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URANIUM AT ROYAL GEORGE MINE

On the 17th January, 1955 the first authentic discovery in Tasmania of a uranium mineral was made at the old Royal George Mine, 10 miles from Avoca in the central east of the State. The finder was Mr. V. Pitulej, a gentleman who for several years has been assiduous in his search for minerals throughout the northern part of Tasmania. The mineral found is torbernite, an hydrated phosphate of uranium and copper, and it has been noted in several places in the large open cut of the old mine.

Location and Access

A car can be driven to within a few yards of the open cut, which is half a mile south of the village of Royal George, which is ten miles south-east of Avoca and near the south bank of the St. Pauls River. Avoca is on the main road and railway line to St. Marys and is distant 50 miles from Launceston.

Topography

The St. Pauls River has carved out a wide valley through first dolerite, then Triassic and Permian sediments and finally granite, until it has almost reached a stage of maturity and meanders rather slowly through wide meadows. Fringing the Tertiary and Recent river flats are rounded gently sloping hills and ridges of granite topped here and there by Permian remnants, while beyond these the country rises more steeply with first Permian and then Triassic sediments capped by dolerite forming St. Pauls Dome (3368') to the North and Snow Hill (3175') to the South.

The top of the Royal George open cut is about 200 feet above the general plain level.

Previous Literature

Early geologists who visited and reported on the area were Thureau (1881), Montgomery (1893) and Twelvetrees (1899). At this time, little development or even prospecting had been done at the site of the present opencut, and the name St. Pauls Tin Mine seems to refer more to exploratory workings to the south (as shown on the attached plan) although it also covered the northern area.

In 1929 Reid and Henderson prepared a Bulletin on the Avoca District and a full description of the Royal George and St. Pauls Mines are included in this.

History.

Tin was first discovered in the Royal George Area in the eighties of last century, but very little was done to develop the deposits until the formation of the Royal George Tin Mining Company in 1911. In 1922 the Company came to an end, but during the eleven years they had produced most of the 900 tons of tin oxide, said to have come from the Mine. Although some interest has been shown since 1922, no actual production has taken place.

Towards the end of 1954 Mr. A.E. Ringwood on behalf of a Melbourne syndicate became interested in the property as a potential tin producer and a few months later, torbernite was discovered in the open cut by Mr. V. Pitulej.

Several applications for leases and prospecting areas etc., covering the cut and surrounding areas are now before the Warden's Court at Launceston and the legal position is by no means clear.

Geology

The only rock seen in the workings or outcropping near abouts is a granite of Devonian age but this granite although of one origin exhibits many different forms. The normal rock is a fairly coarse grained typical tin granite with well developed crystals of quartz, biotite and the felspars.

In the cut itself a rather curious type occurs. It consists mainly of a fine grained granite but here and there are large crystals of both quartz and felspar and curious nodules of a few inches in diameter consisting of finely crystalline quartz and tourmaline. Jointing, very regular in strike and dip, (the strike is 320° and the dip to the S.W. at 75°) is well developed in this rock and on either side of the joint planes the rock has been altered to a greisen consisting mainly of quartz and mica.

In the northern part of the cut, the hanging wall consists of a rock that I have called pegmatite as it appears to consist of large crystals of quartz and felspar. Microscopic examination, however, shows the presence of mica and tourmaline. The field name has been retained.

As an appendix to this report a description of the different rock types by Petrologist G. Everard is appended.

Workings

Although all the workings below the open cut are now inaccessible, a good record of them can be obtained from the Mine Plans and from Reids Bulletin.

The open cut itself is nearly eight hundred feet in length and averages eighty feet wide. The floor of it is most irregular, islands have been left and much has fallen in and as the surface itself rises in the centre, there is no regular depth, but 40 feet would be an average figure. The adit level is about 20 feet below the floor of the cut. The adit itself runs almost due south for 150 feet when it comes out in an open stope, north west of the main cut. It then continues beneath the open cut for almost its entire length. The lower level was reached by an underlay shaft (at 50°) in a south easterly direction and was about 70 feet below adit level. From the shaft (on the footwall side of the lode) a cross cut 60 feet in length connected with the main drive 620 feet long.

In both levels at about 400 feet along the main drive another ore body appeared to join the main vein and the drives were widened to nearly forty feet, gradually narrowing again to their ends. A horse of country was left between the two makes of ore. Most of the ground was stoped between the two levels but no development seems to have taken place below No. 2 level nor has any attempt been made to locate parallel formations by cross cutting.

Sampling.

Most of the sampling was carried out by the Chief Geologist, Mr. H.G.W. Keid. It was of course realised that nothing very much would be left to sample in the open cut as all the ore would have been removed and only unpayable stone left. However, some of the porphyry and greisen material remained in the hanging wall side near the centre of the cut and it was felt that a systematic sampling of this remnant might establish some sort of relationship between the rock types and the tin, uranium and copper percentages. Chip samples were also taken of pegmatite showing some torbernite in the north-western part of the workings and of porphyritic material in the foot wall side. The positions of the samples are shown in the accompanying plan. Samples 1 to 23 are generally at right angles to the strike of the joint planes and represent a continuous channel sample. The material is alternate bands of greisen (round the joint planes) and softer quartz felspar porphyry with quartz-tourmaline nodules. Samples 24 and 25 are chip samples from larger distances but not altogether at right angles to the joint planes. Sample H10 is from pegmatite showing splashes of torbernite, H12 is a chip sample from a large block of porphyry partially greisenised that has yielded most of the torbernite specimens, and H11 and H14 from porphyry on the foot wall side of the cut.

Details of the samples are as follows:-

Sample No.	Width	Material	Equivalent Uranium Content by Radiometric Assay U_3O_8	Cu	Sn
1	2'3"	Porphyry (K1 of Appendix)	.003	Trace	Trace
2	1'4"	Porphyry	.002	Trace	Nil
3	4"	Porphyry and Greisen	.004	.01	Nil
4	1'2"	Porphyry	.003	Trace	Nil
5	1'4"	Porphyry and Greisen	.02	.01	.33
6	1'2"	Porphyry with Quartz-Tourmaline Nodule (K6)	.025	.02	.13
7	2'4"	Porphyry and Greisen	.006	.01	.11
8	1'5"	Porphyry	.003	.03	Nil
9	1'2"	Greisen	.004	.02	.25

Sample No.	Width	Material	Equivalent Uranium Content by Radiometric Assay U308	Cu	Sn
10	10"	Porphyry	.004	Trace	Nil
11	1'5"	Greisen with large quartz and tourmaline crystals (K11)	.004	Trace	.45
12	1'6"	Porphyry and Greisen	.006	.02	.31
13	8"	Greisen	.008	Trace	.34
14	8"	Porphyry with tourmaline (K14)	.005	Trace	Nil
15	1'7"	Greisen and Porphyry	.007	Trace	Trace
16	1'3"	Greisen	.006	.02	.13
17	2'2"	Greisen	.01	.01	.44
18	2'3"	Porphyry showing torbernite	.07	.02	Nil
19	2'5"	Porphyry	.015	.01	Nil
20	1'6"	Greisen	.04	.03	.75
21	2'0"	Greisen and Porphyry (K21)	.02	Trace	.12
22	2'0"	Greisen - some torbernite	.03	Trace	.10
23	2'0"	Greisen	.035	Trace	.12
24	Chip 8'±	Greisen and Porphyry	.03	.01	.26
25	Chip 5'±	Greisen and Porphyry	.03	.03	Nil
H10	Chip	Pegmatite with torbernite	.015	.01	Nil
H11	Chip	Porphyry and Greisen (Hanging Wall)	.03	.01	Nil
H12	Chip	Porphyry (Foot-wall)	.04	.03	Nil
H14	Chip	Porphyry (Foot-wall)	.015	Trace	.4

__Mineralisation__

The results of this sampling are very interesting. Before discussing them it might be as well to speculate on the sequence of events leading to the deposition of the tin, and uranium minerals. It is obvious that some portions of the magma cooled much quicker than others. The portion represented by the pegmatite in the hanging wall of the ore-body cooled quite slowly and the portion which is now the porphyry was also cooling slowly forming large crystals of felspar and quartz when suddenly something happened to cause the rate of crystallisation to accelerate. Perhaps this part of the intrusion had assimilated large blocks of sediments and indeed a possible origin of the quartz-tourmaline nodules is xenolithic.

The next stage was the development of a remarkably even and well developed set of joint planes, striking at 320° and dipping to the south west at 75°. These are varying distances apart but average about 3 feet.

Up these joint planes ascended hot solutions and gases rich in silica, fluorine etc., from the yet unsolidified portion of the magma, soaking into the porphyry on either side of the joint planes like ink into blotting paper and changing the porphyry to greisen so that a view of a section across the planes today shows a banded effect with nearly half the porphyry greisenised.

Up these joint planes, too, came the metallic minerals of tin, copper and uranium. Now in considering the mineral, torbernite, which occurs at this mine, it is necessary to remember that not only is it a uranium mineral but also that it has much greater powers of migration in ground water solution than most other minerals. This is well illustrated by the results of the sampling. If the table is studied it can be seen that the tin values follow fairly closely the greisenisation of the porphyry; that is, where the material in column 3 is marked greisen, the tin values are highest. This is what might be expected; but if the uranium values are compared with the material, no such regularity can be noted and indeed the uranium values in the porphyry are higher. It will also be noticed that the uranium occurs in barren pegmatite (M10). At this particular spot in the cut plentiful bright green crystals can be seen splashing the rock, but the U_3O_8 content is quite low (.015%) showing that the material is confined mainly to joint planes and open faces and is not disseminated throughout the rock.

The percentage of copper in the various samples should also be noted. The theoretical amount of copper in torbernite is less than one-seventh the U308 content so that most of the copper in these samples must be in a different form, and quite a lot of the green material is probably not torbernite but malachite.

When the primary uranium mineral is located it will probably be found that the tin and uranium mineralisation closely follow each other and occur in the greisenised portion of the porphyry and not in the pegmatite.

Oxidation and Erosion

These two subjects are of great importance to the present investigation. Firstly, how much of the granite has been eroded? The introduction of mineral solutions to the granite mass, when it was far below the then surface, would be concentrated near the top of that mass and the more granite that has been eroded the less chance of the tin and uranium bearing material persisting to any great depth. Now erosion of the granite has occurred in two widely separated periods. Firstly, from the end of the Devonian, right through the Carboniferous, erosion was taking place of the Silurian sediments overlying the granite and finally of the granite itself. Beds of Silurian sediments may be seen at Roy Hill not a great distance from here which seems to show that the erosion did not extend far into the granite. From Tertiary times again the Valley of the St. Pauls has been forming and deep erosion has occurred in both dolerite and Permian and Triassic sediments. However, that erosion barely reached the granite and Permian sediments to a hill just east of the open cut. Thus it appears that probably during the first great erosional period little of the granite was removed and certainly during the second, erosion did not penetrate deeply into that rock.

The second problem is to ascertain the depth of the oxidised zone or how far below the surface may we expect to find a primary uranium mineral. Unfortunately, all the workings below the open cut are inaccessible but Reid in his bulletin states that in the shaft workings pyrite, chalcopyrite and tourmaline are abundant ore components. The possibility must be considered that the zone of oxidation of the uranium minerals extends below that of the copper and iron, but I would expect the primary minerals to be encountered at not more than 300 feet from the surface.

Other Workings

About a mile south west of the open cut is a series of workings, shafts, pits and trenches which was once known as the St. Pauls Tin Mine and which is referred to as Bailey's Lode in Reid's Bulletin. The main shaft (said to be 60 feet in depth) is now inaccessible but material on the dump, a greisen-like rock, showed small patches of torbernite and gave readings of 1000 on an Austronic PRM Counter.

The workings seem to follow a fairly vertical 12" vein of blue quartz tourmaline which courses almost east and west. This vein, however, apparently was poor in tin and certainly gives little increase in count. The greenish greisen, which is apparently in the northern wall, but may be in both, did carry tin and also has a percentage of U308.

Although not as promising as the Royal George occurrence there is evidence of the uranium here and if an investigation were undertaken I should think that the first step would be to pump out the shaft.

Conclusions and Recommendations

There is sufficient evidence to show that in the open cut of the old Royal George Mine, there exists, fairly widely dispersed, the secondary uranium mineral torbernite. Now before too much optimism is expressed, two factors must be considered.

1. None of the samples taken show stone of ore grade.
2. No primary uranium mineral has yet been detected and torbernite is a notorious "wanderer".

However, there appears to be a sufficient showing of uranium to warrant further investigation and the first step is to discover the primary uranium mineral and its lateral extent. The uranium mineralisation at depth should follow closely that of the tin; that is the greisenised portion of the quartz felspar porphyry below the open cut should first be tested. This has been stoped out to shaft level so that any bore must be designed to intersect the formation below this and also it must intersect the greisen below the oxidised zone. The accompanying plan shows the recommended positions, direction and angle of the first two bores designed to intersect the formation from 250 to 500 feet.

What must not be forgotten is that this was once a tin mine and could be again and that the uranium need after all be but a by-product.

Sgd. Terence D. Hughes

GEOLOGIST

April, 1955.

APPENDIX

Petrological Report by G. Everard

The following descriptions apply to rocks collected at the Royal George Mines by Chief Geologist, H.G.W. Reid, and Geologist, T.D. Hughes.

K1 Porphyritic rock, containing large crystals of quartz and felspar in a medium of fine grained ground mass.

In thin section in ordinary light the rock is a mosaic of clear quartz, cloudy felspar, yellowish, brownish and colourless mica and various grains of different minerals stained with iron oxides.

Under crossed nicols the larger felspar crystals show simple twinning; but are extensively albitised. The albite can be readily recognised by its fresh appearance.

Quartz occurs in two characteristic ways; firstly as irregular grains somewhat embayed and corroded and secondly as inclusions in felspar, groups of inclusions extinguishing together.

Mica is in irregular plates, often ragged and showing signs of alteration. The colour varies from brown to pale yellow but all varieties are distinctly pleochroic. The mottled character of many of the patches of mica suggests metamict products, but may be due to other causes.

Most of the areas stained with iron oxides have a very fine grained structure and appear to consist of secondary silica and sericite. They can easily be distinguished by colour from the altered felspar.

The rock is a granite porphyry which has undergone some alteration.

K6 Medium grained rock consisting chiefly of light coloured granular quartz and black tourmaline.

In thin section the rock is an aggregate of interlocking quartz grains with interstitial tourmaline and white mica. The mica has a radiating structure. Much of the mica is stained brown with iron from disseminated iron ore minerals, and the tourmaline similarly by oxidation of the iron in its composition.

The rock is a tourmaline granite.

K11 Medium grained light coloured rock, weathered and stained by iron oxides.

In thin section the rock appears as a mosaic of quartz grains, with a fine grained felted mass of muscovite filling the interstices. The muscovite sometimes shows radiating structure and occasionally appears as books rather larger than the quartz grains.

The rock is a greisen.

K14 Light grey rock of medium grain with phenocrysts of quartz and kaolinised felspar.

In thin section the rock appears as an even grained mosaic of clear quartz, semi opaque kaolinised felspars with traces of simple twinning. Well crystallised pale coloured pleochroic mica is prominent, but many crystals have been altered in whole or part to give a scaly aggregate. There is also interstitial quartz-sericite material. A little interstitial tourmaline is present.

The rock is a granite porphyry showing the beginnings of pneumatolytic alteration.

K21 In thin section the rock consists of groups of interlocking grains of quartz, the interstices being filled with a fine felted mass of sericitic mica. Skeletal crystals of felspar and muscovite indicate the process of sericitisation.

The rock is a greisen and differs from H1 in the almost complete alteration of the mica.

H1 Light greenish grey rock containing quartz and mica.

In thin section the quartz is seen to be in interlocking grains, some showing hexagonal section, the interstices being filled by a pale brownish-yellow mica which is quite distinctly pleochroic.

Small irregular masses and grains of opaque iron ore minerals are disseminated through the rock, more particularly associated with the mica. There is a little of some translucent mineral which appears to have been formed by alteration from the iron ore. This mineral is green in transmitted light and purple in reflected light.

The rock is greisen.

H9 Leucocratic rock of porphyritic texture.

In thin section the felspar phenocrysts with simple twinning, and cloudy with alteration products, show evidence of albitisation. In the large crystals are wavy areas with lamellar twinning. There are also groups of rounded quartz grains with simultaneous extinction, as inclusions.

Quartz, generally, is in rounded grains, embayed and irregular.

Mica is in irregular masses sometimes with intense pleochroic haloes. In the same crystalline masses the mineral may be brown pleochroic as in biotite or relatively colourless.

In reflected light the rock is largely white and opaque with a few black opaque grains.

The rock is a slightly altered granite porphyry.

H11 Leucocratic medium, even grained rock. Visible minerals are felspar in creamy somewhat lath like crystals, quartz in dark glassy grains, biotite, and a black vitreous mineral.

In thin section the rock is holocrystalline allotriomorphic-granular, even the felspars showing very little of crystal outline.

Quartz-irregular, equi-dimensional grains with the periphery sometimes corroded and embayed. In some instances groups of scattered grains in large felspar crystals extinguish together.

Felspar.

Plagioclase, - largest crystals in the section, partly altered and containing many inclusions.

Albite, - rather small, fresh crystals shown multiple twinning - often inclusions in other minerals.

Orthoclase - less common, large lathlike crystals much altered, but showing simple twinning.

Mica - ragged books - pleochroic-white to yellow. A few opaque inclusions with pleochroic haloes. Also some included small crystals of albite.

Tourmaline - rare interstitial patches, grey-blue pleochroic.

The rock is a fine grained granite slightly affected by pneumatolytic action.

H10 Leucocratic coarse, even grained rock consisting of felspar and quartz. Black glassy schorlite tends to be associated with the quartz, and makes it appear dark.

In thin section the texture is hypidiomorphic. Felspar is of three types :-

Plagioclase in large twinned crystals, not greatly altered. Orthoclase, showing simple or no twinning; but smoky with alteration products, and enclosing well formed albite crystals. The orthoclase also is in part intergrown with albite, to give an irregular wavy structure. The albite can be distinguished by slightly higher polarisation colours and multiple twinning.

Quartz is in irregular fractured grains.

Mica is in books showing strong pleochroism white to yellow and containing pleochroic haloes.

The rock is much weathered and contains white opaque leucoxene after ilmenite. It is a coarse grained tourmaline granite.

In general the suite of specimens indicates an original granite, or granodiorite, which has been altered in part to greisen. Some specimens are examples of the almost complete breakdown of all minerals except quartz to give greisen proper; but intermediate stages are typified also. No fresh granite was obtained, all specimens showing at least some degree of alteration. Superimposed on the greisening is the pneumatolytic introduction of fluorine and alkalies, to give tourmaline and perhaps the pleochroic yellow mica. Other minerals have probably been introduced in a similar way, but direct evidence is more difficult to obtain. Thus radioactive elements in the rock, no doubt, have a similar origin, but primary radio-active minerals have not been identified. Pleochroic haloes are prominent in the biotite of one granite but not in others, and in that instance are around minute zircons.

Sgd. G. Everard.

Mineralogist and Petrologist.