPATETIC COMPANY.**

*Water-wheels.*—One. *Actual No. of Heads.*—Ten.

*Process.*—Crushed sands on to splash-boards, direct on to centre-head buddle to three labyrinth settling boxes, thence on to second head-centre buddle, to be followed by a "dead frame," working continuously and automatically, and is intended for saving finest tin. Clean tin—Wastes.

**THE ORIENT COMPANY.**

*Water-wheels.*—One. *Steam Engines.*—One. *Actual No. of Heads.*—Ten.

*Process.*—Crushed sands on to splash-boards in to receiving-tank, by Launder's to Munday's self-emptying buddle; strakes at periphery lined with bagging (a); on to second buddles for slimes; final cleaning of ore in a hydraulic and automatic concentrator. Wastes into settling boxes for reworking. Clean tin. (b)

**THE CORNWALL COMPANY.**

*Stonebreaker.*—One. *Water-wheels.*—One. *Actual No. of Heads.*—Ten.

*Process.*—Crushed sands on to splash-boards, supplying a Frue's Vanning Concentrator (a), residues and wastes to Borlase's Buddle; slimes on to a second Borlase's Buddle (cemented bottoms.) Impure tin ore through hydraulic cleaner and settling boxes. Clean tin. (b)—Wastes.

**THE CLIFF COMPANY.**

*Water-wheels.*—One. *Actual No. of Heads.*—Five. (Provision made for other five heads.)

*Process.*—Crushed sands on the splash-boards to Cornish tyes to Cornish strakes, on to Borlase's Buddles; thence to automatic dead frames, hand-dressing tables, and finally into tossing tubs. Wastes—Clean tin.

(a) (b) (c) (d) showing collection of concentrated ores during the process.

G. F. THUREAU, F.G.S.

TABLE showing different kinds of Machinery employed at Mount Heemskirk.

|                                    |     |                               |    |
|------------------------------------|-----|-------------------------------|----|
| Stonebreaker .....                 | 1   | Labyrinths.....               | 16 |
| Steam engines .....                | 2*  | Settling boxes .....          | 15 |
| Turbines .....                     | 2   | Hydraulic concentrators ..... | 2  |
| Water-wheels .....                 | 5   | Tossing-tubs .....            | 4  |
| Heads of stampers.....             | 65† | Gyrating-tubs .....           | 27 |
| American classifiers .....         | 6†  | Strakes .....                 | 12 |
| Automatic jiggers (American) ..... | 12  | Tyes .....                    | 3  |
| Frue's concentrators.....          | 2   | Pyramidal boxes .....         | 4  |
| Buddles (rotating) .....           | 11  | Hand-buddles.....             | 2  |
| Slime tables .....                 | 9   |                               |    |

\* One of these steam-engines is used for pumping and winding—horizontal, with Cornish flue boiler, &c. The other is used for driving a ten-head battery of stamps.

† The stamps are all arranged in five-head batteries, and as provision has been made for other ten heads additional, there would be eventually seventy-five heads of stamps working in fifteen boxes or batteries.

‡ To these six American classifiers, of double capacity, two more, of Mr. Lewis's invention, should be added; the former are self-acting, and the latter are rotating in cylindrical tanks, by means of belting from the main shafting.

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