CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 60-99

MINERALOGICAL REPORT ON LEACHED RESIDUE FROM THE BEAVERLODGE OPERATION, ELDORADO MINING AND REFINING LTD., ELDORADO, SASKATCHEWAN

by

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EXTRACTION METALLURGY DIVISION

COPY NO. 2

OCTOBER 6, 1960

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SYNOPSIS

Uranium analyses of the sized fractions of washed residue show that the grade of the coarsest sizes is approximately twice that of the finest sizes so that while 50% of the weight of the tailings is in the plus 40 micron fractions, these fractions contain 64% of the uranium.

Most of the radioactivity in the residue occurs in weakly radioactive grains which contain submicroscopic inclusions of an unidentified uranium-bearing mineral. Such grains appear to be as abundant in the finer sizes as in the coarser sizes. A smaller proportion of the radioactivity is due to moderately to strongly radioactive grains which contain microscopically visible pitchblende or brannerite-anatase intergrowths and these grains appear to be much less abundant in the finer sizes. Hematite is usually associated with the uranium-bearing minerals, particularly in the weakly radioactive grains where it occurs as fine inclusions.

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INTRODUCTION

On May 2, 1960, a 50 lb sample of washed residue was received from Eldorado Mining and Refining Ltd. and was given our Reference No. 5/60-2. The sample was reported to be a yearly composite representative of the tailings for 1959 of the carbonate leach plant at the company's Beaverlodge operation, Eldorado, Saskatchewan. It was requested that the Mineralogical Section of the Extraction Metallurgy Division undertake an investigation to determine the uranium mineral constituents and their approximate proportions in the various size fractions, particularly in the sub-sieve sizes.

PROCEDURE

Since the sample, as received, was a composite, it was thoroughly mixed and then a 5 lb sample was cut out for examination by the Mineralogical Section. The 5 lb sample was split, one half being set aside as a retain, and the other half was sized by screening and infrasizing. The results of the sizing analysis are given in Table 1. A chemical analysis of the original head sample showed 0.023% U_3O_8.

The mineralogical investigation consisted of a microscopic and X-ray diffraction study of the mineral constituents in three sized fractions.

Uranium Mineralogy

The mineralogical investigation was started with an examination of one of the coarser fractions to facilitate the determination of the uranium minerals and study their association. Two polished sections were prepared of the heavy liquid sink fraction (Specific Gravity = 2.76) of the minus 48 plus 65 mesh size. The radioactive grains were located by comparing the tracks on alpha autoradiograph plates with the respective polished sections. The alpha track plates were exposed for 9 days.

The alpha track plates indicate that, relative to each other, most of the radioactive grains are weakly radioactive with some moderately to strongly radioactive grains also present. They indicate as well that the radioactivity in the weakly radioactive grains is uniformly distributed (Figure 2). Under the ore microscope the weakly radioactive grains are seen to consist of non-opaque minerals and usually also numerous small laths or irregular specks of hematite (Figures 1 and 2). There are no visible radioactive minerals and none could be identified by X-ray diffraction methods.

TABLE 1

Sizing Analysis of a Composite of 1959 Tailings

Size	Weight grams	Weight %	% U_3O_8 *	% Distribution U_3O_8
+100 M	24.8	6.25	0.029	8.1
-100 +150 "	40.9	10.30	0.029	13.5
-150 +200 "	70.1	17.66	0.030	23.9
-200M +56 μ	11.8	2.97	0.035	4.5
-56 + 40 "	51.0	12.85	0.024	14.0
-40 + 28 "	36.9	9.29	0.021	9.0
-28 + 20 "	29.1	7.33	0.019	6.3
-20 + 14 "	24.4	6.15	0.014	4.0
-14 + 10 "	62.9	15.84	0.013	9.0
- 10 "	45.1	11.36	0.015	7.7
Totals	397.0	100.00	0.023**	100.0

*Chemical Assay

**Original Head Sample

Non-opaque minerals that were identified were plagioclase, quartz, calcite and chlorite.

The moderately to strongly radioactive grains, although similar in appearance to each other, have some variations. The most common type consists of non-opaque minerals intergrown with varying amounts of a grey mineral resembling pitchblende (Figures 3 and 4).

Using X-ray diffraction methods, an unignited grain consisting largely of the grey mineral was identified as pitchblende. This X-ray pattern was very weak but an approximate cell edge of 5.40 kX was determined from it. Brannerite was identified in another grey grain which was ignited, prior to being X-rayed, to restore its crystalline state. Other grains containing the grey mineral, and which were ignited, produced only X-ray diffraction patterns of the non-opaque gangue minerals.

The grey mineral is not completely opaque, having a faint greyish-brown internal reflection when viewed through the crossed nicols of an ore microscope. It occurs as irregular patchy areas forming all or part of a grain and also as a network of fine veinlets. The latter is more common where the grey mineral forms only a small part of the grain, and when examined at high magnification the veinlets appear to be made up of laths or needles. Hematite usually occurs as laths much coarser than the grey mineral.

Some moderately to strongly radioactive grains differ from the above in that the indicated source of the radioactivity is a white mineral; none of the grey mineral being visible (Figure 5). The white mineral has a strong yellowish-white internal reflection when observed through crossed nicols, which suggests the presence of anatase. It commonly occurs as fine veinlets but may be found as dissiminated anhedral grains that often coalesce into dense aggregates.

By X-ray diffraction anatase was identified in some of the unignited grains and brannerite was identified in an ignited grain. However, in one strongly radioactive grain of this type polycrase was identified (Figures 6 and 7) and in others only non-opaque minerals were identified, such as feldspar, quartz and calcite. Hematite is present in many of these grains.

Two of the finer-sized fractions, minus 150 plus 200 mesh and minus 20 plus 14 microns, were studied for comparison with the minus 48 plus 65 mesh fraction. The minus 20 plus 14 micron fraction showed more variation and was examined in greater detail. A polished section of a superpanner tip of this material was exposed to an alpha track plate for 9 days. When developed, evenly scattered but thinly spaced alpha tracks were observed on the plate. Occasionally concentrations of alpha tracks of varying density were also noted indicating that a few moderately to strongly radioactive grains are present. Such grains are much less abundant than in the coarser sizes.

Because of the fine size and close spacing of the grains in the polished section difficulty was experienced in positively locating the radioactive mineral grains. In a few cases a grain similar to the moderately to strongly radioactive grains observed in the coarser sizes was found. Only hematite and some non-opaque minerals were identified by X-ray diffraction.

DISCUSSION AND CONCLUSIONS

The uranium remaining in the 1959 Beaverlodge leach plant tailings is more abundant in the coarser fractions. The grade of the minus 40 micron fractions is lower and is quite uniform. Much of the uranium appears to occur as submicroscopic inclusions which are uniformly disseminated in grains of non-opaque minerals which also contain small inclusions of hematite. These grains appear to be present in approximately equal proportions in all the size fractions examined. The uniform spacing and random direction of the alpha tracks in autoradiographs of such minerals suggests that the uranium occurs as submicroscopic inclusions rather than adsorbed material on the surface of the grains.

In contrast are more strongly radioactive grains which are fairly numerous in the coarser fractions but become more scarce in the finer fractions. These grains contain microscopically visible pitchblende or brannerite-anatase. Anatase is associated with the brannerite but not all anatase-bearing grains contain brannerite.

The grain of polycrase is anomalous since polycrase has never been reported in Beaverlodge ores and it may possibly have been introduced into the sample as a contaminant.

It is concluded that the more strongly radioactive grains become less abundant in the fine sizes because more of the uranium-bearing mineral is exposed to attack by the leaching reagents. However, the unidentified, submicroscopic inclusions of uranium mineral are much less likely to be exposed even in very fine sizes. It would appear therefore, that while fine grinding will liberate the pitchblende and brannerite in microscopically visible grains for attack by the leach solutions, the ultra-fine inclusions will remain inaccessible.

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PHOTOMICROGRAPHS

Figure 1. A weakly radioactive grain of non-opaque minerals containing finely disseminated hematite (hem). X200.

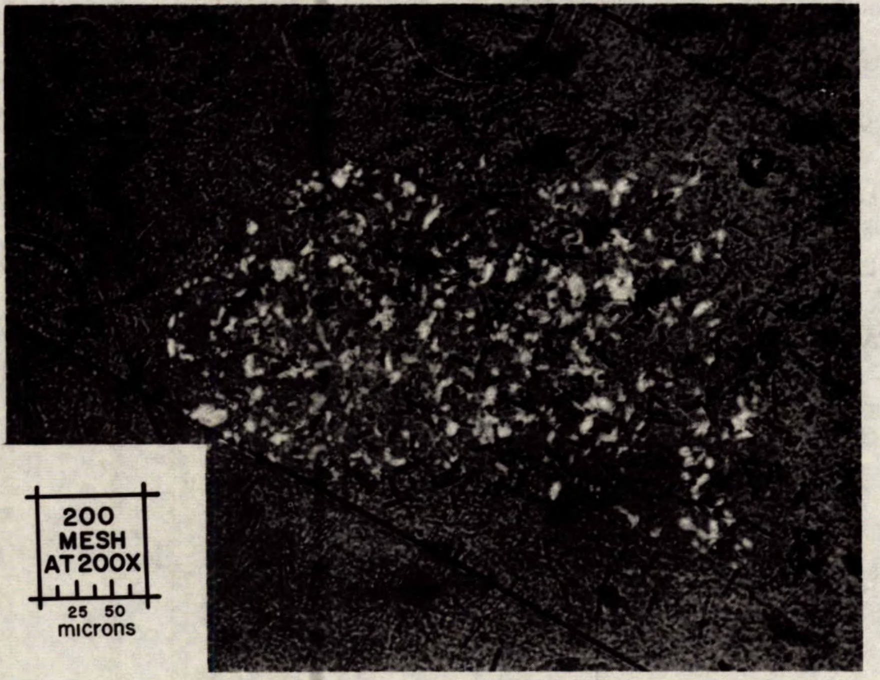

Figure 2. The same field as in Figure 1 with the alpha track plate superimposed to show the location and density of the tracks. X200.

Figure 3. A grain of non-opaque minerals containing two moderately radioactive grey areas (A and B) and associated lath-like hematite (hem). X300.

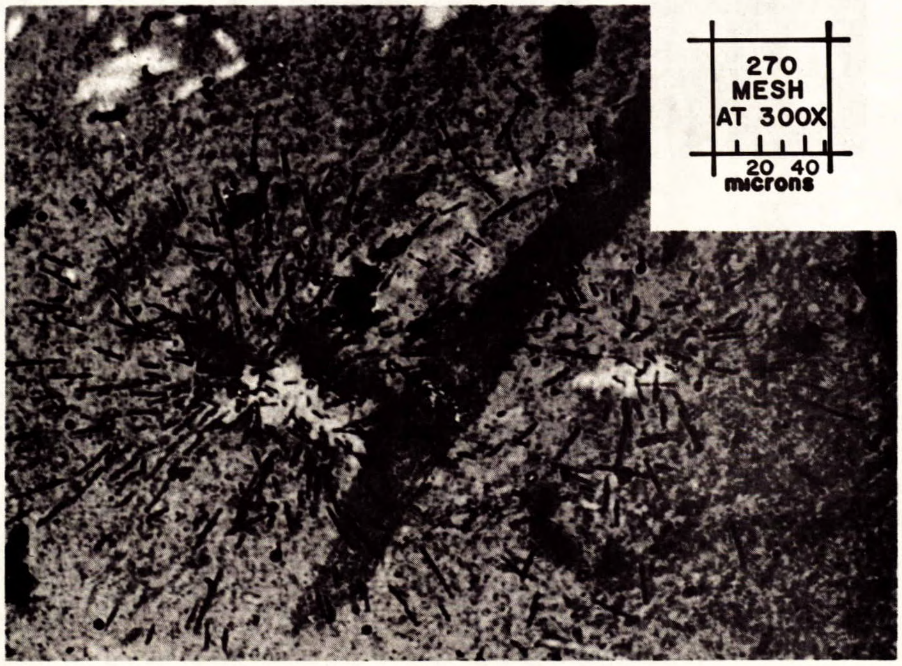

Figure 4. The same field as in Figure 3 with the alpha track plate superimposed to show the location and density of the tracks. X300.

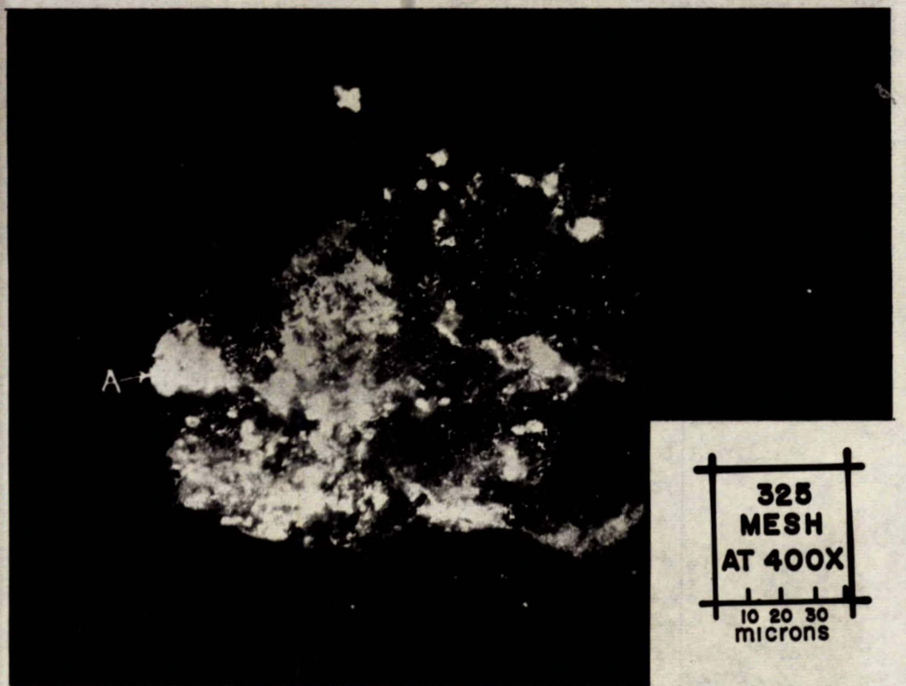

Figure 5. A strongly radioactive grain of non-opaque minerals containing a disseminated white mineral (A) having a yellowish-white internal reflection. Brannerite is present. X400.

Figure 6. Grain A, strongly radioactive, consists of polycrase, hematite and non-opaque minerals. A grain of hematite (hem) is on the right. X200.

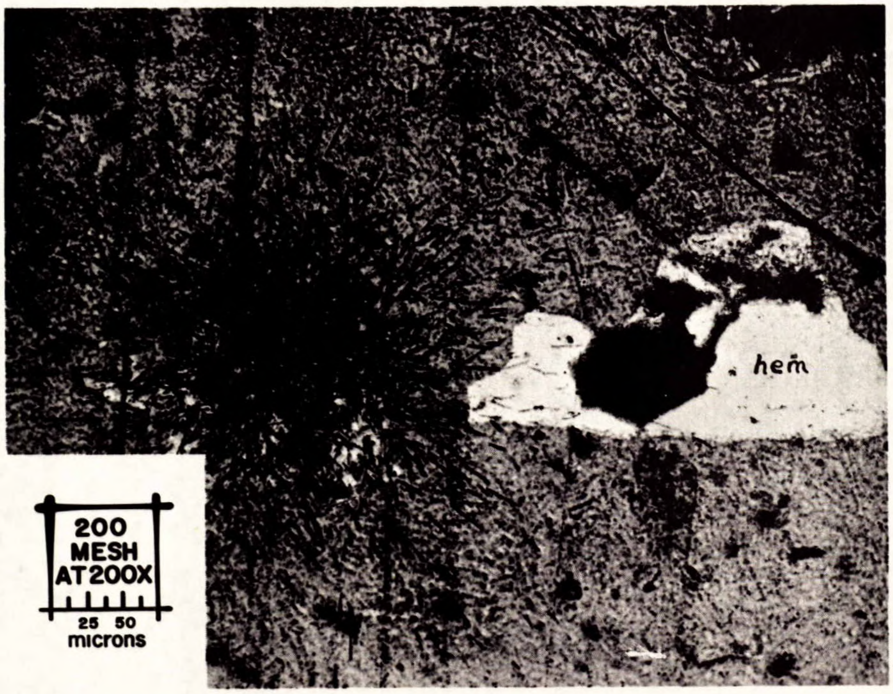

Figure 7. The same field as in Figure 6 with the alpha track plate superimposed to show the location and density of the tracks. X200.