The Tin, Tungsten, and Molybdenum Deposits of Australia

An Annotated Bibliography with a Discussion of the Geology of the Deposits and of Problems connected with their Mining.

BY


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SUMMARY.

This work aims at giving a complete bibliography of published work on the tin, tungsten and molybdenum ores of Queensland. Under each paper, a summary of the contents is given, sometimes by means of quotation of important passages, sometimes by giving a resume of the paper and sometimes by a combination of the two methods. The geology of the deposit is discussed under the following headings:—Ores, Associates, Types of Deposits, Age of Deposits, Ore Shoots.

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ORES.

Cassiterite, tin oxide SnO₂, is the only important ore of tin, Stannite, tin, copper and iron sulphide, Cu₅S₄FeSnS₄, being rare in the State. Wolframite, iron and manganese tungstate, (Fe, Mn)WO₄, is by far the most important ore of tungsten, though Scheelite, calcium tungstate, CaWO₄, is found at several localities and Hubnerite, manganese rich wolfram, at one locality. Molybdenite, molybdenum sulphide, Wulfenite, lead and molybdenum oxide, PbMoO₄, are not uncommon and Ilsemannite, a mixture of molybdenum oxides, MoO₃, MoO₂, and an unnamed molybdate of iron are found at Bamford.

ASSOCIATES.

Besides the usual gangue minerals, quartz and the various acid modifications of granite, the following minerals are commonly associated with Cassiterite in Queensland: Amethyst, Chalcopyrites, Chlorite, Copper carbonates, Fluorspar, Galena, Garnet, Hematite, Ilmenite, Limonite, Magnetite, Mispickel, Molybdenite, Pyrites, Silver Ores, Sphalerite, Stibnite, Topaz, Tourmaline, Wolfram and Zircon, while Aluminitite, Cyanite, Goethite, Penninite, Rutile and Scheelite are less common as associates; in addition Corundum, Gold, Monazite, Platinum and Ruby occur with it in alluvial deposits. Wolfram and Molybdenite frequently occur together and often with them also Bismite, Bismuthinite. Bismutite, Calcite, Cassiterite, Chalcopyrites, Fluorspar, Galena, Hematite, Kaolin, Limonite, Magnetite, Mispickel, Native Bismuth, Powellite, Pyrites, Scheelite, Sphalerite and Tourmaline; more rarely Azurite, Hyalite, Ilsemannite, Molybdate, Monazite and Opal are found with them. In addition to Orvantine, Chlorite, Garnet, Pinite, Pitchblende, Psilomelane, Pyrrhotite, Scorodite, Sericite, Siderite, Stibnite, Topaz, Turgite and Tungtite have been recorded with Wolfram and rarely Gold and Barytes with Molybdenite.
TYPES OF ORE DEPOSITS.

(a) Tin. The commonest type of tin deposit is a discontinuous lode on joint planes as at Herberton and the Sundown mine near Stanthorpe. This type of deposit has probably always a structural control though this may be difficult to discern. It usually occurs in granite, granitic modifications, or metamorphics invaded by granite. Rather less commonly the lodes occupy fissures as in some cases at Watsonville and Kangaroo Hills. This type of deposit is usually found in sedimentary or metamorphic rocks. Pipes—more or less cylindrical ore bodies at the junction of two or more fractures (usually joints)—are much less common as ore bodies of cassiterite than of wolfram or molybdenite but examples are found in the Stanhills area of the Croydon Gold and Mineral Fields and some of the ore bodies on joint planes at Herberton are pipelike in form. Ore bodies in which the cassiterite occurs disseminated as a primary constituent of the rock have been important at a number of places. Such are Lode Hill, China Camp where the margin of the granite modified to greisen, and some of the granite itself was sluiced for a large quantity of cassiterite, and Boulder West Mine, Gurrumbah where a considerable quantity of low grade stanniferous greisen was mined and crushed. Cassiterite also occurs in aplite and greisen lodes (dykes) along fissures as in the Herberton district. Although cassiterite is common in the aplite dykes of this area they are usually too low grade to be payable.

(b) Wolfram. Wolfram occurs mainly as short shoots of ore at intervals along more or less continuous lodes in granite or in granite veined through with mineral bearing quartz. Both these types appear to be connected with the joint systems of the granite, for cross joints, both horizontal and vertical, frequently contain rich offshoots from the lode, extending however usually for only a short distance. These veins frequently make into large bodies of ore but usually pinch out again into almost nothing within a short distance. Wolfram frequently occurs also in quartz pipes which commonly contain molybdenite in addition or as their major ore.

(c) Molybdenite. By far the most important type of deposit is the more or less cylindrical, regular or irregular pipe. Such pipes are also an important source of wolfram in some cases and in New South Wales payable tin and gold bearing pipes are known. In size the pipes vary from a few inches up to over forty feet in diameter and in some cases they have been mined to a depth of several hundred feet.

In composition the pipes at Wolfram and Bamford consist of crystalline white quartz with vugs which vary from a few inches to a few feet across and up to twenty feet or more long. Wolfram and molybdenite occur in variable proportions in the quartz. Surrounding the quartz is bluish "quartz rock" (replaced country) or silicified greisen, then silicified granite and then normal granite.

The origin of these pipes has been the subject of considerable discussion. Cameron (1904, p. 8) regarded them as probably replacement bodies, the form of which was controlled by intersecting joints, as did Andrews (1906).

But later Andrews (1905, pp. 131-151; 1907 (a), pp. 233-237; 1907 (b) pp. 237-257) discussing the wolfram, tin and gold bearing pipes of the New England district of New South Wales considered that they were connected with joint intersections and resulted from the action of heated mineralised waters rising along them, and replacing the country rock. But he appears also to have considered that assimilation of the invaded country rock played its part for he says (1907 (b) p. 249) "in this way the 'quartzite' appears more
of a compromise between the advance agents of the rising solutions and the country . . . .” Later, following evidence brought to his notice by J. E Carne, he changed his view eliminating assimilation from the process of formation reducing it to replacement, in particular for the Bismuth, Fielder’s Hill, Rockvale and Oakleigh Mines where the ore bodies are tabular to irregular in shape, and presumably also for the pipes. (See Carne 1911 (b) p. 36). These New England pipes differ from the North Queensland pipes only in the frequent development of felspar and sericite in the centres of the pipes.

MacAlister (1907, pp. 96, 116-117) describes the carbonas of the St. Ives Consol Mine, Cornwall as pipe like or irregularly shaped bodies of tin ore, schorl, chlorite and quartz with other minerals, as nothing more than exceptional developments of the features of ordinary lodes and in all cases associated with cracks or joints, and owing their origin to great alteration and mineralisation of country rock. But from the description these ore bodies which occur at the junctions of lodes and cross veins appear more akin to the “bungs” of the Australian mines than to the pipes, though they may well represent a type intermediate between the pipes and linear lodes and thus give a clue to the origin of the pipes.

Kynaston and Mellor (quoted in Carne 1911 (a), pp. 30-32) have described tin bearing pipes in South Africa. These appear to be definitely replacement deposits, for gradual gradations are described in some cases from quartz in the centre to unaltered granite on the outside; in other cases replacement did not proceed so far, the centre of the pipes being essentially red felspar and cassiterite. Kynaston and Mellor however consider that they have no genetic connection with fissuring, though in some cases fissures have affected their form. They consider that the pipes were formed while the granite, although practically consolidated, was still at a high temperature. Relief of pressure consequent on formation of fissures at higher level, may have initiated the release from the underlying magma of the metalliferous compounds which would then have ascended in a gaseous condition through a practically unfissured zone.

This recalls the theory of formation of the “Ore Chimneys” of the Bassik Mine, the Bull Domingo mine, the Anna Lee ore chimney and others in America as discussed by Spurr (1923, pp. 858-891). Spurr considers the more or less circular (in cross section) and tortuous (vertically) ore bodies were formed following an explosion of gases like that of certain volcanoes, followed by the welling up of ore magma instead of rock magma. A different mode of origin has however been suggested by Locke (1906). Briefly, he suggests removal of rock along trunk channels by rising solutions during an early stage of their activity, collapse and brecciation of the rock thus left unsupported and deposition of ore and gangue minerals in the brecciated mass. But these ore chimneys differ in two important respects from the Australian pipes; first the ore bodies are sharply marked off from the country outside the ore body and second the ore is full of rounded fragments of the country. The ore body of the O.K. Mine at Cripple Creek, Colorado, seems more akin to our type of pipe. This ore body, 100 feet across, consists of a central chimney of pegmatitic quartz surrounded by altered and mineralised quartz monzonite surrounded again by unaltered quartz monzonite country. Butler (1920, p. 517) does not mention any fragments of country in the ore. The ore body occurs in a fissure which is not mineralised outside the chimney, but no mention is made of any other fissure or joint intersecting the main fissure. This ore body then appears to be due to ore solutions forcing their way up a weak zone in the fissure and replacing the country. Spurr comments “the hole was bored by the magma which now fills it; and this proves anew the-
power of these magmas to bore up through solid rocks. The jacket of altered monzonite around the solid pipe shows the effect of aqueous solutions, residual upon its solidification."

Other chimneys discussed by Spurr have ore bodies consisting of a network of mineralised fractures in the country rock, in reality "pipe" shaped stockworks.

These examples suggest that there are all gradations from the stockwork type in which the solutions filled numerous small fractures, through the type common in Australia in which apparently the ore magma pushed its way up intersecting joints, forcing the walls apart and in addition replacing part of the country rock, to the agglomerate type in which it was suggested that a volcanic explosion opened a vent which was partly occupied by fragments resulting from the explosion and the ore magma filled the remaining space.

Ball, however, discussing the pipes of northern Queensland (1915, 1919-1920), did not think that injection and replacement would explain all the characters of the pipes there. The features difficult of explanation were the form of the pipes, the characteristic vugs and the distribution of the metallic minerals. Ball distinguished two types of vugs—smaller vugs containing quartz crystals, large flakes of molybdenite and some kaolin; these he took to mark the sites of former segregations of pegmatite; the larger vugs are rounded elongated spaces up to twenty feet or more in length and contain "quartz rock," greisen, quartz, much kaolin and various sulphides (molybdenite, bismuthinite, etc.) some of which do not occur elsewhere in the pipes. To account for these features Ball suggested magmatic stoping and assimilation of the granite, producing colloidal silica. At a somewhat later stage gases charged with sulphides, silica, etc. diffused through the colloid and collected in pockets which later became the larger vugs containing the sulphides, etc. Surrounding this area of assimilation pneumatolysis and replacement took place producing greisen or "quartz rock."

This hypothesis appears to me unnecessarily complicated, there is no direct evidence of a colloidal stage and I fail to see that assimilation of a granite consisting of quartz, orthoclase, a soda lime felspar, and some biotite, could produce colloidal silica. It could produce a gelatinous magma rich in silica but in that case some trace would be expected of the orthoclase, biotite, etc. of the assimilated granite. In my opinion all the features can be accounted for on a theory of igneous injection and replacement.

Spurr (loc. cit.) has argued that certain types of ore bodies and veins akin to pegmatites and aplite were formed by the igneous injection of "ore magma" in the same way in which dykes are formed by the igneous injection of rock magma, and that such ore bodies should be termed "vein dykes." If we accept this suggestion, and Spurr produces much evidence in its support, the size of the pipes presents no difficulty. The form of the pipes was determined by the intersection of certain joints being the weakest places in a fracture system which on the whole must have been very tight. Although Ball distinguished two types of vugs they appear to grade into one another and I see no difficulty in all the vugs being formed by residual pockets of fluid in the injected ore magma. The sulphides one would expect to crystallise later than the wolfram and they were thus (except for molybdenite) confined to the vugs. The fact that some vugs do not contain sulphides may be attributed to the latter being in small quantity, except molybdenite which apparently began to crystallise with the wolfram and thus occurs in the "quartz rock" and quartz as well as both types of vugs. Surrounding the area of injection
is the "quartz rock" or greisen grading into granite and due to replacement of the granite country, as agreed by Ball.

It should however be noted that a colloidal stage during replacement (metasomatism) has been advocated by Lindgren (1925) and Boydell (1926, 1927), as affording a means of egress of the replaced material, which could pass through the colloid or the spongy crystalline material which it is suggested would be the first product of crystallisation from the colloid.

Discussion of this is beyond the scope of the present work but if such a phase is essential for the replacement of granite by the "quartz rock" of the north Queensland pipes it may well have preceded also the formation of the centres of the pipes though I see no necessity for assuming it to account for the vugs or the distribution of the metallic sulphides. The following questions appear to me pertinent: Why, if there was a colloid phase, is not some at least of the stannic oxide, which is found in places in the pipes, in the form of wood tin, and some at least of the quartz in the form of chalcedony? and why is there no trace of colloform structures?

The mechanism of intrusion is of interest in this connection. Niggli (1929) and Morey (1922, 1924) have shown that in a system consisting of a large quantity of a substance of low volatility as quartz and felspar and a small quantity of a volatile substance such as water, the first effect of decrease of temperature and consequent beginning of crystallisation is a great increase in pressure due to the increased percentage of the volatile in the fluid and consequently increased vapour pressure of the latter. On further fall of temperature the pressure decreases again. Goranson, (1938) who experimented with the system albite-water found that in cooling from 1100° C. and a pressure of 606 kilobars (corresponding to a depth of about 2½ kilometres) to 960° C. the pressure dropped to 500 kilobars; albite then began to crystallise and if the system is closed, i.e. the walls are impervious, when the temperature had fallen to 819° C. the pressure had increased to 3000 kilobars. This is an increase in pressure equal to the weight of about 10 miles of granite. In the case of a magma the system is not closed as the roofrocks would not be quite impervious and joints, or at least incipient joints, would exist. The effect of this would be to reduce the pressure somewhat. Further the pressure generated by crystallisation of a granitic magma or an ore magma separated therefrom, would not be the same as for the above system for the presence of the many other substances would modify the pressure temperature relations: but it is safe to say that it would be very great. If the load on the magma was great, not much less than the force exerted by the increase of pressure, injection of the ore magma would take place only at the points of greatest weakness which in general would be at the intersections of joints and fissures. In this way a roughly cylindrical ore body or "pipe" would be formed. If the load were less, escape of the pressure would be easier and would take place along lines of less weakness than in the previous case, and in this way elongated normal types of lodes might be formed.

On this theory then formation of "pipes" depends upon a nice adjustment between the increased pressure resulting from crystallisation and the load of overlying rock.

Emmons (1940, p. 190) suggests that the type of lode is determined at least partly, by the shape of the cupola of ore magma, at the margin of the intrusive; an elongated cupola would produce a lode system parallel to the elongation of the cupola and a conical cupola might be expected to have radial fractures and lodes. While the former is common the latter is rare and Emmons
suggests that ore pipes might be formed in place of the radial pattern but gives no reason for the alternative. Perhaps the lode pattern is influenced by both the shape of the cupola and the balance between the pressure due to crystallisation and the overlying load.

If the temperature fall is sufficiently rapid the rise in pressure is rapid and the succeeding fall equally rapid, so a suction effect due to the rapid fall in pressure would follow the blast or explosive effect due to the rise in pressure. This suction effect might cause the rounding of fragments of country rock noted in several of the American ore pipes mentioned above, by temporarily sucking back the ore magma and with it the fragments of country rock.* Whether or not the effect was manifested would depend on several factors. First the nature of the intruded rock, whether tough or brittle; second, the balance between pressure and load—a greater margin between the two than in the case of pipes without country rock fragments, or the explosive or blast effect would not be great enough for shattering; third, this margin would probably not be attained unless the magma were relatively near the surface so that breccia pipes are more in the nature of volcanoes and in some cases may have actually reached the surface.

AGE OF THE DEPOSITS.

It is generally agreed that the tin, tungsten and molybdenum ores belong to the final stages of the various granitic masses with which they are associated, so that the fixing of the ages of the ore bodies resolves itself into the determination of the ages of the various granites.

The evidence of the age of the granites has been summarised and discussed by Skects (1930), and little can be added to that excellent summary. It is suggested that the majority of the tin, tungsten and molybdenum bearing granites of Queensland are of Permian (Perm-Carboniferous) age, a view which is supported by David (1932). It should be pointed out however that the "sandy" granite at Stanthorpe which is stanniferous is very similar to the "sandy" granite of the New England district of New South Wales which Andrews (1905) thought to be early Mesozoic, which view received support from evidence obtained by Richards, Bryan and Whitehouse in the Drake area, where a similar granite was found intruding rocks of Mesozoic, probably Jurassic age. This suggests that the granitic intrusions of the Stanthorpe area continued into the Mesozoic, the stanniferous "sandy" granite being one of the latest. Dr. Bryan however has informed me that Madigan has advocated (in letters) a different interpretation of the evidence. He favours a strong unconformity between the Mesozoic strata and the granite, the former having been deposited on a very irregular granite surface, slumping of the sediments around high points of the granite producing an appearance of intrusion. Professor Richards and Dr. Bryan, and later I myself re-examined the area and all are agreed that the evidence is inconclusive and either interpretation may prove to be correct.

A similar inference was drawn by Jensen (1920, 1923) concerning the tin granites of North Queensland. At Newellton the granite intrudes the Devonian Hodgkinson series but not the Star sediments with Rhaecopteris. From this Jensen infers that this and other similar tin, tungsten and molybdenum granites of North Queensland are Upper Devonian or Lower Carboniferous, but that the "Newer granites" of the Etheridge and Croydon districts are of

* I have to thank Dr. W. H. Bryan for calling my attention to the significance of the sudden rise and equally sudden fall in pressure due to the beginning of crystallisation, the production of a suction effect, following the explosive.
Carboniferous or later age, probably late Carboniferous. Skeats accepts the evidence for Newellton but considers the other granites to be Permian and indeed it may be very unsafe to generalise for a large part of North Queensland from the evidence of the very limited area of Newellton.

**Ore Shoots.**

The determination of the factors which localise ore shoots as a means of predicting the position of shoots and thus directing prospecting and development has always been a subject of great importance and much discussion. The practical results have however been meagre especially as to generalisations which could be applied to most or to all mines of a particular type. One is forced to the conclusion that frequently each mine and almost always each district must be treated as a separate problem.

Hulin (1929) says (p. 19) "In short, the deposition of ore is dependent on the physical-chemical conditions of temperature, pressure and concentrations of the mineralising solutions, while the control of the locus of deposition is mechanical, being dependent on favourable local structures coupled with fault movements occurring at the proper time during the sequence of mineralisation." He classifies favourable structures as follows:

1. Variation in Strike of Vein; 2. Variation in dip of vein;
3. Intersection of veins and cross-faults; 4. Vein intersections;
5. Simple shear along veins; 6. Torsion structure;
7. Saddle Trough and Leg Reefs; 8. Mineral Pipes;
9. Miscellaneous structures.

The majority of tin, tungsten and molybdenum deposits of Queensland fall under two headings: (1) Deposits on joints and (2) Deposits in pipes, both of which fall into No. 9 of Hulin's classification, but were not discussed by him.

With regard to the first type, typified by the tin mines of Herberton, in which the ore occurs on joint planes and a shoot of ore may end in either an horizontal or vertical direction at any time, and be succeeded by only a thin vein, often a mere knife edge, which may later open out into another shoot. Ball (1923 a, b, c) mapped as far as possible the joint systems in some of the mines at Herberton but without being able to determine the factors which localised ore deposition. He pointed out the necessity for this work of complete mine plans of earlier workings showing the joint system and ore values, plans which are rarely if ever available.

Work by the Aerial Geological and Geophysical Survey of Northern Australia at Herberton led to the suggestion put forward in the report for 1937 that the formation of the lode depends on the intersection of three planes —two joint directions and a pitch, which in many cases leads to complicated conditions. This theory with modifications was repeated by Broadhurst (1942) for Herberton and Watsonville, but he concludes that a complete geological mapping of the fields both surface and underground, probably followed by diamond drilling, is necessary for the reopening of the fields.

After two years of study of the literature and the visiting of a fair number of the mines, I am inclined to concur in this view, despite the meagre results of the good work along these lines begun by L. C. Ball.
REFERENCES TO LITERATURE.

Figures in heavy type refer to papers cited in the annotated bibliography following.


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While the bibliography aims at being as complete as possible it is probable that some references have been missed. It is hoped that such are of minor importance. References to the Annual Progress Reports of the Geological Survey are not included unless the information is not published in other reports.

ABBREVIATIONS USED.


2. GREGORY, T. F.; "A Report on the Tin Discoveries in Queensland." Q.J.G.S. Vol. xxix, pp. 1-5. With reference to Stanthorpe he quoted from notes furnished by D'Oyley Aplin saying that Cassiterite is associated with granite alone and while the granite has a pink or red orthoclase and usually black mica, when cassiterite is associated the mica is white. The cassiterite is usually found along the margins of quartz veins which form a network in certain zones of the granite.

1874. 3. HUME, W. C.; "Report on the Queensland Tin Field." Published as a pamphlet of 31 pages. Includes a geological map of the Stanthorpe district showing granite, slates and volcanic rocks. A number of stanniferous veins are described.

1879. 4. JACK, R. L.; "Report on the Geology and Mineral Resources of the District between Charters Towers Goldfield and the Coast." G.S.Q. Pub. 1, with two maps. Mentions the occurrence of alluvial cassiterite in Running Creek, a tributary of the Star River, and that magnesia alumina garnets and yellow topazes occur with it.

1881. 5. JACK, R. L.; "Report on the Wild River Tin Mines." G.S.Q. Pub. 9, with one map. This report described the area in which the town of Herberton is now situated. The map shows the area to be occupied by granite and porphyry. Eight lodes were described, the Great Western as a granite dyke impregnated with tin and iron ore, the No. 2 Wild Irishman as having brown ferruginous ore, replaced to some extent at depth by a black argillaceous gangue with joints and faces coated with fibrous serpentine; the other lodes were described as having mainly quartz as gangue. Jack expressed the opinion that the ore would persist in depth and would be payable if a battery were to be erected.

1882. 6. JACK, R. L.; "Stanthorpe Tin Mining District." G.S.Q. Pub. No. 12. Describes two distinct types of tin bearing rocks—quartz reefs and igneous dykes (granular quartz, fine scaly lithia bearing mica and small crystals of tinstone, striking N.N.E. to E.N.E., coinciding with a system of vertical jointing). Refers to quartz reefs on the left bank of Quartpot Creek containing much wolfram and some moderate sized crystals of tin. Suggests the dykes have good prospects but the reefs poor, except for occasional bunches of ore.

1888. 7. JACK, R. L.; "Tin Mines of Herberton, Western and Thompson's Creek Districts, and the Silver Mines of the Dry River, Queensland." G.S.Q. Pub. No. 13 with two maps. Describes 111 claims. Considers there is an intimate connection of the tin deposits with metamorphosed igneous dykes. The dykes were intruded into fissures in the solid porphyry and consolidated as basic igneous rocks, and gradually metamorphosed. They now consist mainly of quartzose chlorite and occasionally quartzose serpentine. Jack inferred they were originally quartz diorite or more or less basaltic. Tin occurs in floors, veins and pipes among the joint planes of the dykes. It may have come up with the dykes and been dissolved and redeposited or may have come up after formation of the dykes. No evidence favouring deposition from vadose waters. The dykes are traversed by another series of quartz porphyry (elvan) dykes which are barren except for the "Three Star" and "Herberton Ironclad."


1887. 11. JACK, R. L.; "Geological Observations in the North of Queensland, 1886-7." G.S.Q. Pub. No. 35, three maps. Mentioned tin discoveries near Cooktown and described claims at Mt. Amos and Rossville, and quartz reefs, up to ten inches wide, in granite with a good deal of arsenical pyrites, a little wolfram and much tourmaline. Described the reef on Owen and Davidson's lease as "a sinuous pipe vein."

12. JACK, R. L.; "On Mineral Lease 276, Watsonville." Legislative Assembly Paper, 14th May, 1887, and G.S.Q. Pub. No. 37. "The mines occur in greywacke and shale country, and the tin ores are sometimes mixed with and sometimes associated with copper carbonates, and are sometimes pure and unadulterated." "It is notable that the shoots of ore in this claim die off in serpentine." "Probably the East-West fault is occupied by a lode in which bunches of ore alternate with blanks, the adjacent country rock being impregnated, along such weak places as bedding planes and joints, with masses of ore, forming sometimes huge ' carbonas.'"

The "Ironclad" is "less a lode than a great thickness of mineralised sedimentary rock; the mineral deposits having emanated from the great east and west fault or from a lode not yet discovered."

The yield of lease 276 up to November 1886 was—1,287 tons 12 cwt. of ore valued at £64,382 7s. 6d.

13. JACK, R. L.; "Report on the Geological Features of the Mackay District" with two maps. G.S.Q. Pub. No. 39. On p. 6 refers to a lode two and a half miles N.N.W. of Eungella station (on the Broken River) with 12" to 18" of ore, a mixture of quartz, mica, garnets, wolfram and iron glance, the garnets comprising about one quarter of the volume. The country rock is granite.


15. RANDS, W. H.; "Glenelg and other reefs in the neighbourhood of Thane's Creek and Talgai, and Certain Mineral Deposits near Stanthorpe." G.S.Q. Pub. No. 40. P. 4. Wellesly Tin Mining Co.—workings on selection 347, six miles due east of Stanthorpe. Workings Nos. 1 and 4 were in a micaceous greisen, with no defined lodes. Workings Nos. 2 and 3 were lodes in a siliceous granite. Pikedale lode—10 miles west of Stanthorpe; a number of parallel veins one to six inches in width in granite, a total of five to six feet in width. The lode material was a soft reddish quartzose greisen.

Mundubbergmere—a large number of greisen lodes, close to the boundary of the granite.


1888. 17. JACK, R. L.; "Geology of the Russell River." G.S.Q. Pub. No. 45. Fine grained alluvial cassiterite is associated with the alluvial gold. The left bank of the river is granite and the right a fine grained hard siliceous greywacke.


1890. 19. JACK, R. L.; in "Annual Progress Report of the Geological Survey for the year 1889." G.S.Q. Pub. No. 58. Refers to Mt. Elliott as being all granite and says "the marked resemblance however of the granite to that of Mt. Bartle Frere suggests the possibility of the occurrence of tin ore as in the mountain referred to."


Romeo, Mt. Hartley, Mt. Amos, and Collingwood. The country is described as slates and schists intruded by granite and the lodes as true fissure lodes. The ore occurs in floors, veins or pipes, among the joint planes of the dykes. Minerals associated with cassiterite are Aluminit e, Azurite, Chlorite, Fluorspar, Goethite, Haematite, Limonite, Malachite, Mispickel, Penninite, (? hydrous talc), Pyrites, Quartz, Topaz and Wolfram. The yield of the field up to the end of 1888 was 4,851 tons 10 cwt. of ore which gave 342 tons 12 cwt. 1 qtr. 4 lbs. of cassiterite concentrates.

25. MAITLAND, A. GIBB; "Coolgarra Tin Mines and Surrounding District." G.S.Q. Pub. No. 72, with a geological map. The country rock of the whole mining district consists of alternations of mica schists, talc schists, greywackes, grits, conglomerates, quartzites and limestones. The schists and quartzites are frequently interspersed with minute garnets which at times are so numerous that for practical purposes they form the joint planes. Minerals associated with cassiterite are Aluminite, Azurite, Chlorite, Fluorspar, Goethite, Haematite, Limonite, Malachite, Mispickel, Penninite, (? hydrous talc), Pyrites, Quartz, Topaz and Wolfram. The yield of the field up to the end of 1880 was 597 tons 2 c.wts. of cassiterite concentrates.

1892. 26. JACK, R. L.; "The Kangaroo Hills Silver and Tin Mines." G.S.Q. Pub. No. 82, with a geological map. The country rock of the whole mining district consists of alternations of mica schists, talc schists, greywackes, grits, conglomerates, quartzites and limestones. The schists and quartzites are frequently interspersed with minute garnets which at times are so numerous that for practical purposes they form the joint planes. Minerals associated with cassiterite are Aluminite, Azurite, Chlorite, Fluorspar, Goethite, Haematite, Limonite, Malachite, Mispickel, Penninite, (? hydrous talc), Pyrites, Quartz, Topaz and Wolfram. The yield of the field up to the end of 1888 was 4,851 tons 10 cwt. of ore which gave 342 tons 12 cwt. 1 qtr. 4 lbs. of cassiterite concentrates.

27. JACK, R. L.; in JACK, R. L., and ETHERIDGE, R.; "Geology and Palaeontology of Queensland and New Guinea." Roy. Soc., pp. 768, with 68 plates and a geological map. F. 5 "Herberton Tin Field." The country rock is divisible into three classes, (1) a perfectly normal granite, (2) a porphyry of quartz and felspar (quartz predominating) with mica as an occasional or accidental and not essential constituent, and (3) highly inclined greywackes, quartzites and shales. The rocks of the first which extend northwards from Watsonville appear to be nearly barren of tin ore, at least in the neighbourhood of Herberton and Watsonville, although at Return Creek they contain tin lodes. Those of the second class were for a time regarded as the only seat of the tin deposits; but it is now questionable whether those of the third class do not excel them in this respect.

The porphyry rocks are intersected in every direction by large 'elvan' dykes (compact, highly silicified, yellowish or greenish felspar base with blebs of quartz). These elvans contain a good deal of arsenical pyrites, but—except in the case of the Three Star Mine—have not yet proved to be tin bearing to any great extent. Dykes of quartzose chlorite and quartzose serpentine—probably originally intruded among the porphyry as quartz diorites, or as rocks of more or less basaltic type, and subsequently metamorphosed—form the chief matrix of the tin ore in the porphyry country. The ore occurs in floors, veins or pipes, among the joint planes of the dykes. Associates of the cassiterite are fluorspar, wolfram, and rarely tourmaline.
"It seems most probable that the tin first came up in solution after the consolidation of the dykes."

"Their (veins etc.) intimate connection with the dykes was a sufficient guarantee of their great vertical range."

"In the sedimentary country rock . . . . the lodes, although themselves sometimes poor for a distance, send off huge 'carbonas' of tin and copper ore, along the bedding planes of the shales and greywackes." Associates of the cassiterite in these lodes are arsenical pyrites, bismuth, stibnite etc. The yield of this district for 1879-1890 was 21,028 tons 12 cwt. of tin concentrates.

P. 7 "Kangaroo Hills and Running Creek Tin and Silver Fields." This is a summary of the report by Maitland 1891, see 24.

P. 10. "Annan and Bloomfield Tin Fields." Yield 1885-90 3,712 tons of concentrates, the greater part of which must have been alluvial. The principal lodes occur in granite or syenite country. The ore is mostly in pipes or shoots, associated with quartz, wolfram and tourmaline, the latter often in considerable quantities.

1893. 28. JACK, R. L.; "Russel River Goldfield." G.S.Q. Pub. No. 89. Alluvial cassiterite is associated with the alluvial gold. "The discovery of auriferous reefs or tin lodes may, however, be confidently expected as the work proceeds."


P. 4 "The Native Youth Tin Mining Co., Annan River." The lease is on the Annan River in granite country, with slates and schists not far distant. The tin is alluvial. The Southern Cross lode is situated 1 mile below Clunn's Falls; quartz and tourmaline are associated with the cassiterite.


1895. 31. MUNDAY, J.; "Notes on Tin Mining in and around Herberton, North Queensland." A.A.A.S., 6th meeting, Brisbane, 1895, pp. 375-381. Disagrees with Jack's theory that the tin producing veins of the Herberton district are metamorphosed igneous dykes, pointing out that in deep ground he observed that "The veins develop more quartz and present a greater resemblance to ordinary lode veins, the enclosed mineral being in a more banded form and parallel with the walls of the enclosing fissure."


P. 26. "Herberton Deep Lead (Tin)." "Waterworn, current bedded sands and gravels, with loams, from 5 to 25 feet in thickness, lying beneath a flow or flows of basalt." There are several channels over an area at least half a mile in breadth.

P. 27. "Watsonville Mines." The permanence of these mines is as certain as anything can be in the nature of a mine. The ore occurs as well defined lodes and as impregnations of the country rock along lines of faults and other fissures. "Montalbion District." The tin and silver mines are small and the output limited but the tin ore is very rich.

P. 27. "Chillagoe District." Refers to the Vulcan (tin) Mine as the richest tin mine in the district but that it had been once if not twice abandoned as "differed out."

33. SKERTCHLEY, S. B. J.; "Deep (Tin) Lead, Herberton." G.S.Q. Pub. No. 115, with five plates. Gives his opinion that the oldest rocks of the district are Permo-Carboniferous, but in a footnote R. L. Jack explains that unpublished evidence recently reached him suggesting these to be Devonian. These rocks are sandstones, grits, conglomerates, greywackes, slates and schists. They were faulted and metamorphosed and intruded by granite and then by porphyries, which also intrude the granite and send off elvan dykes into it and into the slates, etc. Associated with, but generally or always subsequent to the porphyries was the intrusion of basic (diorite) dykes and other fractures through which the tin was brought up. From 1883-1895 a total of 4,529 tons of cassiterite concentrates of an estimated value of £199,595 was won from the deep lead.


35. RINGROSE, R. C.; "Notes on the Conglomerate and Sandstone Series of the Wild River Valley and of the Head Waters of the Walsh River." P.R.S.Q. Vol. xii,
(for 1896) p. 54. Description of unfossiliferous sandstones and conglomerates apparently equivalent to the *Rhacopteris* beds at Newellton. (See Stirling, 62.)

36. SKERTCHLEY, S. B. J.; "Tin Mines of Watsonville." G.S.Q. Pub. No. 119, with two geological maps, etc. The district contains gold, silver, tin, copper, lead, antimony, bismuth, manganese and iron. The various minerals are not confined to any particular rocks, but are found alike in the sedimentary and igneous series, excepting the basalt. Nor can one determine any definite zones for particular minerals, for although the tin, gold and silver deposits are usually separate, they frequently occur either together or in close proximity and under similar geological conditions. At Herberton gold occurs frequently in proximity to tin and silver. At the North Australian, Watsonville, tin and copper are intimately associated.

The primary source of the ore is deep seated. Tin, silver and gold are everywhere associated with intrusions of dykes and elvans. Around Herberton the tin is largely connected with and often contained in dykes of basic rock and as frequently in the immediate vicinity of elvans. The dykes are intruded along faults and the shoots of ore appear to be due to fractures, being sinuous both horizontally and vertically and therefore pinching and widening.

Production 1883-95—142,601 tons 14 cwt. 1 qtr. of ore which yielded 22,618 tons 14 cwt. 7 lbs. of tin concentrates.

1898. 37. JACK, R. L.; "On the Chillagoe District and Projected Railway." G.S.Q. Pub. No. 134, Bull. No. 9, with one map. Expresses the opinion that the district will produce much tin and wolfram.

38. SKERTCHLEY, S. B. J.; "On the Geology of the Country round Stanthorpe and Warwick, South Queensland, with special reference to the Tin and Gold Fields, and the Silver Deposits." G.S.Q. Pub. No. 120, with two geological maps, etc.

"In the granite area tin has never been found away from it" (greisen).

"No geologist can wander over this wide area of granite without becoming sure that it is one and undivided; that it is not made up of a series of granites of different ages and constitutions . . . ."

The tin is invariably associated with the joint planes of the granite and the cleavage planes in the slate.

"The tin bearing area . . . occupies a definite zone running about north-east and south-west, corresponding exactly to the direction of the master joints of the granite and the cleavage of the upturned slates."

P. 25. Conclusions—

"1. The Gympie slates once covered the entire granite area to a depth of several hundreds, perhaps thousands of feet and with the granite have suffered enormous denudations.

"2. Into these slates, probably in Permian times, the granite forced and ate its way, tilting them at high angles, and baking them into hard rocks in places.

"3. The granite was intruded as a pasty mass and consolidated at a great depth below the surface, and under conditions of varying stress and strain.

"4. Afterwards another set of stresses and strains was induced, acting along an axis having a north-east and south-west direction, and inducing the master joints of the granite and the cleavage of the upturned slates.

"5. During this period elvans and dioritic dykes forced their way upwards along the north-east and south-west lines of weakness.

"6. At the same time alkaline water, carrying tin and other metals in solution, passed upwards along the planes of easy access, changing the adjacent granite into greisen and depositing the tin therein, and in and around the quartz which was also laid down in the fissures.

"7. Hence the tin does not occur in lodes, but in very coarse stockworks.

"8. The richness of the stream tin was due, not to the presence of rich lodes, but to a wide extent of stockworks, and to the enormous amount of denudation the district had suffered."

P. 50. "It is clear that as one approaches the slates on the western side of the granite area, the conditions of mineral deposition begin to change. Thus at the Pikedale reef pyrites begins to make its appearance in force, associated with gold and galena in quartz veins which though still connected with greisenised granite, are more definite than the stockwork granite further west" (? east).

At Redrock this becomes more clear, and the tin was connected with distinct reefs of quartz.
Finally, at Sundown we have ore bodies, which though not true lodes, in the sense of being fissures filled with metalliferous minerals, would ordinarily be classed as lodes.

These ore bodies occur along the cleavage planes of the slates and are due to the mineral charged waters and vapours from below having eaten out or corroded the country rock and deposited the lode stuff in its place.

The distribution of the various metals is summed up in a table on p. 93, which is reproduced below—

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<th>Copper</th>
<th>Lead &amp; Silver</th>
<th>Gold</th>
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and the relative importance of the various types of deposits in the following table reproduced from p. 97:

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This table indicates a zoning outward from the centre of the granite.


- Alluvium and Gravels (Tin bearing) . . . . . . Post Tertiary.
- Basalt . . . . . . . . . . . . Pliocene.
- Deep Lease and old gravels (Tin bearing) . . . . . . Pliocene.
- Granite, Diorite Porphyry, Elvans, etc., intrusive
- Eclogite (Tin bearing) . . . . . . Upper and Lower Permian.
- Chillagoe Limestone . . . . . . Lower Permian or Upper Carboniferous.
- Montalbion beds—little altered shales and sandstone . . . . . . Lower Carboniferous.
- Herberton beds with main tin veins . . . . . . Devonian.
- Dargalong beds with main tin veins . . . . . . Silurian or older.
The ore deposits he classified as:

1. True fissure lodes, tin bearing.
2. Dyke lodes, tin bearing.
3. Carbonas, copper and silver bearing.
4. Impregnations from faults, tin bearing.
5. Bedded or cleavage deposits, tin bearing.
6. Cave deposits, copper bearing.


Referring to prospecting for tin at Crow’s Nest, north of Toowoomba, and stated that there were no indications of tin in payable quantities.


Referring to alluvial tin at China Camp (Bloomfield River) and stated “no lodes of any consequence have as yet been found in the granite, though thin quartz leaders containing tin have been found occurring here and there.”


The report dealt in particular with leases Nos. 1403 and 1407 and he described the country as highly inclined and somewhat altered sedimentary rocks, mainly felspathic sandstones and shales, in places passing into quartzites and slates. Immediately east of the leases are granite and quartz porphyry intruding the above. Ore bodies represented are irregular pipes, fissure lodes and impregnations of the sandstone around certain planes (? joint planes).


The country was described as highly inclined micaceous and felspathic sandstones, and dark green slaty shales and greywackes with a general strike of N.E.-S.W. to E-W. Tinstone occurs as impregnations along the bedding planes of the green chloritic slaty shales, to which the deposits are almost entirely restricted. The intervening and coarser felspathic sandstones carry no tinstone. From the regularity of dip and strike of the chloritic shales the permanency of the lodes in depth might be confidently expected. There was no data on values in depth but they might be expected to fluctuate both in linear extension and depth.


Among many others Cassiterite, Stannite, Wufenite, Wolfram, Scheelite, and Molybdenite were listed.


On the Cardigan, Queensland, Tin Syndicates leases the country rock is a porphyry or eurite composed of blebs of pink orthoclase and quartz in a fine grained matrix of quartz and felspar. Further north the metamorphic rocks into which it was intruded can be seen. The lodes are decomposed dykes traversed by veins of quartz carrying the main tin values.

On the Coolgarra Federal Tin Corporation Limited leases (on Return Creek, 6 m. from Coolgarra) the country consists of folded and altered sedimentaries. The tin is fine grained and disseminated and associated with quartz throughout a ferruginous fine grained sandstone, which has apparently been silicified and rendered tin bearing along certain lines.

47. CAMERON, W. E.; “The Kangaroo Hills Mineral Field.” G.S.Q. Pub. No. 167, with a geological map. Contains extensive quotations regarding the geology from Jack (26) and descriptions of a number of mines.
The country rock was described as a clay schist with a general N.-S. strike and high dips. Through the schist there are abundant lenticular quartz veins and veinlets, parallel with the bedding (? cleavage). It was suggested that these are segregation lenses such as occur in the Brisbane schists. They are characterised by massive quartz and general barrenness of metallic minerals, short outcrops and relatively great widths. In one outcrop small scales and bunches of molybdenite were found. Granite occurs on the left side of the Perry River, about a mile west of the workings.


The country consists of sandstones, conglomerates and shales, presumably Trias-Jura in age, with basalt overlying to the south and on the east overlying granite. Lode tin had been proved in only one locality and the deposits appear to be neither large nor rich enough to be profitably worked, nor could very rich alluvial deposits be expected. Greisen which has been developed in the joints of the biotite granite is the probable source of the tin.


The information in this report is contained in an expanded form together with statistics and a section on technology, in Cameron (55).


"Wolfram (was) first found in payable quantities in 1894 on the Hodgkinson goldfield at a place now known as Wolfram Camp, ... has also been mined in some quantity at Lappa, near Petford Siding, on the Chillogoe railway line, on the same goldfield. Other small parcels have been obtained at Tinaroo near Mareeba, at Coolgarra on the Herberton Tin Field, at Port Douglas, the Kangaroo Hills Mineral Field, and at Noble Island 100 miles north of Cooktown."

From 1894 to the end of 1903, 947 tons of Wolfram of a value of £30,773 and from 1900 to the end of 1903 85 tons of Molybdenite of a value of £8,820 were mined in Queensland.

Geology.—On the Hodgkinson Goldfield Wolfram and Molybdenite frequently occur together in the same lode, the former being much more abundant. The lodes at Wolfram Camp are the only ones in which Molybdenite has been found in payable quantities. Associated with the Wolfram and Molybdenite is a considerable quantity of metallic Bismuth and in the lower levels of some of the mines arsenical and iron pyrites are met with. The Wolfram and Molybdenite occur in large masses scattered through the quartz gangue.

In a number of cases the outcrops of quartz occur at intervals along a fairly well defined line, but are of workable size and richness only at detached points. There is never a well defined and continuous lode with distinct walls of cleavage between the quartz and the granite. In many cases the lode consists of granite veined through with mineral bearing quartz; in others the quartz occurs in vertical or horizontal veins irregularly distributed through the granite and seldom continuing of the same thickness for any great distance.

At Top Camp the ore occurs in vertical joints, often fairly continuous, and with short horizontal offshoots on horizontal joints. The latter are usually very short but richer than the vertical. The thickness of the horizontal veins is never more than
10" to 12" but some of the vertical ones open out into large bodies, 3 to 4 feet wide, for a few yards.

At **Jeffs Camp**, there is more Molybdenite and the outcrops consist of "blows" or roughly circular or oval shaped outcrops of quartz, wolfram and bismuth. The molybdenite is usually below 10' from the surface. These outcrops develop at depth into irregular pipe shaped bodies, sometimes almost vertical, sometimes flat. They are apparently formed at the intersections of two main joints. The granite walls are considerably altered.

At **Peford** (Lappa Lappa), sixteen miles south of Wolfram Camp, the mode of occurrence is similar to that at Wolfram Camp.

At **Tinaroo**, fourteen miles S.S.E. of Mareeba the country is biotite granite and there is a well defined vein of white quartz which is very persistent and regular. It contains Wolfram throughout, but parts are not rich enough to work. There are traces of bismuth and copper carbonates and molybdenite occurs in one place.


Localities for Wolfram given as Thornborough near Cairns and for molybdenite: Thornborough, Moonmera, Maxwelton, Degilbo and Stanthorpe. The table facing p. 24 gives the location of these fields.


Deals mainly with methods of recovery of alluvial tin—dredging etc. He indicates agreement with Skertchley's opinion (38) that the bulk of the alluvial tin was derived from (1) greisen on joint planes and (2) the dykes, chiefly elvan, and that rich lodes may not exist.

Mines at Ballandean and prospecting at Red Rock are briefly described. The ore is mainly on joint planes.


Description of alluvial tin workings on Brovinia Creek. The country is granite and "the tin has probably been concentrated in joints on the exterior of the granite mass by pneumatolytic after action . . . . and is therefore not to be expected many miles from the junction of the slates . . . ."

Associates in the wash are ilmenite, rutile, topaz, zircon, and amethyst.

"The only sign of a lode was . . . . a body four feet wide, of fissile and spherulitic felsite, dipping 60 degrees to the south-west." It contains grains and films of cassiterite but to an amount of less than one per cent.


"The tin mines are scattered over an area of 12,000 sq. miles in some of the most mountainous country in Queensland, ranging from 2,000 to 4,000 feet above the sea. The country rock is quartzites and greywackes, slates and schists. A great number, perhaps the greater number of the more important lodes are associated with these rocks, occurring generally in the coarser greywackes and quartzites.

"The plutonic rocks consist mainly of holocrystalline types of biotite or hornblende granites, but there are large areas of euritic types such as granite porphyry and quartz felsite. Lodes of tin occur in both, and dykes of elvan intrude both the plutonic and altered sedimentary rocks.

"The deposits of ore seldom lie along a well defined course between walls of country rock, but are as a rule distributed through it in an irregular manner, forming bodies of very varied size and shape. The lode material is only in exceptional cases separated by well marked planes of division from the enclosing country. As a rule it merges into it with a gradual change from lode material to barren rock. The lode material is in almost all cases evidently a product of the alteration of the country rock by the action of mineralising agents, which have changed its constitution by chemical action, and have at the same time deposited tin and other minerals within its interstices.

"In the case of the granite rocks . . . . the felspar and other silicates may be changed to serpentine or chlorite or may be completely replaced by silica. In other cases the products of alteration are sericite and silica. In some cases very little alteration is noticeable to the eye, the tin occurring in grains through the apparently
unaltered granite or porphyry. The results are ores varying through every degree of alteration from the normal granite rocks, splashed through with grains of tin, to purely siliceous tin bearing material.

"In the sedimentary rocks the lode material varies from an almost unaltered quartzite, showing under the microscope crystals of tin in the interstices between its grains, to a massive green chlorite which weathers on the surface to a rusty-red kaolinitic material. A normal sample of "chlorite ore" from the 500 feet level in the Vulcan mine, showed under the microscope a mass of grains of quartz and felted patches of chlorite, splashed through with crystalline grains of tin and magnetite. In the alteration of these greywacke and quartzite rocks also, the silicate minerals have evidently been first attacked, and changed into chlorite by the mineralising solutions.

"The fluoric minerals—topaz, fluorspar, and tourmaline—are of very usual occurrence...while the metallic minerals— wolfram, bismuthine, antimonite, galena, chalcopryite, and magnetite—are frequent accompaniments..."

"I do not think Mr. Jack's theory of their (tin ores) intimate connection with altered basic dykes can be accepted as an explanation of the cause of their formation... The chloritic and serpentinous gangue materials of each of these lodes can, I am of the opinion, only be explained as the result of the alteration in situ of the country in which they occur, by the action of mineralising vapours and solutions. Genetically there seems little doubt that the lodes owe their presence to the intrusion and solidification of the granite mass in and around which they occur, their metallic contents having been extracted from the molten granite magma in the form of gaseous sulphides, fluorides and borides, as the mass solidified downwards and became creviced and cracked on its outer surface.

"The fracturing of the overlying sedimentary rocks, near their contact with the heated granite, would allow of the penetration into them also of these metal bearing vapours. The subsequent precipitation of their metallic contents with an accompanying change of the wall rocks of the fissures, would be brought about on their meeting with the cooler streams of the meteoric waters..."

"The irregular character of the tin deposits seems to be due primarily to the irregular disposition of these fissures and fractures through the country."

From 1883 to the end of 1903, 268,279 tons of ore yielding 28,797 tons of tin concentrates were obtained in the Herberton district.


Vermiculite granite, pegmatite, aplite and quartz veins intruding diorite, breccia, granite, syenite and felsites. Thin films of molybdenite on joints in the breccia and thin veins in the granite and felsite.


In the tin bearing wash on the Tate River Oriental rubies, zircons and garnets are associated with the cassiterite.


He gave the rock succession as—
1. Metamorphics—Silurian or Devonian.
2. Granite intruding 1 but not 4.
3. Diorite.
4. Sandstones and then conglomerates containing Rhacopteris and therefore Carboniferous.
5. Porphyries (volcanic).

"The tin veins are invariably connected with either granite or effusive eruptive rocks associated therewith, such as quartz porphyry etc."

"All the metallic ores of the Silver Valley are connected genetically and were deposited by ascending metallic solutions in faults or lines of fracture."
THE TIN, TUNGSTEN, AND MOBYDENUM DEPOSITS OF AUSTRALIA.


Tinstone is present in these sands to the extent of up to 0.26 per cent.


A brief description of North Queensland occurrences.


Notes on the production of ten leases and claims at Ollera Creek, about fifty miles north of Townsville.


At Mt. Brown "the ore bodies occur as shoots and patches of tin bearing chloritic and siliceous material along the main outcrops, which latter appear, from the evidence supplied by the work on the lodes, to be the result of alteration of the country rocks along the main fracture lines of the country. The alteration consists mainly in a silification of the country rock. The shoots of profitable ore have not proved of any considerable length...."


1907. 69. DUNSTAN, B.; "Stanhills Tinfield (near Croydon)," with two plans and three photographs. G.S.Q., Pub. No. 211.

The country is granite with numerous alternations of masses of quartz-felsite, aplite and chlorite. Tin occurs in chlorite, sometimes with quartz and greisen and aplite. Associates are copper and iron pyrites, galena and zinc blende, and alluvial gold is associated with the cassiterite near Locket Creek.


Deals mainly with alluvial deposits.

"The lodes of Mt. Amos lie along parallel joint planes of the granite, and are due to alteration of the granite walls of the joints by mineralising vapours or solutions that have been forced into them from below. They are characterised by intense tourmalisation and silification of the granite along the joint planes, the zone of alteration in some cases occupying a width of as much as 10 feet, and being traceable at detached points along the joints for considerable distances......the width of the zone of alteration to lode matter and its richness in tin contents vary rapidly from place to place, and as far as can be seen at present, the shoots of ore are not very long."

"At Lion's Den (Tableland) a similar character of mineralisation, along the numerous parallel joints of the granite can be noticed."

"The quality of the ore is very uneven, and the shoots appear to be short, the ore bodies occurring in "pipes" along joint planes as pointed out by Dr. Jack in his report."


The association of small quantities of molybdenite with the copper ores is noted (p. 225).

72. BOGENRIEDER, C.; in "The Australian Mining Standard," Dec. 16th. Gives a list of localities, Australian and foreign, where tungsten ores have been found (p. 693).


Notes on the progress of the mines.


Short notes on the progress of the fields.


"The country rock has thus been variously described as granite, porphyry, and greywacke; and without examination under the microscope ... absolute certainty cannot be attained, but the rock as a rule more nearly agrees with greywacke than porphyry, except in a few places where there are undoubted quartz and felspar phenocrysts. . . .

"Great numbers of roughly parallel and intersecting joints have been produced in these rocks, the main ones or master joints striking east north east and dipping to the north north west. These are intersected by two other series, one striking north and south and the other north east, and it is only in the vicinity of the intersections that the tin ore has been found."

"Though the joints occasionally and for short distances form walls for the ore bodies, the latter are on the whole without defined or regular boundaries, as is to be expected from the nature of their genesis."

Associates of the cassiterite are quartz, wolfram, arsenical pyrites, chalcopyrites, fluor spar, galena.

The ore is simply altered country rock, chloritised or intensely silicified.


The country is mainly an acid intrusive which varies greatly in mineral composition and on the whole should be classed as granodiorite. At Bee Creek, lodes, in places associated with pegmatite, occur on master joints of some persistence. The lodes contain small amounts of gold, silver, lead and specks of molybdenite.

See Jack (13) for reference to occurrence of wolfram.


The mine is situated one mile south west of Kingsborough and is notable for the unusual association of gold and scheelite. The reef runs N.N.W. and S.S.E. underlying W.S.W. at 45 degrees. The scheelite was first noticed at 90 feet and is most abundant where there is most gold. The ore is distinctly banded in places as though it had replaced crushed country. Pyrites, arsenopyrites, chalcopyrites, galena, blende, and molybdenite are associated with the gold and scheelite and sometimes form dark lines separating the gold from the scheelite. Tourmaline occurs in acicular form. The nearest surface granite is more than ten miles away. The hanging wall of the reef is micaceous greywacke and the footwall indurated micaceous shales, sandstones and conglomerates, showing facture and slight serpentinisation near the reef. A characteristic feature is the presence of muscovite disseminated in silvery flakes through the country.


CHILLOGOE DISTRICT.

Convict Creek, six miles north of Almaden. The country is granular felspathic granite. Wolfram occurs in quartz with scattered felspathic crystals, which is seldom sharply marked off from the granite.
**THE TIN, TUNGSTEN, AND MOLYBDENUM DEPOSITS OF AUSTRALIA.**

**Koorbora.** Lead, zinc, and tin are associated with the wolfram, but in small quantities in the rich stone. The country is slate resting on intrusive granite and surrounded by granite.

**Garrumba.** The country is granite porphyry. A strong formation, up to six feet wide, of bleached biotite contains lenticular quartz veins and traces of wolfram. The formation occurs at the intersections of joints.

**Gilmore.** Some wolfram is always associated with the tin, and is occasionally abundant. The main ore shoot occupies a well defined fissure but others occur on joints and are pipe like in character, 5 to 20 feet in diameter. The country is slate or greywacke, silicified near the ore into which it grades. Granite occurs nearby.

**Spinifex Creek.** Wolfram occurs on joints in slate near granite.

**Tommy Burns.** The country is much broken and jointed slate, near granite. The formation is silicified or chloritised country, occurring where the country is more broken. Wolfram and tin are associated.

**HERBERTON MINERAL FIELD.**

**Coolgarra.** Only a few persistent occurrences.

**Butler's Gully,** 2½ miles north of Coolgarra. Formations occur along joints, in slate, near granite. Tin is the only associate of the wolfram in mines near the granite, but in those further away arsenopyrites and chalcopyrites appear. The shoots are rich but short and don't continue in depth.

**Nettle's Creek.** The wolfram lodes are mainly black mica or silicious and a point of great interest is the association with the wolfram at one place, of considerable quantities of monazite and fluor spar.

**Butchers Gully.** The country is slate with granite nearby. Fluorspar and zinc-blende are associated with the wolfram in the lode. Three impoverished zones in the lode have been sunk through and new ore shoots found.

**The Glen.** The bismuth wolfram ore is a friable topaz rock about one foot thick, usually overlain by a band of kaolinised granite under two to three feet of silicified granite. The ore bodies are on flat joints planes but there are at least two vertical channels. The country is granite.

**Emuford.** The deposits are irregular in form but always at the intersection of joints. The country is altered sediments or granite. Tin, fluorspar, topaz and sometimes tourmaline are associated with the wolfram.

**Leahys Creek.** Similar to Emuford.

**Fingertown.** The country is granite porphyry—the peripheral portion of the acid igneous magma that intruded the nearly slates and interbedded lavas. The lodes are on joints and fluor spar, bismuth and molybdenite are associated with the wolfram.

**Reids Creek.** The country is granite near the slate contact. The lodes are greisen carrying wolfram near the surface and tin at depth.

**STAR RIVER MINERAL FIELD.**

The wolfram is very patchy and most of the ore low grade. Mostly rich patches have been worked resulting in numerous shallow workings and much work for a small yield. Little information available as all the workings are flooded.

**KANGAROO HILLS MINERAL FIELD.**

**Running River.** Thin leaders containing more molybdenite than wolfram.

**Waverley.** Forty feet of formation with bunches of wolfram throughout. A three foot band in the centre is likely to be productive. Many other wolfram lodes in the district.

**TOWNSVILLE MINERAL FIELD.**

**Ollera.** Wolfram and molybdenite with appreciable bismuth and traces of tin occur in irregular, elongated shallow workings and much work for a small yield. The granite is greisenised.
HERBERTON MINERAL FIELD.

Wellington lease. Wolfram occurs in an unusual matrix—crystalline chlorite.

Peeramon. Wolfram occurs in a white quartz, which in some parts contains felspar and then has all the characteristics of a pegmatite dyke.

Tinaroo. Cassiterite, copper ores and mispickel associated with wolfram on joint planes.

CHILLAGOE MINERAL FIELD.

Fischerton.

Oliver lease—wolfram in quartz on the granite—slate contact.

Macdonald's—wolfram in quartz veins on joints in granite. The veins are up to one foot in width and carry tin and wolfram.

Dickson. Wolfram in quartz veins in granite.

Broodies. Wolfram occurs with bismuth and tin on joints in greisen, at the contact of porphyry and granite.

Fossilbrook. Wolfram, molybdenite and some bismuth occur sometimes in parallel joint veins, sometimes in greisenised granite and in one place in a quartz reef genetically connected with graphic granite dykes.

Galala. Wolfram is found in flat undulating veins and in some that dip steeply.


The lodes are situated 64 miles N.W. of Charters Towers in granite country surrounded by slates and mica schists. The lodes are all situated in the granite.

"The occurrence appears to be due to the alteration and replacement of the granite along well defined fissures, which give promise of a considerable amount of persistency with depth."

The Standard Lode.

"The altered granite 'formation' between these walls (ten feet apart) is a tough dark coloured rock in which the felspar and ferro-magnesium minerals have been altered to an amorphous kaolin material, coloured a greyish blue, probably by oxides of iron."


P. 30. Wolfram and Molybdenite. Twelve miles due south of Kidston there is a quartz reef over half a mile long and up to two feet wide, seldom less than one foot. It is a white glassy quartz with wolfram and molybdenite disseminated throughout (not in bunches). The country is muscovite and biotite granite and pegmatite. A little alluvial tin is found in a neighbouring gully.


1912. 87. BALL, L. C.; "Occurrence of Tinstone in the Burnett District." Q.G.M.J., vol. xiii, Mar. 1912, pp. 107-111. "The tin bearing area is on the contact zone of palaeozoic sedimentaries and a granitic intrusion which occupies the greater part of the Boyne Valley . . . ."

Tin has not been discovered on the eastern part of this massif, but on the western side it has been reported from several localities between Rocky Creek and Burrandowan. Farther south again is the small area of stanniferous granite near Crow's Nest which serves as a connecting link between the Rocky Creek and Stanthorpe tinfields, all three although 200 miles apart may reasonably be bunched together as a mineralogical province . . . . the tinstone of Rocky Creek is closely associated with the 'splatific granite of the contact and the porphyry dykes in the vicinity of the same, and it was probably introduced into these rocks shortly after their intrusion." The granite is kaolinised but not greisenised; topaz is rare, tourmaline plentiful. Pegmatite occurs in only one place.

The workings are alluvial except M.L. 1 (Burnett Tin Lode claim) sunk on leaders in aplite and kaolinised granite.

This mine is situated 13½ miles west by north from Mt. Molloy railway station and 6½ miles south of Mt. Carbine. The oldest rocks are slates and schists which are intruded by syenite and porphyritic dykes which strike N.N.W.-S.S.E. with the schistosity. There are big outcrops of silicified country, mostly striking like the dykes but more irregularly. The ore bodies are dykes of pegmatite and veins of quartz with all gradations between them. They cut across the schistosity, striking E.N.E. The longitudinal extent of the veins is seldom more than a few feet, doubtfully ever more than a chain. Wolfram and cassiterite occur in both types of ore bodies but are seldom seen in intimate association.

Ball suggested that a subterranean spur of the granite at Mareeba extends north west to beyond Mt. Carbine, thus bringing the ore bodies in proximity to a granite mass.

Two ore bearing zones are distinguishable—that at the top of the mountain where tin predominates and that on the south east flank of the mountain where wolfram predominates. These two zones are ten chains apart.


Hartley's Creek is situated near Port Douglas. The country is granite, but a mile further inland schist appears. The main lode is in the granite, striking east and west and dipping south at 75° from the horizontal. The footwall is decomposed felspathic material and the hanging wall hard quartz mica granite.


The road from Ballandean passes over granite to within 2 or 3 miles of Ballandean sheep station where altered mudstones—“slates”—appear.

The granite is highly acidic and is fine grained with little mica or other ferromagnesium mineral except near the contact where it is frequently altered to greisen. Several lodes striking N.E.-S.W. In the “slates” these have well defined outcrops but break up into a line of quartz veins on entering the granite. The greisen on the contact carries tin, molybdenite and wolfram in bunches in the granite away from any vein. In the “slates” the lodes are largely saccharoid quartz with the appearance of an exceedingly acid granite but no pegmatoid structure.


Genesis of the ore deposits.

"The Wolfram fields are located directly on or adjacent to the periphery of areas of intrusive granite, of which it is now known the tungsten bearing solutions were magmatic differentiation products. . . .

". . . . the result of their action (the magmatic solutions) on the adjacent granite has been the production of greisen . . . . Pegmatites are the ore carriers in the slates of the Mt. Carbine district but elsewhere in Queensland as far as examined by me the pegmatites are conspicuously barren. The various metallic metals are sometimes found in close association; but more usually, though associated in one and the same deposit, they occur in different parts of it, as if they had been given off one at a time and at different times from the source . . . .

"The deposits when occurring in granite are peculiar in shape, being typically bent and contorted tubes and pipes, the origin of which is not perfectly clear, beyond that they have been produced in the solidifying magma by the escaping gases and solutions. The pipes are frequently, but not always, connected with joints in the rock, and every endeavour was made to prove that the deposits were simply the infilling of spaces of discission at the intersections of such joints. The failure of this theory to account for the observed facts was so frequent that its insufficiency had to be reluctantly admitted."

Wolfram ore bodies are sometimes found in the intruded rock directly connected with marked joints and fissures and pass sometimes into ordinary tabular fissure veins.

Details of mines at Wolfram (Camp), Mt. Carbine, Bamford, Parada, are given and a map of the mines at Wolfram (facing p. 526).


THE TIN, TUNGSTEN, AND MOLYBDENUM DEPOSITS OF AUSTRALIA.

Contains 453 references to occurrences of cassiterite, 6 to stannite, 59 to molybdenite, 6 to molybdate, 2 to wulfenite, 140 to wolfram, 3 to tungstite, and 22 to scheelite. Also list of fields and mining centres where tin, tungsten and molybdenum were known to occur, references to reports dealing with these. Many of these occurrences are of small quantities, too small to be of economic value. Associates at each locality are listed.

The mine is situated eleven miles south east of Croydon. The country is granite and the chlorite lode can be traced for 500 yards. Copper pyrites and zinblende are associated with the tin.

Consists mainly of notes on the progress of the mines. At the St. Patrick the ore is tin impregnated granite, 30 feet long by 20 feet wide. The granite is only very slightly altered. The tin appears to replace the ferro-magnesium minerals and to some extent the felspars. At Mt. Kidston the country is granite, containing irregularly shaped ore bodies with the long axes vertical and the short N.N.W.-S.S.E., which is the direction of a well defined fissure.

Much the same material as in Saint-Smith, G.S.Q. Pub. No. 243 (100), but more condensed.

The country consists of metamorphics intruded by basic dykes; this was followed by east west fissuring, then intrusion of much aplite, then intrusion of porphyries, then intrusion of ores.
The copper ore is siliceous and pyritic. Blende is not plentiful and there is little bismuth. There are small amounts of biotite, pink and white felspars and small crystals of garnet. Barytes is present in small quantities and molybdenite can be detected with a little trouble.

"The presence of molybdenite and bismuthinite . . . is noteworthy."
"Molybdenite specimens have been observed infrequently in the ore raised, but a close examination of my ore samples proves the mineral to be well distributed, albeit in minute quantities, through much of the ore, embedded in chalcopyrite, in magnetite and in barytes."

Records the occurrence of Ilsemannite (MoO₄, 4 MoO₃) and a molybdate of iron, yellow, ochreous and sub fibrous, believed to be a new mineral.


At Stanthorpe the lodes are in very coarse and porphyritic granite. The gangue is quartz and tourmaline is associated with the tin. One lode, "The Wonder," can be traced for 600 feet and is ten feet wide.

Classification of the Stanthorpe-Wilson's Downfall Rocks.
POST TERTIARY.

1. Granite sand, clay, gravels and rubble. Usually stanniferous.

Pleistocene (?).

2. Coarse semi-waterworn gravels, red clay etc. Frequently contain a little waterworn tinstone and gold.

TERTIARY (?).

3. Dykes of Diorite, mica lamprophyre, basalt, dolerite etc. Non stanniferous, but frequently intimately associated with gold, silver, lead, zinc and copper deposits.

MESOZOIC (?).

4. Dykes of rhyolite, quartz felspar porphyry, quartz porphyry and aplite granite; greisen seams and pegmatite veins. Stanniferous; also contains small quantities of wolfram and molybdenite.

5. Fine grained acid granite (the "Sandy" granite). Stanniferous; frequently also wolfram and molybdenite bearing.

6. Coarse grained acid granite (the "Stanthorpe" granite).

7. Porphyritic granite, giant crystals of felspar (mostly orthoclase) with macroscopic sphen and numerous large basic segregations; at times closely approaches to a diorite in composition. Non stanniferous and not known to be genetically connected with other metals of commercial value.

8. Biotite granite (the "Maryland" granite). Belongs to the type named Adamellite. Non stanniferous.

PALAEZOIC.

PERMO-CARBONIFEROUS.

Upper Bowen (?).

9. Micro-granite, dacite, quartz porphyry (the "Blue" granite). Non stanniferous.

Lower Bowen.

10. Marine slates; tuffs, conglomerates, limestones, shales, sandstones, and volcanic breccias. Rarely stanniferous, except along its contact with the intrusive acid granites.

Pre-Permo-Carboniferous.

11. Acid grey felspar porphyry probably a flow. Non stanniferous.


According to the Euritic period and it is practically certain they were the final phases of the sandy granite. The residual highly siliceous magma, accompanied by the original tin, tungsten, molybdenite and bismuth contents were introduced into the cooling cracks of the already formed less acid and therefore more fusible rock masses.

"The lode tin was in the main confined to greisenised veins and seams." (Greisenised = true greisen also granite altered to somewhat micaceous quartzose granite.)

Numerous pipe like structures consisting of apparently circular pegmatites . . . . characterise the marginal zone of this rock mass (sandy granite)."


By far the most important of the host rocks of this mineral is granite, and more particularly those having an acid composition . . . . also in pegmatites, gneisses, crystalline limestones, schists etc."

Common associates are bismuth ores, wolfram and tinstone.

The occurrences in the Stanthorpe-Ballandean district are in the somewhat more acid variety of the coarse grained acid ("Stanthorpe") granite than the normal rock. Aplite dykes and veins and pegmatite are sometimes associated with the mineral and it occurs in the dykes, on joint planes and sometimes as sparsely distributed flakes in the "sandy" granite.
At Chalmer's claim near Ballandean the rocks are—

1. Sandy granite.
2. Stanthorpe granite.
3. Slates etc. (Permo-Carboniferous).

The workings are an open cut in the centre of an aplite dyke intruding the slates. The outcrop is mainly quartz—a large acid segregation, roughly circular and 50 feet in diameter. Wolfram, arsenical pyrites, iron pyrites, copper pyrites and fluor spar are all associated in small quantities.

104. SAINT-SMITH, E. C.; “Dreadnought Molybdenite claim, Mount Perry.” Q.G.M.J., vol. xv, May, 1914, pp. 246-247. The lode is a true fissure vein in an even grained hornblende granite. Copper pyrites and carbonates occur in lenses at intervals, and the mine (shaft 110 feet) was worked for copper before molybdenite became valuable. The lode is ten inches wide with a three inch seam of molybdenite. This seam appears to be lenticular. The lode material is crushed granite.


The molybdenite occurs in quartz veins in hard coarse grained acid granite—“Stanthorpe” granite. This is intruded by dykes of the fine grained acid granite, which show, in places, graphic and pegmatite structures.

Three hundred feet to the west of the claim there are highly altered slates of Lower Bowen age.

The veins are three inches to one inch in width and there are eight veins in all.

The section nine feet to the south of the workings is:—

| Coarse acid “Stanthorpe” granite—slightly silicified. Highly altered and silicified “Stanthorpe” granite | 3” |
| Honeycombed sugary brittle white quartz with occasional small flakes of white mica | 4” |
| Semi translucent hard compact bluish white quartz with occasional flakes of molybdenite (vein No. 18) | 8” |
| Honeycombed sugary white quartz | 1½” |
| Hard compact white quartz | 1” |
| Honeycombed sugary white quartz | 1½” |
| Semi translucent somewhat compact bluish white quartz with odd flakes of molybdenite (vein No. 7) | 10” |
| Highly altered and silicified “Stanthorpe” granite | 3” |


“In brief, then, we have on the Etheridge an irregular core of granite enclosed by schistose metamorphics, which shade outwards into but slightly altered though much disturbed sedimentary rocks . . . .”

“We have true fissures, joints and bedded veins.”

“In both slate and schist the intimate relationship between mineralisation and igneous action is witnessed by the numerous porphyry and diorite dykes in the vicinity of the lodes.”

“Pneumotolytic effects are widespread, but there has been no marked concentration of the characteristic metals, except at Angore which geographically belongs to the Chillagoe Field. Tin has been worked at Buchanan Creek and on the Robertson; tungsten on Buchanan Creek and the Copperfield; . . . . and molybdenum is an occasional if rare constituent of the Einasleigh ore.


“At some period subsequent to the earliest part of the Permo-Carboniferous epoch, the great series of porphyries that forms the Featherbed Range was intruded by an acid magma, cooling as normal biotite granite; . . . . The Magma in contact with the porphyry crystallised without appreciable differentiation; but the cooling was
rapid and shrinkage sufficed to develop well marked jointing that later played an important part in the formation of the ore deposits. The slow crystallisation of the main mass was accompanied by the expulsion of the more mobile constituents, otherwise known as mineralisers, of which, after water, the chief were various fluorides, chlorides, borates, tungstates, etc. These collected under high pressure in the open joints of the overlying contact zone and thence gradually penetrated the cool granite; ... the rock ... was changed to quartz rock and greisen containing greater or less quantities of bismuth, molybdenite and wolfram. The chief repositories of these minerals are however the quartz pipes, which are perhaps the most puzzling features of the wolfram fields. I doubt if they can be explained as replacement deposits of any variety, and as an alternative venture to suggest magmatic gas stopping with change from crystalline granite to colloidal silica, subsequently solidifying as crystalline quartz ...."

"The porphyries are remarkably free from jointing, and to that we must attribute their complete want of ore bodies at this centre."

The granite is composed of quartz, orthoclase, plagioclase, biotite sometimes altered to chlorite. Wolfram is a primary constituent in 3 cases all within the contact zone.

Greisen. All stages between slightly greisenised granite (wherein the felspar is slightly kaolinised, the biotite chloritised or changed to muscovite, and the quartz much in excess) and quartz rock with little more than traces of silicates.

Quartz Rock, enclosing the "spar" pipes, almost entirely bluish crystalline granular quart often much cramped and with miarolitic interspaces, some of which contain flakes of muscovite or a chlorite mineral. Exceptionally a little white kaolin derived from felspars is seen in the cavities and in one case granular magnetite was observed. Both wolfram and molybdenite may occur in this rock ... and bismuth has been noted in the interspaces. Pyrite is a comparatively rare accessory and actinolite was found in the rock at one point only.

"It is plainly evident that 'bastard spar' is simply silicified country, one stage beyond greisen ...."

Graphic granite is rarely developed and pegmatite is not very common. The former presence of pegmatite in the ore bearing pipes is denoted by the wolfram bearing kaolin and crystallised quartz filled vugs of many of the mines.

Ore Deposits.

"The master-joints, but slightly less inclined than the porphyry contact surface, have had the most potent influence in directing the final trend of ore deposition, for it has been found that most of the pipes pitch along them. The steeply inclined subsidiary joints on the other hand have been of no less moment in that they provide conduits for the mineralisers and the ore bringers, and under favourable circumstances some actually become the loci of ore deposits."

"... the ore bodies proper fill irregular and deformed pipes, which frequently branch and repeatedly give off short spurs. They are subject to tapering, either gradual or acute, and they are specially liable to abrupt truncation on any of the numerous cross joints of the enclosing quartz rock. Empty pipes are extremely rare ...."

"The great bulk of the pipe filling is a white crystalline quartz, which contains wolfram and molybdenite in variable proportions ... the evidence is plain that the quartz wolfram and molybdenite crystallised almost simultaneously; but the introduction of the metalliferous minerals is thought to have been later than the first emanation of mineralisers. Much of the molybdenite occurs in miarolitic cavities and seems to have come in or remained mobile till towards the completion of solidification."

"The vugs ... as a rule contain detrital matter including quartz rock, greisen, crystalline and crystallised quartz and much kaolin ...."

Genesis.

"... the residual gaseous emanations of the deeper seated crystallising granitic magma, on their expulsions from the still highly heated interior, stopped their way into the cooler contact granite, following preferably but not exclusively joint intersections; and that the contorted tubular channels or pipes so formed were simultaneously filled with colloidal siliceous solution derived from the minerals of the rock destroyed. The 'spar' surrounding the pipes was produced by pneumotolytic action."
Productive zone. One would expect the periphery of the intrusive dome to be a favourable locus but this is not by any means the case. It is more probable that the summit of the massif was the most favourable but this idea fails time and time again.

Associates of the Wolfram and Molybdenite, (r) = rare, (c) = common, (?) = doubtful. Actinolite, Azurite (r), Native Bismuth (c), Bismuthinite (c), Bismutute (c), Bismite (c), Blende (r), Cassiterite (r), Cerussite (?), Chalcopyrite (c), Chilagite (?), Fluorite (c), Galena (r), Hematite (r), Hylaitite (r), Ilsemannite (r), Kaolin (c), Limonite (c), Magnetite, Meymacite (?), Molybdate (?), Monazite (r), Opal (r), Powellite (r), Pyrite (c), Quartz (c), Scheelite (c), Stolaitite (?), Tourmaline (r).


"The upper portion of the Mitchell River is a mineralogical province characterised by the occurrence of tungsten and tin bearing pegmatites in altered sedimentary rocks near their contact with intrusive granite . . . . the granite outcrops lie in three nearly parallel lines, along which are strung numerous wolfram and tin workings."

"Schist and slate are the enclosing rocks of the ore deposits at Mt. Carbine, but the always present intrusive granite approaches within a few hundred feet of the workings and I anticipate that it will be met in sinking within a few hundred feet of the mill level."

![Diagrammatic Section through Carbine Hill and across the Mitchell Valley.](image-url)

"A study of the grouping of the granite outcrops leads to the conclusion that a number of parallel batholiths have been partly exposed, and further that these occupy anticlinal loci in a series of great earth folds produced by forces acting from North East and South West."

"The granite" is a tenary quartz orthoclase biotite granite, of medium texture . . . . and in many parts exhibiting a well defined porphyritic structure."

True greisen is rare.

"The ore deposits are tabular in form and the veins are bunched into overlapping and slightly radiating zones of which at least twelve can be distinguished. Each zone includes fissures which while preserving on the whole a rude parallelism, frequently branch and in places converge sufficiently for anastomosis."

"Petering out is a constant characteristic but an overlapping vein is almost always to be found within a few feet."

"They are plainly composite fissure veins or dykes formed in intrusive emanation zones—the ore bearing solutions forcibly intruded the overlying rock under disruptive pressure."

Where the slates and schists have been fissured the ore does not follow joint planes but where there is little fissuring it does.

In general there is no replacement of the country and the pegmatites are sharply divided from the country.
“Apparent faulting is not uncommon but the heave is never great and most of the faults or joints are older than the reefs.”

The Gangue is mainly quartz but felspar is abundant and muscovite occurs in a few veins. Tourmaline is not common. Associated minerals are pyrites, cassiterite in quantity on the old Joseph lease, a little molybdenite. Scheelite is a constant associate of the Wolfram but mainly small quantities. The Wolfram is probably ferritungstite.


The country is highly altered metamorphics with a central core of igneous rocks—diorite, felsite, pegmatite. Pegmatite suggests granite somewhere nearby.

The specimens forwarded are crystalline, calcareous metamorphics. Calcite is abundant with much fibrous green hornblende in a matrix of pinkish felspar. One specimen very siliceous with a few flakes of Molybdenite. Another has thin stringers of chalcopyrite.

The specimens from the limestone which Mr. Russel (Inspector of Mines) found to contain molybdenite in situ is a coarse crystalline aggregate of granular calcite with a few crystals of quartz and numerous pencils of a dark green silicate believed to be Actinolite. The occurrence of molybdenite in such a matrix is probably unique.


The Tyrconnel lies on the eastern side of a granite massif. The granite is of medium texture, sometimes containing biotite, sometimes hornblende. Greisenisation and granite dykes were observed in some places. The intruded sedimentaries on the eastern side are schistose.

At the Tyrconnell itself the granite is aplitic in aspect and the ore body is a nearly vertical pipe of crystalline quartz, believed to be about forty feet in diameter. Outside the quartz is three to nine inches of grey felspar, projecting into the quartz in pegmatitic fashion. Outside again is one to six inches of coarse grained aplite or fine grained pegmatite, with quartz and felspar in equal amounts. Beyond this again and sharply marked off from it, is decomposed granite. In the shaft, which is on one side of the pipe, the footwall is slickensided.


The reef is situated on the north west slope of a rough granite ridge. It occupies a master joint in the granite, a joint which was reopened by subsequent earth movements and filled with molybdenite and wolfram bearing quartz.

The country is pink to red moderately coarse granite, sometimes with bronze mica, but often without. On the footwall of the reef there is a band of grey glassy quartzose granite with splashes of molybdenite. The width of the true reef is ten inches and in it are two generations of quartz, the later of which is richer in molybdenite. In addition there are a little iron pyrites and a secondary green mica.


At the Nagoorin Molybdenite claim the molybdenite is sparsely distributed in a coarsely crystalline white quartz, which fills joints, fissures and pipes in a rather basic intrusive granite, within a few chains of its contact with volcanic breccias.


“2. Molybdenite.”

The principal lodes are at Wolfram; others are at Bamford, Sandy Tate River, Kidston, Ollera Creek and Stanthorpe. Other areas being prospect are in the Chillagoe and Herberton Mineral Fields and at Rosedale, N.W. of Bundaberg.

The district is ten miles southwest of Almaden. The outcrops of the lodes are massive, "buck" quartz, with cavities where the molybdenite has weathered out.

The Kitchener lode dips at 45°; the country is granite; at 40 feet depth the shoot of ore is 122 feet long and the average grade of the ore is 3 per cent. The lode appears to be of true fissure type.


The country is altered much silicified slate, with well developed and approximately vertical joints. Other joint systems, not vertical and running parallel and across the vertical system, occur in proximity to the lodes; these sometimes determine the boundaries of the ore lenses. The Comet lode like the Sundown is genetically connected with the dominant vertical joints. The lode contains copper ore and tin and wolfram is disseminated throughout. The ore occurs in lenses, irregular in shape and erratic in distribution.

Probably, as suggested by Saint-Smith, reopening of certain joints allowed upward passage of mineral bearing solutions and thus the ore is confined to certain zones.


There are two parallel lodes, one tin and one copper. 3½ chains apart. They are on approximately vertical joints in silicified slates. The ores occur in lenses.


Classification of rocks.

Recent and Post Tertiary.

1. Granite and slate derived alluvial detritus
   Usually stanniferous
   2. Older alluvial deposits occupying terraces
   Usually stanniferous
   3. Basalt
   Non stanniferous but overlying stanniferous alluvial in places.
   Post-Perm-Carboniferous (?)
   1. Diorite, quartz diorite etc. dykes.
   Non stanniferous.
   2. Granite and porphyry with their associated acid dykes
   Stanniferous for the most part.
   Perm-Carboniferous (?)
   Slates, shales volcanic tuffs and agglomerates, quartites sandstones, grits etc.
   Rarely stanniferous except along the contact of the intrusive granites.

By far the greater portion of the tin won has come from the alluvial deposits.

The granite is mostly normal biotite granite, but at times has a tendency to develop porphyritic crystals of orthoclase. Except in one instance (N.W. of Mt. Leswell) the granite becomes progressively finer as the periphery of the intrusion is approached. This fine grained marginal zone is distinctly more acid. Tourmaline is abundant throughout the granites. Pegmatite veins occur in several places. The porphyry is in the form of large dykes, but no tin appears to be genetically connected with them.

In several places masses of tin bearing crushed and decomposed greisen and granite have been sluiced, e.g. Lode Hill, Mt. Hartley, Sand Hills. These parts are seamed with very numerous tiny veins of tourmaline and tin.

Tourmaline is also very abundant in reefs which carry tin.

Mt. Hartley Wolfram lode is the only place where there has been any attempt to mine wolfram. Elsewhere it occurs in insignificant quantities. Mt. Hartley lode is situated in porphyritic granite country. The hanging wall is well defined and slickensided; the lode is fine grained quartz seamed with very fine grained tourmaline and muscovite. It was very rich at the surface. The wolfram occurs in small bunches throughout the lode.
Other associates of the tin are, gold common in very small quantities, molybdenite rare, copper and galena in Mt. Amos lodes, mispickel in lodes, corundum in alluvial in three localities cyanite in one alluvial; ilmenite abundant magnetite widespread in small amounts, hematite rare, monazite in small amounts, scheelite rare, topaz rare.


The mine is situated near Irvinebank. The lode formation is a mass of low grade stanniferous greisen in coarse acid granite. There is a huge quantity of greisen and the mass probably widens in depth. Six hundred tons of stone have been crushed, averaging 1.78% tinstone. There is no trace of wolfram, pyrites, copper ores or bismuth ores.

There are other stanniferous greisens in the area, e.g. Dalziell Boulder.


The main lode is a large pegmatite dyke, mainly quartz and coarse biotite, in acid granite. Another lode shows ten inches of biotite on the eastern wall and a few inches on the western wall, with three feet of brittle white quartz with a little scattered biotite, in the centre. A little wolfram occurs in the biotite.

In the main lode wolfram occurs in masses of biotite, associated with monazite and fluor spar. A little iron pyrites and scales of molybdenite also occur. The biotite is frequently in oblique seams.


There are nearly horizontal seams of greisenised granite formation, which carried rich pipes of ore on the outcrop. They probably mineralised material filling joints in the granite. There are two main tin bearing seams, in which the ore occurs in bunches and shoots.


In the United claim there are numerous veinlets in fine grained acid biotite granite as country rock. The veinlets vary from knife edges to three inches in thickness and are usually separated from each other by about six inches of granite. Wolfram occurs in the veins and on strongly developed vertical heads. It is accompanied by greenish biotite and a little molybdenite. Slickensides are abundant near the mineralised parts and there is most mineral where there are most heads.


Ore bodies occur at the intersections of indistinct joint planes in highly altered slates. They form rich patches up to fifty square feet in area, but without persistence in depth. New shoots of ore may be located by following the joints. The slates rest on a stock of granite of which tin and wolfram are the magmatic segregation products.


The country is even grained hornblende biotite granite. It is intruded by numerous, extensive dykes and sills of a fine grained acid granite with abundant biotite (like "sandy granite" at Stanthorpe and New England). The edges of the "sandy granite" are often very fine grained (felsite) other times it merges into a quartz porphyry. There are some small veins of pegmatite in it.

Quartz reefs occur along the margin, having been formed in cracks and fissures, caused by 1. disruption of coarse granite 2. contraction of "sandy" granite.

In some cases the reefs represent an ultra-acid phase of a pegmatite. There is no evidence of true fissure reefs.

The lodes consist of a series of lenses usually overlapping slightly and there are many stringers and veinlets of quartz in addition to the lodes. Increase in width
of the ore body is usually accompanied by increase in value of the ore. In the Kitchener the best values accompany the steeper dips of the reef.

Wolfram bismuth iron oxides, copper pyrites, and iron pyrites are sometimes but not often associated with the molybdenite.

The country is fine grained red granite, much crushed and altered alongside the lode channel. The deposit is a fissure vein and the casing of the ore body is fluorite in which there are stringers of wolfram. On the western side, outside the fluorite casing, there is a considerable width of highly crushed and silicified granite, with stringers of wolfram and a little fluorite. The gangue is a silicified altered, fine grained granite. The length of the shoot is approximately 270 feet and the average grade is 4% wolfram.

The country is a dense, hard, fine grained aplite (quartz and felspar), intrusive into coarse acid granite. The aplite is replaced by quartz along the joints, giving a patchwork appearance. Molybdenite occurs in patches in the quartz. There is no wolfram, bismuth etc. associated with the molybdenite.


The molybdenite is restricted to the peripheral part of the intrusive granite. The outcrops would seem to suggest the influence of pronounced fissuring in the granite, but further work will probably show that the quartz occurs on joints. The country rock is coarse, pink biotite, granite.

The wolfram and molybdenite are usually conspicuously connected with intrusions of "sandy" granite. As a rule the "sandy" granite itself does not contain the minerals, but they occur in the quartz aplite, greisen, quartz and minette dykes, which represent the mother liquor of the sandy granites, and which were injected in the final stages of consolidation of the "sandy" granites.

Saint-Smith Q.G.S. No. 243. (102) emphasises the peculiar octopus shapes of the "sandy" granite masses. They seem to have eaten their way upwards in an irregular manner and have sent tentacle like dykes out to all sides, following principally the joint directions of the host rock.

In New England the "sandy" granite is definitely the source of tin, wolfram and molybdenite. In the Northern Territory it is the mother rock of all the principal metalliferous lodes.

The "sandy" granites generally speaking, are aplitic granites, consisting principally of quartz and orthoclase. A little biotite is generally present. The dyke derivatives are (1) quartz aplite dykes (2) greisen dykes. Wolfram is generally found in (1) or in quartz veins connected with (1). Molybdenite may occur in (1).
but more often in (2) and in quartz veins connected with (2). Tin is also a product of (2).

Benjamin's Molybdenite Mine, mines at Mineral Hill, Lord Nolan and Kilminster, and F. Paul's claim are described in detail with sketch plans.


Production and price of wolfram and molybdenite 1914-1917.


The Molybdenum deposits of New South Wales and Queensland are associated with various "sandy" granite and occur close to the contact of the granite and the rock which it intrudes. The deposits occur as:

1. Pipes of quartz pegmatite granite.
2. Aplitic segregations.
3. Pegmatitic segregations.
4. Quartz veins containing felspar.
5. Quartz veins.
6. Contact deposits.


The country is, metamorphosed diorite—decomposed felspar and mica—traversed by scheelite bearing quartz veins. To the north is a bill of mica schists intruded by a network of granite and pegmatite dykes. Scheelite occurs in some of the pegmatites as well as in the quartz veins in the decomposed diorite. The pegmatites are the source of the mineralisation, having introduced gold, scheelite and bismuth.


A white quartz pipe in granite, which, for its size and regularity must be unique in Australian occurrences. The pipe is approximately cylindrical in shape and has been worked to a vertical depth of 180 feet. In No. 1 level the diameter is 42 feet, in No. 2 (160 feet) 58 feet. The inclination is regular 10 to 20 degrees. Associated with the molybdenite there is a little chalcopyrite, galena, iron pyrite and zincblende.


The outstanding feature of Wolfram as a mineral field is its location on the periphery of a granite massif . . . . This particular granite area has an average width of four miles in a total length of twenty miles . . . .

At several places the granite, near its contact with the intruded porphyry and slate, has been altered and more or less greisenised, the end product of alteration being quartz rock (and less commonly mica-rock), within which the ore bearing quartz pipes occur. The older rocks, however, nowhere exhibit more than the slightest trace of greisenisation and they are quite unproductive.

The variant granitic types aplite and pegmatite have been met within the mined area, but diorite was found only without the greisenised terrain.

We have evidence of faulting . . . . These are in all cases younger than the ore deposits . . . . Normally, the granite, or more properly speaking grano-diorite, consists of granular glassy quartz, abundant lath shaped white plagioclase, and a little pink orthoclase, with scattered flakes and books of biotite . . . .

Where it has escaped greisenisation in the close vicinity of the quartz pipes, pinitsation and chloritisation have prevailed and impregnation by molybdenite is not unknown.

In addition to the grano-diorite the following igneous rock types are described—aplite, pegmatite, diorite, and porphyry. The sedimentaries which contain Lepidodendron australc were placed as Carboniferous but Ball points out that they may be Devonian.

Regarding the ore deposits Ball says—

"We have four separate loci of greisenisation and ore deposition on the periphery of the Wolfram granite massif . . . ."
Mineralisation is general and ore deposition in particular are conspicuously absent from both porphyry and slate; and it is only at the few places mentioned that they have taken effect in the granite by reason of the favourable contact contours subsisting there at the time of intrusion.

Confining ourselves to the immediate vicinity of Wolfram, reference to the accompanying maps will make plain the following facts. The mines are on the northern edge of the granite massif, near the junction of the Featherbed Range porphyries and the Hodgkinson slates; in the granite along its contact with the older rocks greisen is developed, but especially opposite the slates, and the quartz pipes, with their metallic minerals, are found in the greisenised country only.

The genesis of the pipes is discussed, pneumatolytic action being accepted as broadly the process concerned, but a difficulty is pointed out in accounting for the form of the pipes, characteristic vugs and the distribution of the metallic minerals at Bamford, where conditions are not unlike those at Wolfram; and the hypothesis of magmatic stoping and the immediate filling of the pipes with colloidal silica is again put forward. The role of colloids in ore formation is discussed at some length.

The following gangues are described and discussed—greisen, mica rock, quartz rock, quartz pipes, and quartz veins.

The following minerals are described from the ore bodies arsenopyrite, bismuthinite, native bismuth, bismuth octre, bismuthite, blende, calcite, cassiterite, cervantite, chalcopyrite, chlorite, felspars, fluorite, galena, hematite, ilsemannite, iron silicates, kaolin, limonite, micas, molybdenite, molybdate, pinrite, pitchblende, powellite, psilomelane, pyrite, pyrrhotite, quartz, scheelite, scordite, sericite, siderite, stibnite, topaz, tourmaline, turgite, wolfram.

1920. 139. BALL, L. C.; “Molybdenite from the Tarong Railway.” Q.G.M.J., vol. xxi, Feb. 1920, p. 56. The prospects are regarded as unfavourable, the area being too far inside the granite and the molybdenite and wolfram occurring only in flakes.


The country is acid biotite granite, with still more acidic quartz aplite dykes, some almost felsitic and one greisen.

Robson’s Top lode is a quartz aplite dyke, eighteen inches to two feet wide, in a vertical fissure. Copper, tin and wolfram occur in patches and molybdenite in veins on joints outside the lode.

On the Star o’ the North there is six inches of quartz with a stock-work of veins in the granite alongside.


The country is “Stanthorpe” granite. The tin bearing formation is probably an irregularly shaped body or a “pipe.” The lode material is a typical soft greisen of mica, quartz and a little felspar.


The country is granite, which is frequently aplitic. Tin occurs in veins on joints, disseminated through the granite and in true fissure veins up to three feet wide. The ore bodies are chloritic.

1921. 144. BENTIVOGLIO, M.; “Notes on Cassiterite Crystals from the New England District, N.S.W. and Stanthorpe, Q.” P.R.S.N.S.W., vol. lv, pp. 65-82, with 12 figs. and 1 plate.


The principal localities in Queensland and elsewhere in the Commonwealth, geological features, mineral associations, molybdenum ores, concentration methods, metallurgical treatment, uses, production and values are discussed.

There are two lodes described. The main lode ( wolfram bearing) consists of fluorspar lode material with quartzose wolfram ore associated. The other lode consists of four feet six inches of fluorspar with a twelve inch wolfram bearing vein. Biotite is abundant in this lode.


In the "Shrimp" and "Barramundi" the country is clay slate and schist with occasional bands of quartzite, intruded by extensive belts of granite and felsite. There is a zone of fractures at right angles to the strike and the richest deposits of tin are in these fractures. In the "Shrimp" the ore is a kaolinised, chloritic, crushed slate and in the "Barramundi" it is ferruginous crushed slate.

In the "Terrible Whale" and "Tin Syndicate" leases the country is granite and the lode chloritised granite.


The country is altered slate and quartzite, intruded by granite and porphyry. The lode is in the quartzite; it is wide and the ore is in large lenses, practically continuous with each other.


The country is crushed slates and quartzites, half a mile to the south of granite. To the south west is a prominent dyke of porphyry. The tin lode occupies a fissure at right angles to the strike of the slate and produced by the intrusion of the granite mass. The ore occurs in lenses.


The rocks of the area are:—

Recent .... Small patches of alluvium.
Upper Devonian .... Quartzites, slates, mudstones, grits and limestones with interbedded andesites and rhyolites;

The latter were traced into less metamorphosed beds underlying beds with Lepidodendron at Clarke river, where there are beneath them limestones with Middle Devonian corals.

They are also intruded by medium grained grey to pink granite and porphyry dykes which caused much more alteration than the granite. There are also typical aplitic granite dykes and margins to the granite mass. There is notable silicification of the adjoining quartzites and slates. There are many chloritic lode formations and evidence is given to show that the porphyry dykes are genetically associated with the tin ore.

The mines are described in detail.


Some of the lodes are in crushed slate country, and some in acid granite. The lodes are usually chloritic and the best values accompany kaolinised material.


The lodes are not fissure lodes and the abrupt termination of shoots is not due to faulting, the controlling part being played by joint systems.

The main granite mass is a coarse grained porphyritic quartz, felspar, mica granite. The presence of aplite and relatively insignificant pegmatite emphasise the unstable conditions of solidification.

Ball plotted the joint systems in the various levels in an endeavour to predict the positions of further shoots. He obtained no definite result, but suggested that more intensive work of that type is needed.

"The rich shoots are without distinctive indicators, but we know that deposition took place where the jointed granite has suffered intense chloritisation and silicification, besides some pinitisation and pyritisation; and plainly we have no alternative but to follow up the joints in the mineralised country."
THE TIN, TUNGSTEN, AND MOLYBDENUM DEPOSITS OF AUSTRALIA.


The wide low grade ore formation is in granite a few chains from the slate contact. Along the contact are numerous shoots of copper ore. The lode is chloritisated and silicified granite with no definite walls and gradual change from chloritisated granite to chlorite.


The Good Friday mine lies wholly within the coarse grained porphritic granite of Herberton, in an area where differentiation was confined to the end of crystallisation, when siliceous fluids accumulated within contraction spaces in the cooler portions of the mass. The rock in the vicinity of these reservoirs has been variously chloritisated, silicified and pyritised, and all impregnated with tinstone, but the richer shoots of stanniferous quartz mark the sites of open spaces. Paradoxically, many of the rich shoots occur in the vicinity of quite unaltered granite; and in these cases major chloritisation may have been effected during crystallisation, while metallic values were being expelled with excess silica into the open spaces of unattacked rock.

"The main joints have been plotted and it has been demonstrated how little continuity they exhibit, there being difficulty in correlating the exposures at the different levels, notwithstanding that mineralisation undeniably was directed by them."


The country rock is coarse grained biotite granite and a fine grained aplite granite, with pegmatite in places. There are numerous joints which strike in all directions but those close to a north-south direction predominate.

The paper includes plans showing the major joints.

The richest shoots do not necessarily follow the master joints and the general experience is that payable tin ore is seldom found where fluor spar is present in any quantity.

Ball considers that secondary enrichment has taken place in the higher parts of the shoots.


This paper deals with the Etheridge Goldfield, the Chillagoe Gold and Mineral Field etc. embracing most of the main areas of Tin, Wolfram and Molybdenite in Queensland.

The geological succession is:

<table>
<thead>
<tr>
<th>Period</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary</td>
<td>Basalt</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Beds west of Gilbert R., Rhyolites?, and Porphyries?</td>
</tr>
<tr>
<td>Jurassic</td>
<td>Beds in York Peninsula</td>
</tr>
<tr>
<td>Devonian</td>
<td>Hodgkinson Series</td>
</tr>
<tr>
<td>U. Sil. and L.</td>
<td>Featherbed Range porphyries</td>
</tr>
<tr>
<td>Devonian</td>
<td>Chillagoe Series</td>
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<tr>
<td>Silurian</td>
<td>Herberton Series</td>
</tr>
<tr>
<td>Ordovician ?</td>
<td>Etheridge Series</td>
</tr>
<tr>
<td>?</td>
<td>Etheridge Series</td>
</tr>
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Two periods of granitic intrusion are suggested:

1. Intruding Etheridge
2. Intruding Hodgkinson

Cairns Coastal Belt. Wolfram has been worked in the scrub near Port Douglas and tin floaters have been obtained in Sawmill Pocket not far from Mt. Peter. The rocks which predominate are greywackes, slates, schists, amphibolites, quartzites and serpentinous rock. These are intruded by granite (biotite hornblende granite). The nature of the rocks of Cairns coastal belt points to their being equivalent to the Hodgkinson series, Devonian.

The Kangaroo Hills District. The district consists of granites and metamorphic rocks capped in places by horizontal sandstones and basalts. The slates, schists,
greywackes and quartzites are steeply inclined and greatly folded. They are intruded by biotite and muscovite granite and pegmatites and are probably early Carboniferous in age. The metamorphics on lithology are equivalent to the Hodgkinson which is equivalent to the L. Burdekin. The tin is derived from lodes mainly in the granite, tin bearing dykes (greisens) and alluvials.

The Atherton-Herberton Tablelands. In the Tinaroo Hills east of Tolga, we have a rough mountain knot consisting of granite, mica schist, slate and phyllite of Pre-Silurian appearance. The granite is mostly a biotite granite but it is traversed by stanniferous greisen dykes; also siliceous felsite and aplite dykes, which are mineralised with copper, tin, wolfram and molybdenite. The rocks of the Herberton tablelands and hills consist of granite, greywackes of a schistose nature, chlorite schists and quartz mica schists. They have a pre-silurian facies and closely resemble the Herberton series. The tin occurs ... in greisen, pegmatite and chlorite lodes. Tin deposition is favoured by chloritic shale, schist or greywackes. The chloritic rocks so largely dispersed in the Herberton, Irvinebank, Emuford and Koorboora districts, were probably at the outset volcanic tufts and tuffaceous shales and sandstones probably erupted in late Ordovician or early Silurian, equivalent to the Featherbed Range porphyries, but antedated the main volcanic outburst, as they are frequently intruded by porphyries. The granite is similar to the Chillagoe and Dimbula granites probably Devono-Carboniferous or early Carboniferous, as they don't intrude the Ehaeopteris beds i.e. it is the newer granite. Lodes are (1) Fissure lodes in chloritic greywacke etc. (2) Chloritic rock irregularly replaced by tin-lenses and pipes.

Cooktown District. The granite at Cooktown itself is like the Etheridge granite.

The Featherbed Range. The Koorboora lodes are of three kinds—fissure lodes, pipes and lenticular replacements. The wolfram and molybdenite of Bamford occur mainly as pipes and splashes in a very acid greiseny differentiation product of the intrusive granite. The greisen forms a contact zone between the granite and porphyry. In the Koorboora portion of the district Herberton rocks predominate.

Percy Scheelite Field. Scheelite is associated with Bismuth carbonate and a little gold in a system of parallel quartz veins with an E.-W. strike in a formation of rotten diorite. This formation and the schists to the north and west of it are traversed by pegmatite dykes running in various directions. The pegmatite north of the scheelite field carries traces of scheelite, molybdenite, bismuth and gold. (plan on p. 38).

Speaking generally the Percy-Einasleigh belt has copper mainly in genetic connection with the older granites; tin, molybdenite, wolfram, scheelite, fluor spar in association with the younger orthophyric granite; gold bismuth and scheelite with the pegmatites. The pegmatites are probably the last phase of the newer granite but cannot be definitely connected with it.

Etheridge district. There are at least two, probably three series of granitic rocks and two series of porphyries. The first two granites are very old, certainly pre-carboniferous, the third is the orthophyric, probably contemporaneous with Chillagoe-Mareeba granites. Jensen says here of the age “consequently Carboniferous or later age, probably late Carboniferous.” (Compare this with earlier statements that Chillagoe-Mareeba granites in age). This third granite is traversed by dykes of red quartz orthoclase aplite and reefs of quartz which carry tin, wolfram and molybdenite in small amounts and sometimes in payable amounts. These may be offshoots from the later granites or from a still later granite magma, contemporaneous with the porphyries.

“... At the Percy the gold, bismuth, scheelite, wolfram, and molybdenite have been frequently found as primary constituents in pegmatite blows and reefs. On this field it is practically certain that the pegmatites introduced the gold. The pegmatites here are later than the newer granite, that is the orthophyric granite, which does not seem to occur at Forsayth.”

“The nature of the tin deposits is well known. Two classes of reefing ground have been worked—namely tin pegmatite blows and tin greisen dykes in granite, and chlorite lodes. The latter occur mainly in the metamorphic sedimentary rocks and are usually short, though sometimes fairly long, shoots along joints and minor faults. These lines of weakness are usually heavily chloritised and in places contain rich pipes or shoots of tin.”


Describes development in the mines and makes suggestions for prospecting.
Descriptions of the mines and methods of working at Wolfram Camp.


At the "Greisen Tin Mine" there is porphyritic granite with dykes of fine grained greisenised stanniferous granite.
At the "Victor Mine" the lode occupies a fissure in coarse acid pink granite, with dykes of aplitic granite.
At the "Clifton Hill" mine the ore is a chloritised greisenised coarse acid granite intruded by sills and dykes of aplite.
At the "Marvel" tin mines the lode is silicificed chloride very like that of the Vulcan Tin Mine at Irvinebank.

The rocks of the field are coarse grey granite, narrow short dykes of aplite generally running N.N.E., aplitic granite which is extensive in parts and slightly stanniferous, and considerable areas of quartz felsite. The lode channels are mostly fissures, the lode material in 19 cases being chlorite (in one case filling a fissure 1000 feet long), in 5 siliceous greisen and in one each altered felsite, chloritised granite (fissure 132 feet long), mottled granite (the mottles being chloritised patches), pipe of chloritic material, chloritised greisen, altered granite, greisenised aplite, aplite dyke. The mines are described in some detail.

"The ore occurs within an 'island' of shales, slates and quartzites intruded by a huge mass of coarse acid granite . . . . mainly rather coarse reddish acid granite . . . . aplitic in places."
"In the main zone of ore deposition there is a large dyke like mass of ferruginous kaolinic chlorite with all the appearance of a breccia, apparently produced by extremely heavy crushing and shearing as a direct result of the igneous invasion. The known length is 380 feet and average width 20 feet, but reaches up to at least 30 feet. Both the breccia and surrounding country is violently dislocated by N.S. faults, E.W. faults, and almost horizontal faults. These fault movements are largely concentrated about the two principal known ore bodies. Subsequent to the deposition of tin and within the breccia and accompanying tangential fractures running E.W. from the breccia, a still later movement has resulted in the dislocation of the already formed ore bodies by normal faults.
"Apart from these displacements the rock is riven by strong master joints.
"The breccia formation can of itself be classified as a very low grade ore body which has at times produced small parcels of good ore within its mass, but by far the greater proportion of the ores so far located can be seen to take their rise from the edge of this formation and gradually wedge out when driven on away from it. The maximum distance to which the pay shoots extend appears to be about 50 feet. The whole of the workings to date strongly indicate that this breccia has constituted the principal conduit up which the stanniferous vapours have risen."

Consists mainly of description of the latest development work.
Regarding the ore deposits seen at the Gully shaft workings, there can be little doubt that the tin has been introduced by the intruding porphyry dykes.


The aplitic, "Sandy," granite, intruding the "Stanthorpe" granite, has great numbers of knife edge quartz veins, greisen seams, pegmatite veins and extremely fine grained felsite dykes and sills. All are slightly stanniferous as is the "sandy" granite itself, and constitute the source of the alluvial tin.


The fields are mainly alluvial. There are large areas of granite with many dykes. The shoots of tin ore are poor and erratic.


The mine is situated 65 miles north west of Charters Towers. The country is porphyritic granite and the lode carries abundant tourmaline, consisting of tourmaline granite, some greisen and a siliceous tourmaline rock. All the stanniferous ore bodies are lense shaped.

A section in a trench at the northern end is as follows:
- 5 feet tourmaline granite
- 4 inches tourmaline rock
- 8 inches tourmaline granite
- 12 inches banded tourmaline granite and rock
- 2 feet tourmaline rock
- tourmaline granite

The "formation occupies some type of compound fissure, probably resulting from contraction of the cooling granite."


All the igneous and associated rocks from Forsayth to Stanhills and Croydon belong to the Pre-Cambrian. The tin of the Stanhills belt has been intruded partly with, partly just after the aplite dykes, which were the last differentiation rocks of the magma. The major portion of the tin on the field occurs as a primary mineral in the aplitic dyke rocks, some was introduced pneumotolitically immediately after the consolidation of the dyke walls, which in such cases are more or less greisenised. In some cases principally on Cassiterite, we have cross faulted country in which the fault filling and the wall rocks have been, changed to tin greisen.

The lodes occur both in the coarse granites and in the porphyries, but are more abundant in the porphyries.

Aplitic tin lodes are by far the most abundant on Stanhills.

The Cassiterite area consists of granite with greisenisation, principally along nearly vertical faults or shear planes and along major or master joints branching off from the fissures.


There is a belt of metamorphics on the coast, lined by granite on the west. The granite is intrusive into the metamorphics in which are dykes of granite, porphyry, aplite etc.

All the granites contain numerous veins that yield tin, wolfram and scheelite.

Tin is found principally in and around the granite, seldom in veins in the metamorphics. Wolfram is common in the contact zone. Scheelite is confined practically to the schistose rocks near the granite contact.


There were successive shoots of rich tin ore down to 130 feet. From 130 feet to 190 feet there is argentiferous copper ore. It is not certain that this is a continuation of the tin ore body, but occasional slugs of rich tin ore up to 2 cwt. and veins of solid wolfram have been encountered in the kaolinised copper ores.
Tinstone and a little wolfram are found in pegmatite dykes and quartz veins traversing granite intruded metamorphics. There are numerous parallel veins with an average width of six inches. The ore shoots are small.


This report deals with the silver-lead mines and the geology of the whole field, including the tin productive area.

Reid considers the metalliferous series to be Silurian in age not, as considered by Saint-Smith, Devonian. His reasons are 1. It is unconformably below Star beds of Carboniferous age. 2. It is not metamorphosed enough to be Pre-Cambrian. 3. It has a general resemblance to the Herberton series and 4. It is more folded than the Burdekin series.


The area is described as an intense fault complex, with the main ore shoots in association with a sub parallel series of fissures. The sequence of events is described as

1. intrusion of the granite bathylith.
2. quartz porphyry intrusions.
3. formation of non productive fissures.
4. formation of productive fissures.
5. faulting, crossing 4.
6. intrusion of aplitic granite dykes.
7. emanation of liquors etc. from 6.
8. formation of irregular quartz chlorite tin bodies, controlled by special local structures.


The Lodes occur in intricately fissured and folded sediments of early Palaeozoic age, in association with intrusive acidic dykes, and in proximity to downfaulted non-metalliferous volcanics and sediments of late Palaeozoic age.


Disseminated tinstone and tourmaline occur in altered sedimentaries and associated with defined fissures.
Ore bodies occur on sub-parallel fissures in granite, thirty five feet apart.

Patches of high grade ore in a siliceous formation on a fissure.

The country is granite and tin is found in association with chlorite, pyrite, wolfram and quartz, on a well defined fissure, 12 inches wide.

The workings are partly in granite and partly in a wide dyke of porphyry. The ore is disseminated in a jointed greisen formation, especially in the vicinity of thin pegmatite veins and sometimes in association with molybdenite bearing quartz.

The country is steeply tilted phyllites, quartzites and greywackes, intruded by fine grained granite half a mile to the south. The ore is associated with a fissure running N. 30° W. and the lode is chlorite, quartz and kaolin.

Low grade tin ores occur in jointed sedimentaries intruded by acidic dykes, near a large granite mass.

This was formerly a low grade tin mine, but it now supplies sulphide flux for the Chillagoe smelters. A stanniferous gossan changed to copper sulphide ore. The lode occupies a steeply dipping fissure running N.W.-S.E. modified by a later flat fissure which separates the tin from the copper ore. The country is silicified sedimentaries, a few hundred feet from granite.

Ore bodies occur on sub-parallel fissures in granite, thirty five feet apart.

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The area is described as an intense fault complex. Granite is intruded by quartz porphyry and later by aplite.

L. C. Ball in a foreword considers that the "faults" may also be interpreted as joints, that there are probably two granites, and that aplite is associated with the lode injection.


Stanniferous gossan gave way in depth to pyrrhotite impregnated with argentiferous chalcopyrite, associated with silica and muscovite on a steeply dipping master joint. The country rock is sedimentary, invaded by granite.


Recommendations for prospecting. L. C. Ball in a foreword repeats that the shoots are associated with intersecting joints and that it is impossible, at present, to determine by why with some joints and not others.


Map showing main localities and an index.


Record of prospecting operations at the mine 10M. north of Crow's Nest. The results are too low grade. This is the "Felix" mine on which L. C. Ball prepared an unpublished report in 1919.


This includes a geological map and sections with levels etc. prepared from the report by Skertchley in 1896 (33), plan by Rankin 1910, report by Marks 1911 (86), sections by inspectors of mines and Annual Reports of the Department: of Mines.


Map of localities and index.


This report concerns the Excelsior and Dalcouth Mines in the Coolgarra District. In the Excelsior the tin ore is associated with an almost vertical fissure and in the Dalcouth rich chlorite ore bodies occur close to a basic dyke.


The country is biotite gneiss with parallel veins of aplite and irregular injections of pegmatite. It is intruded by granodiorite which contains veins of pegmatite. The Hubnerite occurs in fissure veins of quartz and is the only record for Queensland.


The country is granite intruding felsite. The deposits of tin ore include both primary and secondary. The primary deposits are tabular with vertical dips and are restricted almost entirely to the granite. The ore shoots are not large.


The country rock is granite with dykes of porphyry and felsite. The ore body is a regular and roughly cylindrical pipe inclined at 15 to 20 degrees. At 75 feet it is 48 feet in diameter; at 160 it is 58 feet in diameter. Between the pipe and the country rock there is a thin layer one to six inches thick consisting of quartz, calcite
and decomposed felspar. Calcite veins and segregations are abundant in the pipe and the veins continue into the granite, running roughly north and south. The gangue is quartz, and the molybdenite is concentrated towards the periphery. Chalcopyrite, pyrites, galena and zinblende occur in small masses throughout the central portion, the outer 16 feet being mined for molybdenite.

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</tr>
<tr>
<td>1933</td>
<td>120</td>
<td>12</td>
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The country is red granite with a large dyke of quartz porphyry. Quartz veins, less than two feet wide occur in the granite and are sometimes associated with mica rock. They have a low tin content and rarely traces of wolfram and molybdenite. These veins are the source of the tin in the alluvial workings.


High level alluvials on the dissected basalt capped plateau, between the heads of the Russel and Johnstone rivers. Auriferous and stanniferous gravels are spread over an area of nine square miles; they are several feet thick and rest on metamorphics and intrusives.


Tin in pegmatite.


Herberton District. “Several very rich lodes had been found on the surface and worked to a depth averaging about 250 feet. Often the lodes terminated on flat heads, and the prevalent belief on the field was that the lodes had been faulted by these flat heads. . . . A thorough examination might reveal the system of faulting prevailing on the field.”

The mines are divided into five classes on the basis of their past production.

The lodes occur in granite in a somewhat pipe like form. They generally consist of quartz and less common “chlorite.”

The discontinuity at depth may be due to three causes:—

(1) The lodes may be entirely irregular, the emanations having ascended through an irregular branching system of fissures. This conclusion can be reached only as an admission of failure of all efforts to show that the position of the lodes occurs in a systematic manner.

(2) The lodes may have been originally continuous, but their course later disturbed by faults. This is the prevailing impression on the field, since many of the lodes have terminated on flat faults. However this impression seems to be wrong, since in many cases the lode has continued beneath the fault, although the tin values have been poor. Also there are cases where certain lodes have ended on flat faults, but adjoining lodes have continued in depth far below the point where the fault would have intersected them. For these reasons it is thought that, in cases where the lodes have apparently been cut off by flat faults, the faults have been planes against which deposition, and perhaps rock alteration, has ceased. The phenomenon is in accordance with the next case.

(3) The third possibility is that the positions of the lodes are systematic in their occurrence and that the termination of the surface lodes in depth is due to the pitch relations of the lodes. From the observations of the survey made of the field, this conclusion seems to our field staff to be the most probable, and it will be elaborated further.”
The intersections of three directions—a "break" (joint running approximately N.70°E.), and "indicator" (joint running N.S.) and a pitch (either N.E.-S.W. or N.W.-S.E.) often seems to cause the formation of the rich lodes.

Since the formation of the lode depends on the intersection of three planes, complicated conditions of pitch arise. It is shown that in the simplest case successive lodes will be found at increasing depths on "indicators" lying successively either to the east or else to the west according to which direction of pitch is operating.

It is pointed out that plans of the ore bodies are needed for each mine in order to work out the structural conditions.

It is considered that enough has been done to formulate an intelligent prospecting programme for any of the mines in the field.

**Watsonville.** The mines are divided into two classes according to production.

There is a general controlling set of structural relationships but each mine possesses its own problems. Recommendations have been made for each mine.

**Wolfram Camp.** The ore occurs in pipes in greisenised granite. There appears to be a structural control of ore bodies.


The Stannary Hills section consists of highly folded metamorphics, with major faulting, supplemented by subsidiary jointing, as the direct influence on tin deposition.

In the Lass o' Gowrie section the country is granite with the tin ore limited to a defined fissure.

The future of Stannary Hills depends on the more isolated low grade section; of the Lass o' Gowrie on occasional comparatively small high grade ore bodies.


The country is slates, sandstones and greywackes silicified in places and with an irregular system of barren quartz veins as well as the ore veins. The nearest granite on the surface is 13 miles to the west, but it is probably not far below the surface on the field. The ore veins are composite quartz mica veins occupying fissures with no fixed strike or dip (dip 30° to 70°); branching of veins and minor normal faulting are common. This faulting has an enriching effect. The veins are six inches to 24 inches in width. The chief gangue is quartz (often bluish in colour) with a selvage of yellow mica, which may carry wolfram. There is also some kaolin. Increases in the occurrence of mica is a favourable indication. There are small amounts of pyrite, arsenopyrite and copper carbonates. The tin is rarely in actual association with the wolfram.

Wolframite, scheelite and tungstite occur: The scheelite seems to be mostly secondary. Tungstite occurs as a coating on wolfram.


The country is granite. The richer shoots are linear and pipe like with quartz tourmaline rock, but occur also along parallel joints or fissures in the kaolinised and greisenised granite. No ore reserves are developed and prospects cannot be defined without some development.


Cassiterite occurs in a pegmatite dyke in biotite actinolite tourmaline aluminous silicate schists. Beryl, muscovite, tantalite, rutile and monazite also occur in the locality. Prospecting is justified.

1939. 221. CONTROLLING COMMITTEE A.G.G.S.N.A.; "Report for the period ended 31st Dec., 1938."

**Herberton District.** Geological Survey with a geological map (plate 1).

An area of 1,050 square miles was photographed from the air. This embraces most of the important mining centres including Herberton, Silver Valley, Watsonville,
THE TIN, TUNGSTEN, AND MOYBDENUM DEPOSITS OF AUSTRALIA.

Bakerville, Irvinebank, Walsh, Stannary Hills, Montalbion, Emuford, Gurrumba, Ord, Nymbool, Mount Garnet, Nettle Creek, Coolgarra and Wild River.

The rock series from oldest to youngest are:

1. Granulites, crystalline porphyries and schists, intruded by innumerable dykes of granite, aplite, greisen and porphyry. General strike nearly east-west with steep dips to the north and south.

2. Quartzites, altered limestones, tuffaceous quartzites, older volcanics (Featherbed porphyries, Return Creek Phyllites and breccias, andesitic rocks and tuffs) and chlorite schists. Probably Silurian.

3. Granite, aplite, diorite, porphyry, syenite and greisen, which intruded the above in Upper Devonian time.


5. Younger volcanics, both acid and basic, with sub basaltic deep leads. Tertiary.

Cassiterite occurs in the following formations.

(1) Granite, as a minor constituent but contributing to the alluvial deposits and in pneumatolytically altered portions of the granite forming important ore bodies.

(2) Aplitic lodes—tin bearing aplite dykes, usually too low to be payable.

(3) Greisen lodes of two kinds—magmatically differentiated and pneumatolitically altered formations along fissures.

(4) Quartz Greisen Tin lodes—greisen bodies subsequently injected with quartz.

(5) Quartz tin lodes.

(6) Tin lodes in metamorphic rocks, as the result of greisenisation near the contact with the granite, occurring on joints or in fissures.

(7) Complex lodes.

Geophysical surveys of the Herberton Deep Lead and of the Herberton lodes and Watsonville lodes were made.


Garrawalt Creek is situated 25 m. N.W. of Ingham. The country is granite with many small tin veins and the granite is greisenised near the new discovery, but there is no evidence of a large lode. The ore is high grade the cassiterite occurring in lode material consisting of felspar, quartz and silvery mica close to joints.


The occurrence consists of chlorite ore bodies in a quartzite capped granite hill. One lode is eight feet wide of 5% ore. The locus of the lodes is the contact zone between intrusive granite and older sedimentaries.

1940. 224. CLAPPISON, R. J. S.; “The Tin Deposits of the Stanhills Area, Croydon Gold and Mineral Field.”


The country rocks are extrusive felsites—fine grained quartz porphyries to quartz felsites, intruded by various types of granite—(1) coarse muscovite granite, (2) aplitic granite, (3) mixed granite (consisting of (1) and (2)), (4) greisenised granite dykes, (5) fine grained aplitic granite. These are overlain by sub-horizontally bedded Cretaceous sandstones.

Fissuring and jointing is pronounced in both the granite and the felsite. There are two main sets of fissures—(1) N.-S. to N.E.-S.W. and (2) at right angles to these; the majority of the fissuring is of a minor type.

The lodes are classed as—

A. Chloritic lodes—alterations along fissures and joints in granite and felsite. These are irregular in shape and consist mainly of chlorite and quartz.

B. Greisen lodes—fine grained quartz and mica, the quartz being surrounded by secondary quartz and mica.

The lodes show a tendency to lenticularity in both horizontal and vertical directions.

Favourable geological factors are:—

1. A well developed fissure in either granite of felsite close to the contact.
2. In the granite where coarse granite aplite granite are close together.
3. Quartz greisen and greisenised granite. The shoots are small and scattered and no generalisation can be made as to controlling factors.


The lodes are classed as:
1. Tabular bodies with well defined walls.
2. Pipe like bodies or shoots.
3. Larger irregular bodies of greisen.

Three of the lodes—the "Hope," "Comet" and "Brilliant," have passed in depth into ore with lead, zinc and copper sulphides, affecting the marketability of the ore.


Contains a discussion of the present position of the mines. The lack of information on workings, especially during 1912-1920 is pointed out.

Many of the pipes are worked to a depth of 300-400 feet and the "Brandon Deeps" to 608 feet on the underlie.

There is no record of any pipe giving out the depth but, probably there was a reduction of average values with depth.


The country is mainly granite with small residuals of altered sediments. Tin and wolfram are found on joint intersections in association with magnetite and garnet bearing chlorite, quartz and greisen. The lodes are exceptional in occurring in only slightly altered granite, but the prospects are poor.

The ore deposits are classed as:
1. Chlorite lodes with little or no quartz.
2. Siliceous lodes with varying amounts of chlorite.
3. Quartz with greisen.
4. Stanniferous granite.

These occur in both granite and sediments. Incomplete returns give the production from 1927 to September 1940 as 1304 tons 1 cwt. of ore yielding 73 tons 18 cwt. 2 qtrs. 19 lbs. of concentrates valued at more than £11,111 4s. 6d.


The wolfram occurs as disseminations in the quartz of a fissure formation in granite. It is one to three feet in width but ore reserves are small.


The island is an extension of Torilla Peninsula where granite intrudes Devonian rocks. The island is wholly granite—quartz, orthoclase and muscovite. There is an east-west zone of heavily quartz veined greisen and a little molybdenite occurs in some of the veins.


The lack of present production on these fields is put down to a lack of understanding of the geological structure of the lodes. (b) Primitive methods of mining. (c) Taxation, of which the first is fundamental. The conclusions expressed in the Annual Report of the Aerial Geological and Geophysical Survey of Northern Australia for 1937 with regard to the Herberton area are qualified by (1) the ore bodies are formed by, not at the intersection of the indicator and break; (2) the breaks do not form continuous lines—they appear to be faulted by the indicators and further they assume their characteristic structures only near their intersections with them; (3) the indicators are arranged en eschelon.

In the U.N.A. Mine and also the ore bodies on the Western Hill he suggests the following facts are clearly established.
(1) The ore bodies occur in coarse sandstone near the granite contact. A distinctive feature is a series of porphyries traversing the field with an average strike of about 30 deg. Underground, these porphyries are soft and fret away easily from the backs of drives.

(2) The ore bodies are associated with the porphyries or with walls having the same strike and dip, the porphyries having acted apparently in much the same manner as the breaks at Herberton.

(3) The porphyries have a general east dip.

(4) The majority of the larger ore bodies are confined to a comparatively narrow zone having a direction of about 60 deg. Another group, the Caledonia, lies to the south of the main zone near the granite contact.

(5) On the eastern side of the porphyries the ore bodies occur on east-west "walls, and pitch west until they meet this formation.

(6) Unlike the breaks at Herberton the ore bodies occur on the western side, or underneath the porphyries, apparently being continuations of the lodes on the "eastern side. In the Tea Mine, a narrow seam of tin ore traversing the porphyry "connected the ore bodies on either side of it.

(7) A number of big rich ore bodies were found on the surface and it is highly probable that similar bodies occur underground. Only in the Tea Mine, however, has an ore body been found of a size and richness equivalent to those on the surface, and even in this case the lode seems to be a continuation on the western side of the porphyry of the lode which was worked down from the surface.

(8) An examination of the porphyries in the various mines shows that they "seem to have an en echelon structure in depth.

(9) The problem of the field is how to find underground ore bodies equivalent to those worked on the surface. If an echelon structure exists in the porphyries, it is natural to assume that the next lode in depth will be formed on the eastern side of the next porphyry in depth. Further investigation should be directed to discover whether an echelon structure exists in the east-west walls carrying the ore bodies and, if so, to determine its nature and also at what depth the ore bodies will form.

He concludes that complete geological mapping of the fields probably followed "by diamond drilling is necessary for the reopening of the fields. An essential "preliminary to this is the dewatering of the old mines for the purposes of mapping."

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