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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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by

W. B. Dallwitz.

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INTRODUCTION.

An enquiry has come from the Melbourne University Ore-Dressing Laboratory concerning the mineralogy of ores from Nos. 1 and 2 orebodies at Rye Park. Mr. K. S. Blaskett, Principal Research Officer at the Laboratory, has done treatment tests on ore from the No. 1 orebody, but is uncertain as to whether the sample investigated is typical of the ore as a whole.

Sullivan and Dallwitz (1952) suggested that scheelite is more abundant than wolfram in the ore, but Mr. Blaskett found that the principal tungsten mineral is wolfram; evidence for this was obtained during ore treatment tests, and was confirmed by mineragraphic work.

According to the geological report, fluorite is stated to be abundant, but very little fluorite was found in the ore treated in the Laboratory.

As the bulk of the ore at Rye Park is in the No. 2 orebody, the question has arisen whether this ore is appreciably different from the sample tested.

Differences in mineral assocation, grain-size, etc., may be very important in ore treatment.

The following report describes in a general way what is known at present about the minerals and problems in which Mr. Blaskett is interested.

Mode of occurrence of ore.

As stated by Sullivan and Dallwitz (loc. cit.) the ore occurs as sub-horizontal sheets interbedded with dacitic volcanic rocks. Mineralization is of the skarn type, and has been brought about by an intrusion of granite, which is greisenized and heavily silicified in places. It is not possible to state as yet the original nature of the beds now containing the ore, but it is tentatively suggested that they were calcareous tuffs. In the vicinity of the granite the ore-bearing beds have been converted to pyroxene hornfels and subordinate pyroxene-garnet hornfelses. These rocks are far more extensive than are the payable orebodies themselves and generally contain little or no tungsten mineralization: the payable ore is found where the host hornfelses have been metasomatically converted to hornblende- and magnetite-bearing rocks, or to biotite-bearing rocks; other variants, including plagioclastic and epidotic types occur in lesser quantity, and also contain payable tungsten mineralization. The plagioclastic type is very abundant in the open cut (No.1 orebody).

In some places conversion of the pyroxene and pyroxene-garnet hornfelses to hornblende- and magnetite-bearing rocks has been complete over widths of 10 feet or more, but generally remnants of the hornfelses are interspersed through

the hornblende-magnetite rocks; this applies particularly to the No. 2 orebody. In this orebody, also, the best ore is largely confined to a central zone within the bed, the upper and lower parts being pyroxene and pyroxene-garnet hornfelses with a low scheelite content; these hornfelses carry narrow runs of metasomatic hornblendic and biotitic rocks which generally have a higher tungsten content than the pyroxene host rock (see, e.g. slides 8/81'3" and 18/92'8").

Mineral composition of the ore.

The following lists show the mineral compositions of each of 51 thin sections of the ore and the associated pyroxene and pyroxene-garnet hornfelses. For each thin section, the minerals have been placed in their relative order of abundance as assessed visually. Volume percentages of magnetite and fluorite have been estimated visually to the nearest 5 percent.; percentages of less than 5 have not been recorded.

(a) Rocks from No. 1 Orebody.

Slide No.	Location	Minerals Present.
R.P.1	Open cut	Plagioclase, muscovite, scheelite, green biotite, wolfram, apatite, grossularite garnet.
R.P.2	" "	Plagioclase, green biotite, scheelite, magnetite (5%), wolfram, apatite, grossularite, muscovite.
R.P.3	" "	Green biotite, wolfram, apatite, scheelite, fluorite.
R.P.15	" "	Plagioclase, scheelite, quartz, green biotite, apatite, sericite, wolfram, grossularite garnet, epidote.
22/29	At 29' in D.D.H.22	Quartz, green biotite, apatite, scheelite calcite, wolfram.
R.P.9	Dump	Brown biotite, plagioclase, muscovite, apatite, fluorite, chlorite, tourmaline.
R.P.11	"	Magnetite (50%), green biotite, plagioclase, grossularite garnet, apatite, scheelite.
R.P.12	"	Brown biotite, plagioclase, apatite, fluorite, muscovite, zircon.
R.P.13	"	Quartz, epidote, green biotite, andradite, calcite, chlorite.
R.P.14	"	Fluorite (35%), quartz, magnetite (15%), hornblende, pyroxene, limonite.
R.P.16	"	Plagioclase, epidote, magnetite(10%), green biotite, sericite, apatite, muscovite, scheelite, grossularite.
R.P.17	"	Plagioclase, brown biotite, sericite, muscovite, epidote, chlorite, apatite, scheelite, magnetite, zircon.

It is not claimed that these 12 specimens are representative of the ore. Some of the specimens from the dump may represent rocks from outside the No. 1 orebody as

delimited in the plans and sections; this is so because the old workings penetrated below the No. 1 orebody, and so the exact source of some of the material studied is not known. Furthermore, the open cut is near the eastern limit of the orebody, and so the material available for study from that source may be by no means representative of the orebody as a whole. Slide No. 22/29 is probably the best guide as to the nature of the ore nearer the granite contact.

From the above lists the following order of abundance of minerals in the ore is indicated:

Plagioclase, green biotite, apatite, scheelite, quartz, muscovite, magnetite, brown biotite, epidote, wolfram, fluorite, sericite, grossularite garnet, chlorite, calcite, hornblende, andradite garnet, pyroxene, limonite, zircon, tourmaline.

For the reasons stated above, very little reliance can be placed on this order. In any case, most of the specimens sectioned were of the richer ore, and so we have the quite misleading position that scheelite in the sections is more abundant than magnetite and quartz, for example. Furthermore, in the ore used for treatment tests in the Ore-dressing Laboratory, wolfram was found to be more plentiful than scheelite, whereas the reverse holds in the thin sections; obviously the estimate from thin sections is less reliable than that from a bulk sample. Again, it is considered that, because the ore tested was taken only from near the eastern limit of the orebody, it may not be truly representative of the whole orebody. In the case of the No. 2 orebody, it was found that the mineralogical constitution of the ore intersected by drilling was far from constant; similar variations can be expected in the No. 1 orebody.

(b) Rocks from the vicinity of No. 1 Orebody.

The following rocks are more or less closely associated with the No. 1 orebody, and may, in fact, be considered as less richly mineralized portions of it. Such rocks will undoubtedly be included in the mill feed, and so their mineralogy is of some importance.

Slide No.	Location.	Minerals Present.
R.P.5	Above No. 1 orebody, 20'S of open-cut.	Pyroxene, fluorite (10%), epidote, quartz.
R.P.10	Dump	Pyroxene, fluorite (20%), andradite garnet, quartz, magnetite.
R.P.18	"	Fluorite (40%), quartz, pyroxene, magnetite (15%), epidote, calcite, scheelite, hematite.
R.P.19	Costean, 60'S of open cut.	Quartz, magnetite (25%), hornblende, scheelite, green biotite.
R.P.20	"	Pyroxene, quartz, magnetite (5%), fluorite, epidote.
2/9	At 9' in D.D.H.2 20' E of No. 1 Orebody as outlined cross-sections.	Fluorite (55%), hornblende, quartz, magnetite (5%), epidote.
2/16'6"	At 16'6" in D.D.H.2 12' E of No. 1 Orebody as outlined in cross-sections.	Fluorite (45%), hornblende, magnetite (15%), quartz, epidote, scheelite, sphene.

Slide No.	Location.	Minerals Present.
2/27	At 27' in D.D.H.2, 10' E of No. 1 Orebody as outlined in cross-sections.	Slide shows two distinct portions: (a) Fluorite (45%), pyroxene, quartz, magnetite (5%), hornblende, epidote, scheelite. (b) Quartz, fluorite (30%), hornblende, magnetite (15%), scheelite.

The most striking feature of these rocks is the abundance of fluorite; otherwise they are similar to many of the rocks found in the No. 2 orebody. Most of those showing no scheelite in the slide do, nevertheless, show traces of it in the hand-specimen; this is, of course, generally to be expected in the hornblende- and magnetite-bearing hornfelses.

(c) Rocks from No. 2 orebody.

The following slides represent rocks from within the No. 2 orebody as delineated on the plans and sections.

Slide	Location	Minerals Present.
2/47	At 47' in D.D.H.2	Quartz, hornblende, magnetite (10%), scheelite, fluorite, epidote.
2/48	At 48' in D.D.H.2	Plagioclase, magnetite (25%), hornblende, quartz, sericite, scheelite, calcite, chlorite, wolfram, apatite, epidote.
2/53	At 53' in D.D.H.2.	Hornblende, quartz, magnetite (15%), fluorite (15%), epidote, scheelite.
2/57	At 57' in D.D.H.2	Siderite, quartz, calcite, chalcedony, pyrite, fluorite.
2/60	At 60' in D.D.H.2 Granite contact.	Apatite, green biotite, sericite, plagioclase, quartz, magnetite (5%), scheelite, wolfram, pyrite
3/42'2"	At 42'2" in D.D.H.3	Sericite, brown biotite, epidote, (clinozoisite), plagioclase, quartz, siderite, scheelite, apatite, allanite.
5/55'5"	At 55'5" in D.D.H.5	Quartz, magnetite (20%), green biotite (incl. chlorite), wolfram, scheelite, grossularite garnet, plagioclase, fluorite, calcite.
5/60'10"	At 60'10" in D.D.H.5	Plagioclase, apatite, scheelite, wolfram, chlorite, quartz, sericite, leucoxene, pyrite, brown biotite, calcite, sphene.
8/110	At 110' in D.D.H.8	Slide shows two distinct portions: (a) Pyroxene fluorite (10%), magnetite (5%), andradite garnet, quartz, calcite, hornblende. (b) Calcite, quartz, hornblende, pyroxene, epidote, magnetite, scheelite.
8/115	At 115' in D.D.H.8	Pyroxene, fluorite (35%), quartz, magnetite (5%), andradite garnet, epidote, hornblende, scheelite.
8/120	At 120' in D.D.H.8.	Pyroxene, fluorite (5%), epidote, quartz, magnetite, calcite.

Slide	Location	Minerals Present.
8/129'3"	At 129'3" in D.D.H.8.	Hornblende, epidote, magnetite (15%), quartz, scheelite, fluorite, pyrite, apatite.
8/129'6"	At 129'6" in D.D.H.8.	Hornblende, epidote, magnetite (10%), scheelite, quartz, pyrite, apatite.
18/103'2"	At 103'2" in D.D.H.18.	Plagioclase, sericite, scheelite, grossularite garnet, wolfram, apatite, chlorite, magnetite.
18/103'8"	At 103'8" in D.D.H.18	Plagioclase, green biotite, grossularite garnet, sericite, scheelite, apatite, wolfram, quartz, magnetite, pyrite, tourmaline.
18/105'6"	At 105'6" in D.D.H.18.	Green biotite, scheelite, grossularite, garnet, wolfram, apatite, sphene.
18/107'6"	At 107'6" in D.D.H.18	Quartz, green biotite, magnetite (10%), grossularite garnet, scheelite, apatite, hornblende, wolfram, sericite.
20/101'6"	At 101'6" in D.D.H. 20	Hornblende, magnetite (35%), scheelite, calcite, quartz.
20/104'	At 104' in D.D.H.20.	Epidote, magnetite (25%), green biotite, plagioclase, scheelite, hornblende, fluorite, apatite, wolfram, grossularite garnet, sphene.
20/104'9"	At 104'9" in D.D.H.20	Plagioclase, green biotite, scheelite, fluorite, magnetite, apatite, sericite, chlorite, grossularite garnet.
21/66	At 66' in D.D.H. 21; low-grade part of orebody.	Fluorite (25%), pyroxene, magnetite(20%), quartz, hornblende, epidote, scheelite
32/46'6"	At 46'1" in D.D.H. 32.	Pyroxene, magnetite (5%), fluorite (5%), epidote, hornblende, scheelite.

(d) Rocks from the vicinity of No. 2 orebody.

The rocks listed below occur close to the No. 2 orebody; their tungsten content is generally considerably lower than that of the hornblendic and biotitic rocks, and may be nil. Similar rocks occur commonly as partially metasomatized residua within the orebody, and form a substantial pro-portion of it; some of these have already been listed under (c), viz. 8/110a, 8/115, 8/120, 21/66 and 32/46'1".

Slide No.	Location	Minerals present.
2/37	At 37' in D.D.H.2; 7' above No. 2 orebody as outlined in cross-sections.	Pyroxene, andradite garnet, fluorite (10%), quartz, epidote, magnetite.
8/63	At 63' in D.D.H.8, 30' above No. 2 orebody	Pyroxene, andradite garnet, fluorite (5%), quartz, calcite, hornblende, magnetite, hematite.
8/78'4"	At 78'4" in D.D.H.8, 20' above No. 2 orebody	Quartz, pyroxene, magnetite (15%), fluorite (15%), hornblende, epidote, allanite.

8/81'3"	At 81'3" in D.D.H.8, 17' above No. 2 ore-body.	Quartz, fluorite (35%), hornblende, magnetite (10%), scheelite, epidote.
8/92'3"	At 92'3" in D.D.H.8, 9' above No.2 orebody.	Pyroxene, andradite garnet, fluorite (5%), magnetite, quartz, hornblende, scheelite.
11/62	At 62' in D.D.H.11, 17' above No.2 orebody.	Pyroxene, andradite garnet, magnetite (5%), fluorite (5%), epidote, hornblende.
18/92'8"	At 92'8" in D.D.H.18, 4' above No.2 orebody.	Quartz, magnetite (25%), fluorite (20%), hornblende, epidote, scheelite.
18/111'2"	At 111'2" in D.D.H. 18, 1'6" below No. 2 orebody	Pyroxene, epidote, grossularite garnet, andradite garnet, fluorite (5%), quartz hornblende, magnetite, sphene, allanite.
33/57'10"	At 57'10" in D.D.H. 33, 9' above No. 2 orebody.	Pyroxene, fluorite (5%), magnetite, quartz, epidote, scheelite, hornblende, calcite.

Combining the information provided by the 31 slides listed under (c) and (d), the following order of abundance of minerals is indicated:

Quartz, magnetite, fluorite, scheelite, hornblende, pyroxene, epidote, plagioclase, green biotite, apatite, andradite garnet, sericite, grossularite garnet, calcite, wolfram, pyrite, chlorite, siderite, brown biotite, sphene, chalcedony, allanite, leucoxene, hematite, and tourmaline.

With certain important reservations this list is considered to give an approximately idea of the relative volumetric abundance of the various minerals in the No. 2 orebody. These reservations are as follows:

1. In selecting specimens of ore for sectioning, the general practice was to take those which were richer than average in scheelite; this was done mainly for the purpose of studying what were the most favourable indicators and the most common associates of scheelite in the higher grades of ore. This means, of course, that scheelite and wolfram occupy positions in the list much higher than those that they should in reality occupy.

2. Pyroxene and the two garnets are probably more abundant than indicated above; it is considered that the pyroxene and pyroxene-garnet hornfels are somewhat inadequately represented in the sections studied. The pyroxene, indicentally, is probably an iron-rich diopside.

The following minerals have also been observed in hand-specimens of the ore, but were not specifically noted in the sections studied:

(a) Pyrrhotite. This mineral is very plentiful in places, particularly in pyroxene hornfels; some sections of massive pyrrhotite were noted.

(b) Molybdenite; present in granite as well as in ore.

(c) Chalcopyrite

(d) Blende (very rare)

Although neither the specimens from the No. 1 orebody nor those from No. 2 orebody - and especially the former - can be regarded as satisfactorily representing the two orebodies, this study has shown that there is a marked difference between them in percentage mineralogical composition. The most striking difference is the greater abundance of plagioclase and biotite in the No. 1 orebody; the higher tungsten content of this orebody is considered to be due to the factors responsible for this general difference in mineralogy. Wolfram has not been observed in any thin section that does not contain green biotite or brown biotite, or chlorite; however, not every rock which contains biotite or chlorite contains wolfram, for in some cases all of the wolfram has been metasomatically replaced by scheelite.

The higher grade and different percentage mineral composition of the No. 1 orebody may be due to one or both of the following factors:

1. The composition of the original rock may have been such as to make it more reactive to metasomatizing solutions.

2. As the ore-bed is somewhat nearer the top of the granite cupola, higher concentrations of at least certain of the volatiles and mineralizers, including tungsten-bearing fluids, would probably have been present there. These solutions would have brought about metasomatic changes, which, although essentially similar to those observed in the No. 2 orebody, may have been different in degree.

Percentages of magnetite and fluorite in No. 2 orebody.

Mr. J. Ward, of the Bureau of Mineral Resources, has determined the specific gravities of 10 specimens of ore and pyroxene hornfels from the No. 2 orebody. The figures obtained ranged from 3.3 to 3.9, and the mean figure was 3.55.

Taking into account all of the rocks listed under (c) and (d) above, it was found that the average volume percentages of fluorite and magnetite were 7 and 9, respectively; the corresponding weight percentages are 6(.2) and 13(.1). In making these calculations rocks containing magnetite and fluorite in quantities estimated at less than 5 percent. by volume were considered as carrying 2 percent. of those minerals. The volume percentages of both fluorite and of magnetite ranged from nil to 35. Of the 31 rocks examined 18 carried 5 percent. or more of magnetite (by volume); 13, 10 percent. or more; 9, 15 percent. or more; and 6, 20 percent. or more.

There is more fluorite in the No. 2 orebody than in the No. 1. It is comparatively rare as an associate of biotite, which is relatively abundant in the No. 1 orebody, more common in association with hornblende, and most common with pyroxene; the latter two minerals are more plentiful in the No. 2 orebody than in No. 1.

Grainsize of the scheelite.

The observed grain-size range for scheelite is about 0.03 mm. to 1.2 mm. In some of the ore, scheelite occurs as aggregates of very fine grains, generally with remnants of wolfram embedded in them. The grainsize of most of the scheelite lies within the range 0.1 to 0.3 mm., but a fair number of grains measuring about 0.3 to 0.5 mm. was also observed.

Grain-size of the ore.

There appears to be no significant difference in grain-size between the rocks of the No. 1 orebody and those of No. 2 orebody. However, it is extremely difficult to access the average grain-size of the ore. In individual specimens the observed grain-size ranges from less than 0.1 mm. to 1 or 2 mm., and the average grain-size in different specimens ranges between similar limits.

It is estimated that the average grain-size of the ore as a whole is of the order of 0.3 to 0.5 mm., and it probably lies nearer the lower of these limits.

Relative abundance of scheelite and wolfram.

When inspecting the open cut (No. 1 orebody) the general impression formed is that scheelite is much more plentiful than wolfram; the same applies for thin sections of the ore and for rich specimens of ore estimated to contain 20 to 50 percent., or more, WO_3. However, as stated previously in this report, the Oredressing Laboratory found that wolfram was more abundant than scheelite in the sample tested; therefore, the more subjective and statistically less accurate estimates can be discounted, and it can be taken as reasonably certain that wolfram is the dominant tungsten mineral in at least the eastern part of the No. 1 Orebody. The presence of wolfram has been shown to be inseparable from that of biotite or chlorite, and as these two minerals are less abundant in the No. 2 orebody than in the No. 1, the observed predominance of scheelite over wolfram in the No. 2 orebody can be regarded as factual.

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Sullivan, C. J., and
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