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MINERALOGICAL REPORT ON LUMP ORE SAMPLES FROM FAY MINE, ELDORADO MINING AND REFINING LIMITED, BEAVERLODGE, SASKATCHEWAN

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EXTRACTION METALLURGY DIVISION

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MINERALOGICAL REPORT ON LUMP ORE SAMPLES FROM FAY MINE, ELDORADO MINING AND REFINING LIMITED, BEAVERLODGE, SASKATCHEWAN.

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SUMMARY

The radioactivity in nine samples of lump ore from the lower levels of the Fay mine, Eldorado Mining and Refining Ltd., Beaverlodge, Sask. is due mainly to pitchblende and, to a lesser extent, to brannerite. Both minerals commonly occur in chlorite veinlets in reddish-brown cryptocrystalline quartz rock. Anatase is usually associated with brannerite and occasionally with pitchblende. Pitchblende also occurs intimately intergrown with quartz in fine veins and larger masses. Occasionally intergrowths of brannerite with anatase are present in the pitchblende-quartz occurrences. Minute particles of galena occur in much of the pitchblende.

Trace amounts of coffinite occur in a quartz vein in a specimen from one sample (No. 130924) and sklodowskite forms a soft yellow coating on weathered surfaces in another sample (No. 120925).

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INTRODUCTION

Nine samples of lump ore were submitted to the Mineralogy Section by Dr. E. E. N. Smith, Eldorado Mining and Refining Limited, Research and Development Laboratory, Tunney's Pasture, Ottawa, Ontario on May 30, 1966. Each sample was comprised of 3 or 4 specimens, several inches in diameter. It was reported that the samples had been taken from particular zones in the lower levels of the Fay Mine, and that in leaching tests on ore from some of these newer zones, abnormally low uranium recovery had been obtained. The submitted samples were designated as follows 120922, 120925, 130920, 130924, 140911, 140920, 140923, 172691, and 244191. The first two digits indicate the level, the second two the zone and the last two the working place: where the last two digits are 91 the sample is from a drift. It was requested that a mineralogical investigation be carried out to determine the uranium minerals present in the nine samples and the nature of their occurrence.

PROCEDURE

Preliminary microscopic examination of the samples as received was carried out with a low-power binocular microscope. A detailed mineralogical investigation was made of both thin and polished sections of rock chips from each sample using a Leitz Dialux Pol microscope equipped for both transmitted and reflected light. Autoradiographs were prepared of the polished sections by contacting them with alpha sensitive plates for exposures varying from 114 to 144 hours. Radioactive areas in the polished sections were located by comparing the sections with the autoradiographs. Where possible mineral identifications were confirmed by X-ray diffraction methods. The photomicrographs of polished sections were taken with a Vickers 55 projection microscope.

ROCK COMPOSITION

The samples are basically a reddish-brown, cryptocrystalline, siliceous rock composed of quartz and small amounts of feldspar. The reddish-brown colour is due to the presence of very finely disseminated hematite. Chlorite occurs as a network of veinlets (Figure 1) which occasionally merge to form fairly large masses. Occasional subparallel formations of chlorite veinlets are observed. In parts of the rock the veinlets appear to be the result of chlorite filling the spaces between brecciated fragments of the red-stained quartz rock. The relative proportion of chlorite in the samples can be roughly estimated from the colour of the rock which varies from bright to dark reddish-brown as the chlorite content increases. The approximate order of the samples from low to high chlorite content is 120922, 140911, 244191, 140920, 130924, 140923, 120925, 130920, and 172691. Medium- to course-grained quartz or calcite form veins up to several millimetres in width. Calcite also occurs as brecciated fragments which in places are segregated into layers as much as two centimetres in thickness.

Small amounts of pyrite are present. It occurs as irregular to subhedral cubic grains either in the red-stained quartz rock or intergrown with chlorite. Other minor minerals commonly associated with chlorite are pitchblende, anatase, specular hematite, brannerite, chalcopyrite, and dolomite. Galena commonly occurs as micron-sized particles in pitchblende. Coffinite was observed in a quartz vein. A yellow coating found on weathered surfaces of some specimens was identified as sklodowskite.

Uranium Mineralogy

Sample No. 120922

Pitchblende is the main radioactive mineral in this sample. It occurs as fine, light grey, irregular masses which form a discontinuous series in chlorite veinlets (Figure 2). A lesser amount of brannerite is present in anatase-rich areas in the chlorite (Figure 3). Pitchblende may have a mottled appearance when it is associated with anatase, which makes it difficult to distinguish these minerals from each other in polished section.

The chlorite veinlets transect the red-stained quartz rock (Figure 1). While these veinlets usually form an irregular network they often show several preferred directions. They are commonly less than 1/10 mm in thickness but some as much as several mm thick have been observed. In many of the chlorite veinlets minute irregular to subhedral prismatic grains of anatase are abundant. Weak to strong straw yellow internal reflection is characteristic of the anatase as seen under reflected light. Calcite, pyrite, specular hematite, and galena are minor constituents in the chlorite veinlets.

Sample No. 120925

The occurrence of pitchblende and brannerite in sample No. 120925 (Figure 4) is similar to that in sample No. 120922. A soft yellow, secondary uranium-bearing mineral sklodowskite forms a coating on weathered surfaces of some specimens in this sample. Sklodowskite is a hydrated silicate of magnesium and hexavalent uranium.

Sample No. 130920

Pitchblende, anatase and brannerite occur in chlorite as in the two previous samples. They also occur in large irregularly rounded masses up to 1 1/2 mm across and are intergrown with red-stained quartz (Figures 5 and 6). Such masses may occur in the red-stained quartz rock with little associated chlorite although usually they appear to be enlargements of the chlorite veinlets. Sparsely disseminated grains of pitchblende occur in a particularly thick chlorite veinlet. Small amounts of pyrite and specular hematite may be associated with such grains.

Sample No. 130924

Coffinite (a silicate of quadrivalent uranium with a variable amount of hydroxyl) was the only radioactive mineral observed in sample No. 130924. It occurs as a series of narrow seams in a white quartz vein (Figure 7). Occasionally the coffinite seams coalesce into small bleb-like formations.

Sample No. 140911

Pitchblende occurs in veins up to 1 1/2 mm in width in red-stained quartz rock. The radioactive veins consist of a very fine intergrowth of pitchblende and quartz, the latter unstained by hematite (Figure 8). In addition some pitchblende occurs as irregular grains up to 1/10 mm in size sparsely disseminated in the red-stained quartz rock. Also present is what appears to be a relict crystal of uraninite intergrown with unstained quartz and pyrite and surrounded by a thin dark grey zone of unidentified material (Figure 9). Minute particles of galena ore disseminated in the vein pitchblende.

Sample No. 140920

Massive pitchblende is intimately intergrown with unstained quartz in sample No. 140920 (Figure 10). Veins of this pitchblende-quartz intergrowth up to a few millimetres in width form networks which in places merge into masses several centimetres across. Although the pitchblende is usually an even light grey, in places it has a distinctly mottled appearance (Figure 10). Minute particles of galena (in the order of 1 micron) are abundantly disseminated throughout the pitchblende. Present in the red-stained quartz rock of some specimens from this sample are irregularly shaped, mottled grey grains of pitchblende less than 1/10 mm in diameter. Pitchblende also occurs in a few chlorite veinlets. A few mottled grey grains in the red-stained quartz rock have a lath-like texture and were identified as brannerite (Figure 11).

Sample No. 140923

Irregular to subhedral cubic pitchblende is disseminated in chlorite veinlets in the red-stained quartz rock (Figures 12 and 13). Anatase, much of it in the form of lath-like crystals (Figure 12), is common in the chlorite veinlets. Other specimens contain pitchblende in chlorite veins in a more massive, irregular form (Figure 14). Anatase is associated with the pitchblende in these occurrences as well and brannerite was also noted (Figure 14). Fine particles of galena occur in the pitchblende.

Sample No. 172691

Areas of dense pitchblende intergrown with quart form networks of veins and large masses similar to those in sample No. 140920. However, in the present sample the quartz intergrown with the pitchblende is for the most part red-stained. Also, the pitchblende in places merges into intergrowths of anatase and brannerite (Figures 15 and 16). Pitchblende is much more abundant than brannerite. Small particles of galena approximately 1/10 mm across occur chiefly in the pitchblende. In one specimen veins of milky white quartz up to several mm thick contain disseminated lath-like anatase and pitchblende (Figure 17). The latter was almost impossible to distinguish from the anatase in most places and its presence was confirmed by X-ray powder diffraction methods. Although the presence of brannerite in the anatase was suspected this was not confirmed by X-ray. A few small blebs of thucholite were observed in this sample. However, the alpha track plates showed that they were not radioactive.

Sample No. 244191

The major proportion of the pitchblende in sample No. 244191 occurs in a dense network of chlorite veinlets in the red-stained quartz rock (Figure 18). Small particles of anatase are locally abundant. In one specimen the chlorite veinlets containing pitchblende are widely spaced.

PHOTOMICROGRAPHS

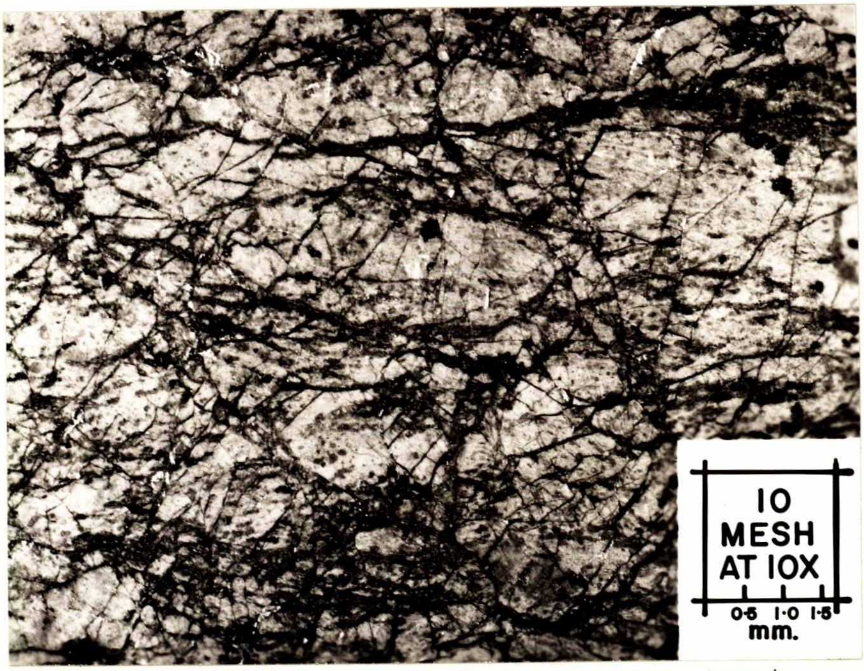

Figure 1. To show the occurrence of chlorite veinlets (dark grey to black) in red-stained quartz rock (light grey). Sample No. 120922.

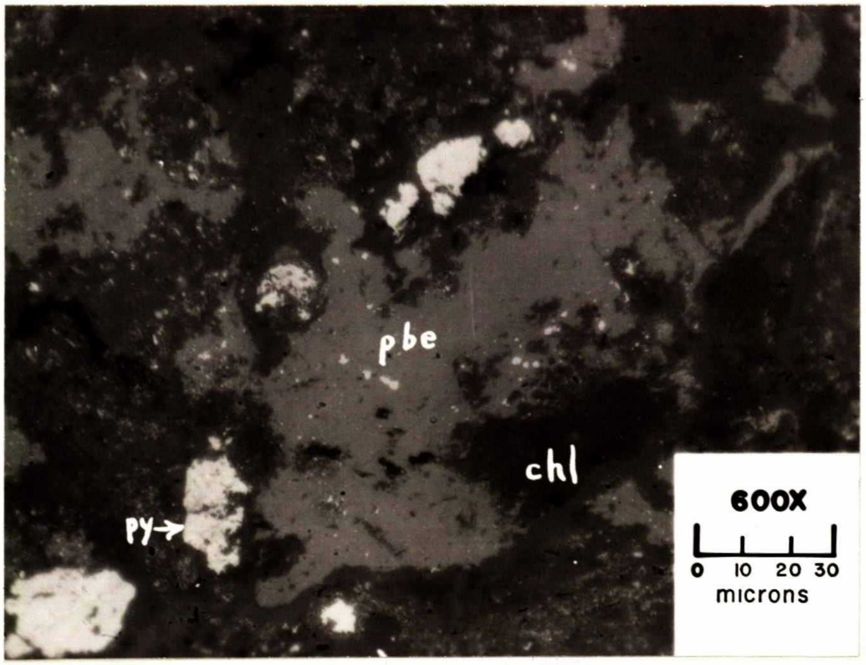

Figure 2. Irregular masses of pitchblende (pbe) in a chlorite veinlet (chl). Pyrite (py) is present. Sample No. 120922.

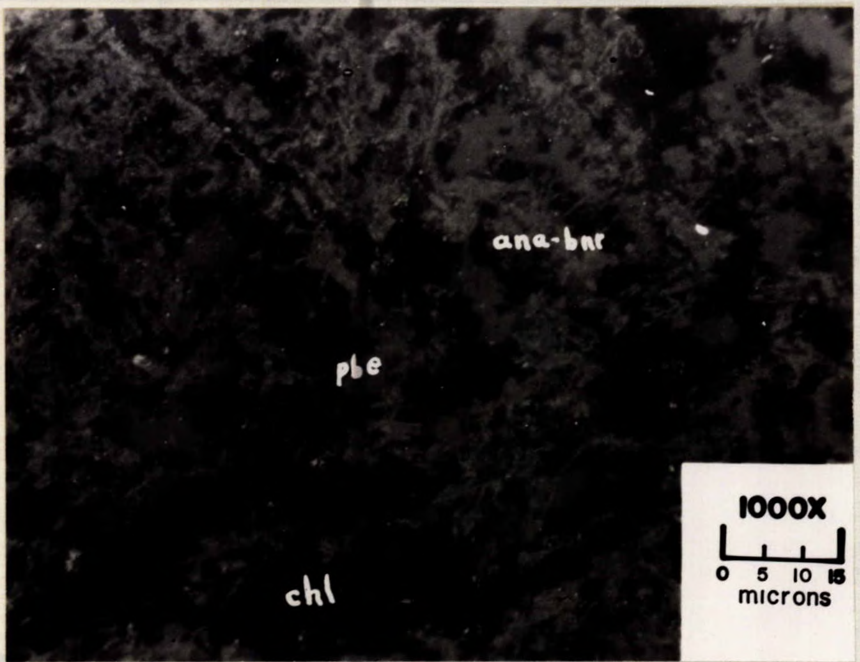

Figure 3. Pitchblende (pbe) and anatase-brannerite (ana-bnr) intergrown in a chlorite veinlet (chl). Sample No. 120922.

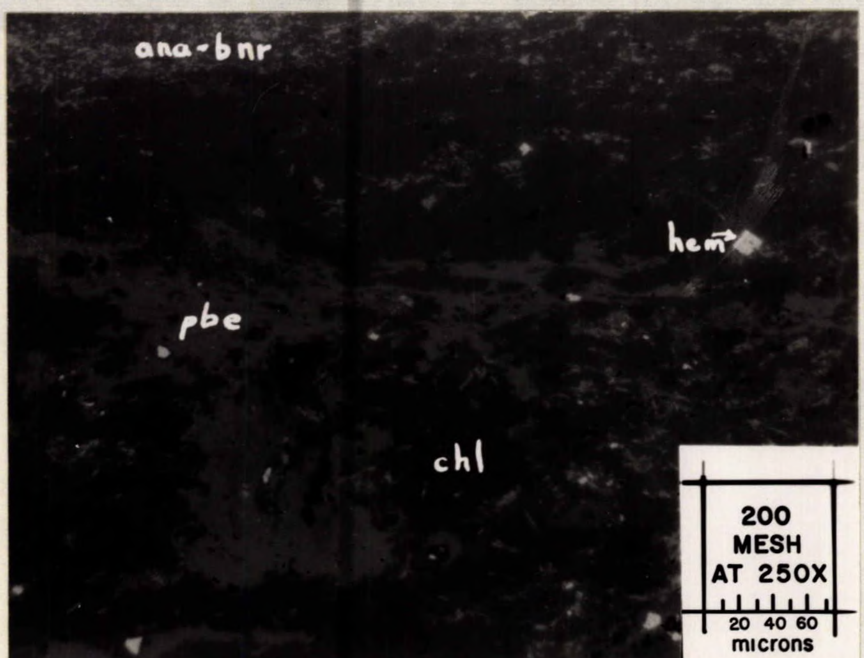

Figure 4. Blebs of pitchblende (pbe) associated with anatase-brannerite (ana-bnr) in a chlorite veinlet (chl). Minor specular hematite (hem) is present. Sample No. 120925.

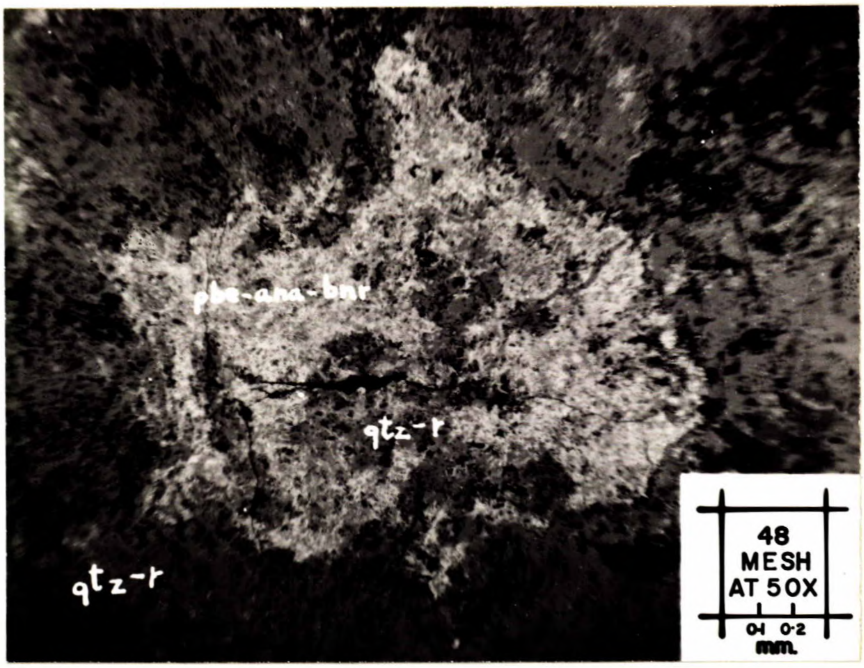

Figure 5. An irregularly rounded intergrowth of pitchblende, anatase and brannerite (pbe-ana-bnr) in red-stained quartz rock (qtz-r). Sample No. 130920.

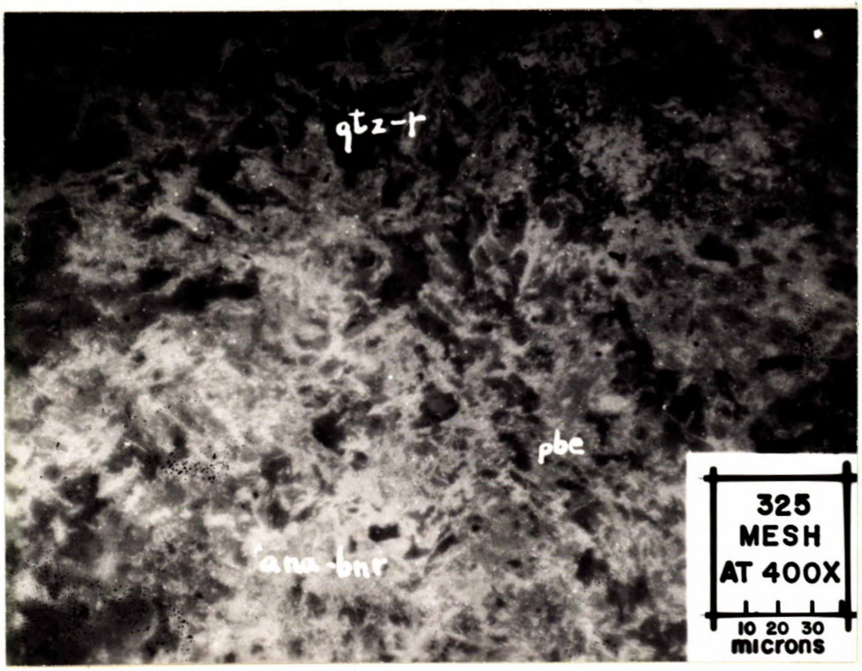

Figure 6. A highly magnified view of an area in Figure 5 showing the intimate intergrowth of pitchblende (pbe), anatase-brannerite (ana-bnr) and red-stained quartz (qtz-r). Sample No. 130920.

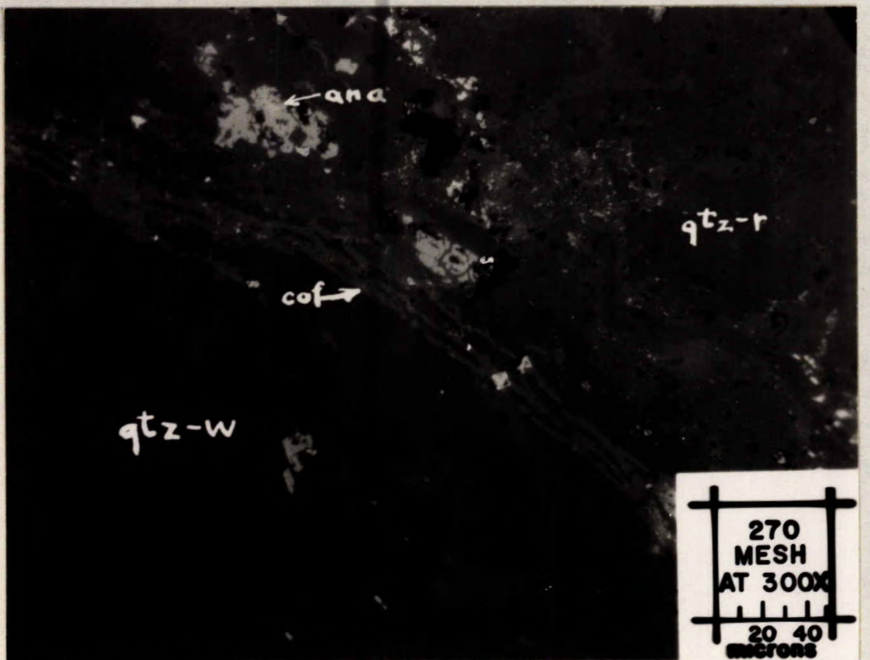

Figure 7. Seams of coffinite (cof) in a white quartz vein (qtz-w). Anatase (ana) is present. The gangue adjacent to the quartz vein is red-stained quartz rock (qtz-r). Sample No. 130924.

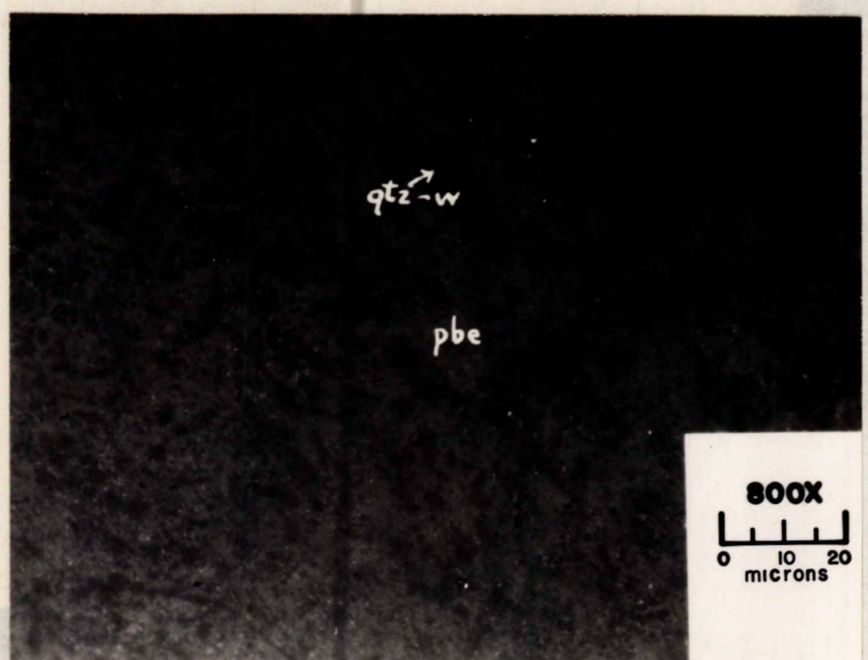

Figure 8. Part of a vein of pitchblende (pbe) intimately intergrown with unstained quartz (qtz-w). Sample No. 140911.

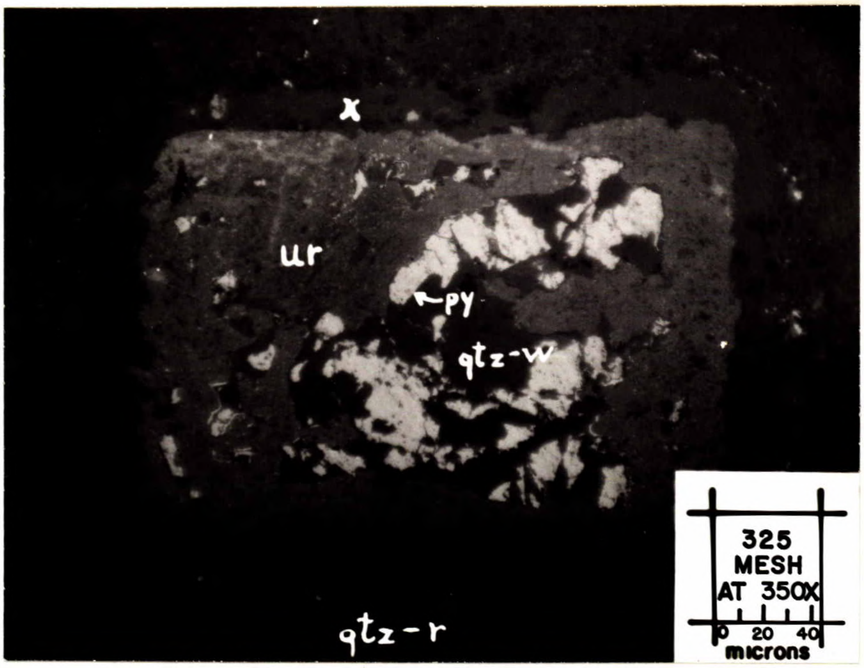

Figure 9. Relict crystal of uraninite (ur) containing intergrown pyrite (py), unstained quartz (qtz-w) and surrounded by a dark grey border zone (x) in red-stained quartz rock (qtz-r). Sample No. 140911.

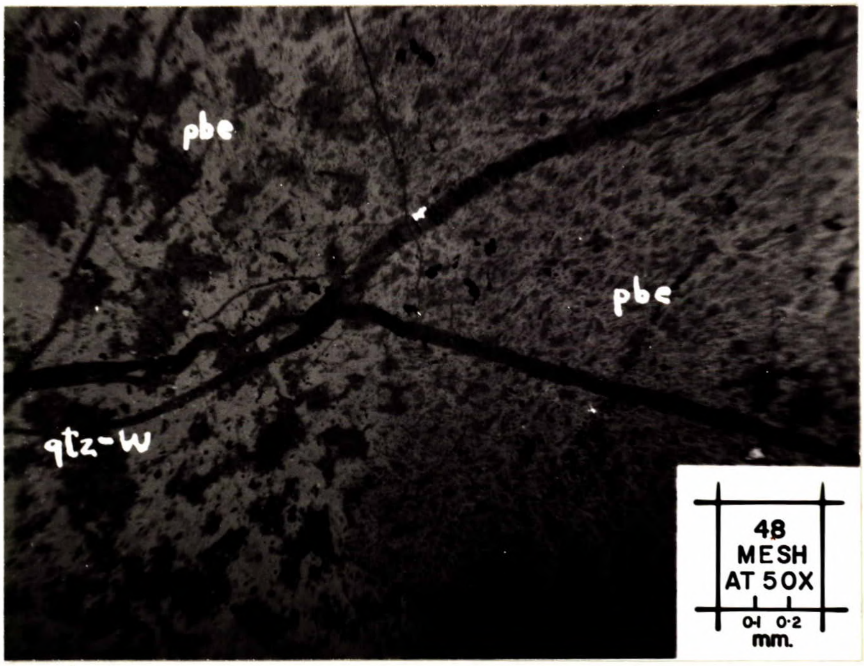

Figure 10. Massive pitchblende (pbe) intimately intergrown with unstained quartz (qtz-w). Sample No. 140920.

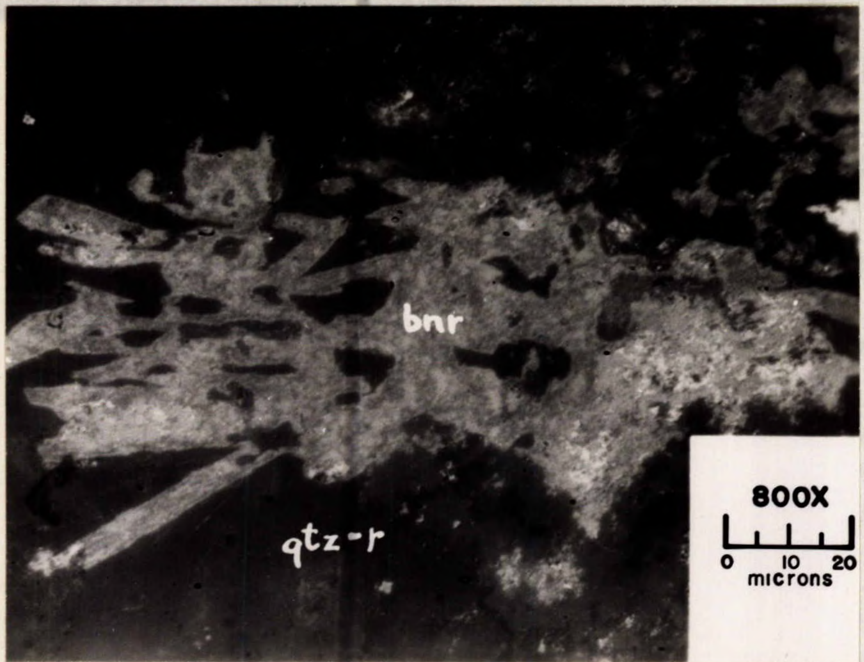

Figure 11. Mottled, grey aggregate of lath-like brannerite (bnr) in red-stained quartz rock (qtz-r). Sample No. 140920.

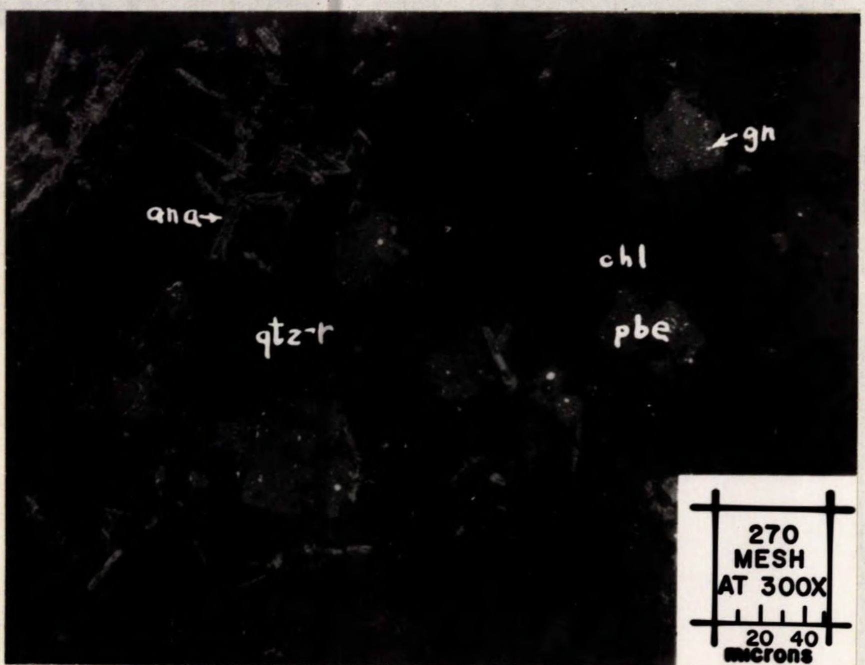

Figure 12. Cubic pitchblende (pbe) in a chlorite veinlet (chl). Anatase (ana) and red-stained quartz (qtz-r) are present. Sample No. 140923.

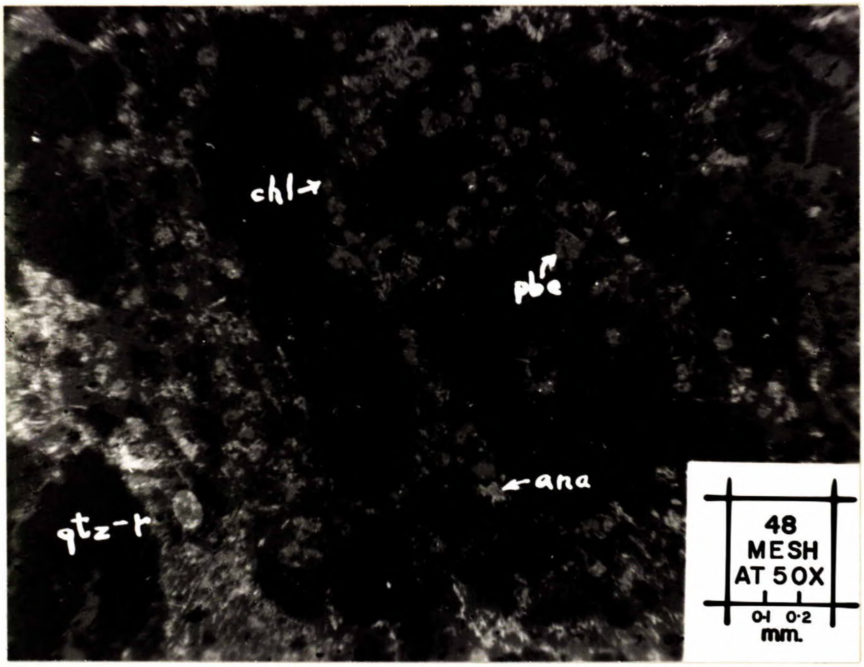

Figure 13. Pitchblende (pbe) in a network of chlorite veinlets (chl) in red-stained quartz rock (qtz-r). Anatase (ana) is abundant in the chlorite veinlets. Sample No. 140923.

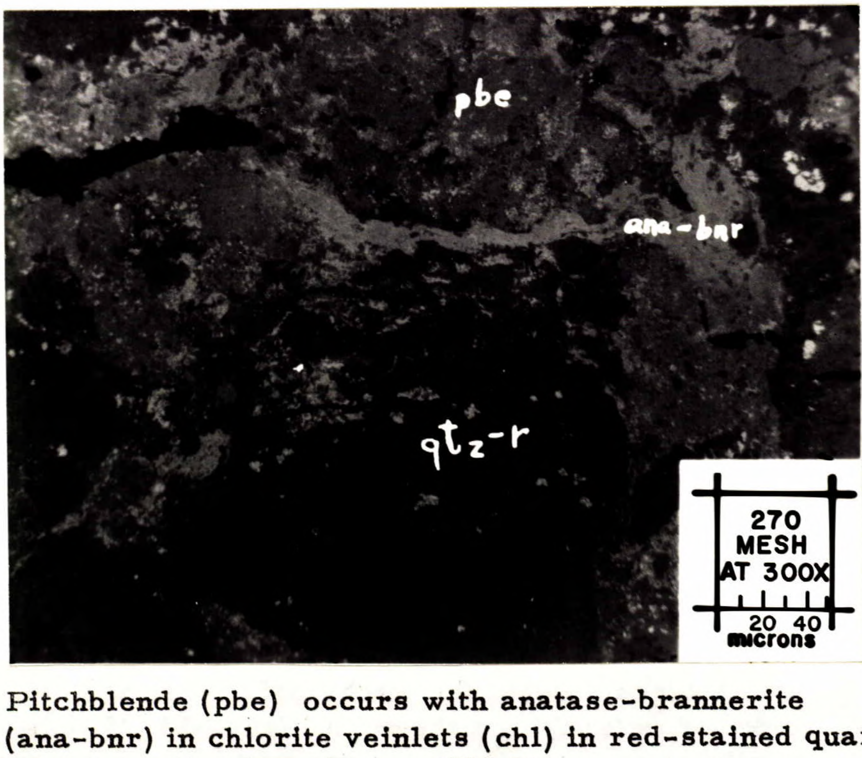

Figure 14. Pitchblende (pbe) occurs with anatase-brannerite (ana-bnr) in chlorite veinlets (chl) in red-stained quartz rock (qtz-r). Sample No. 140923.

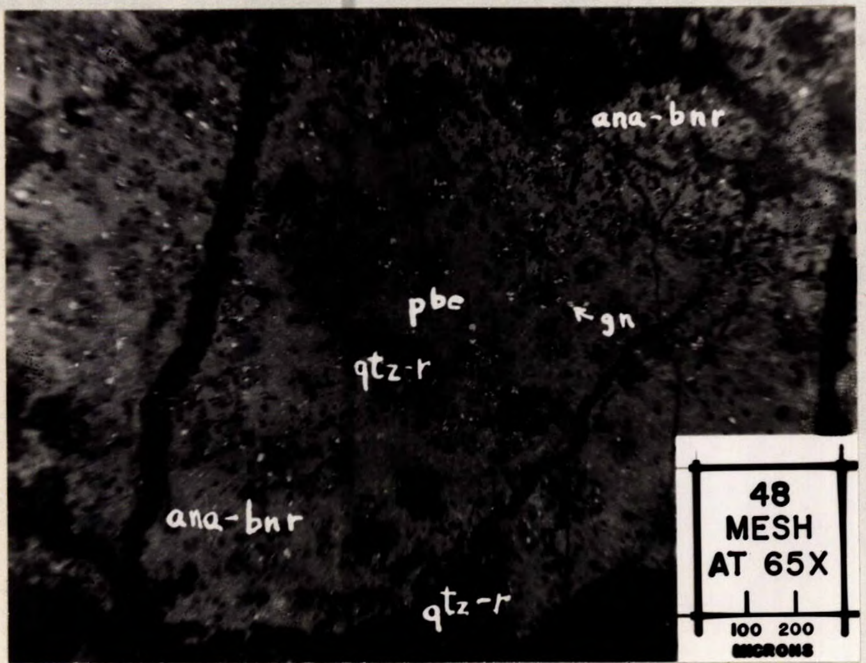

Figure 15. Area of dense pitchblende (pbe) and red-stained quartz (qtz-r) in centre of photo merges into intergrowth of anatase-brannerite (ana-bnr). Minute specks of galena (gn) occur in the pitchblende. Sample No. 172691.

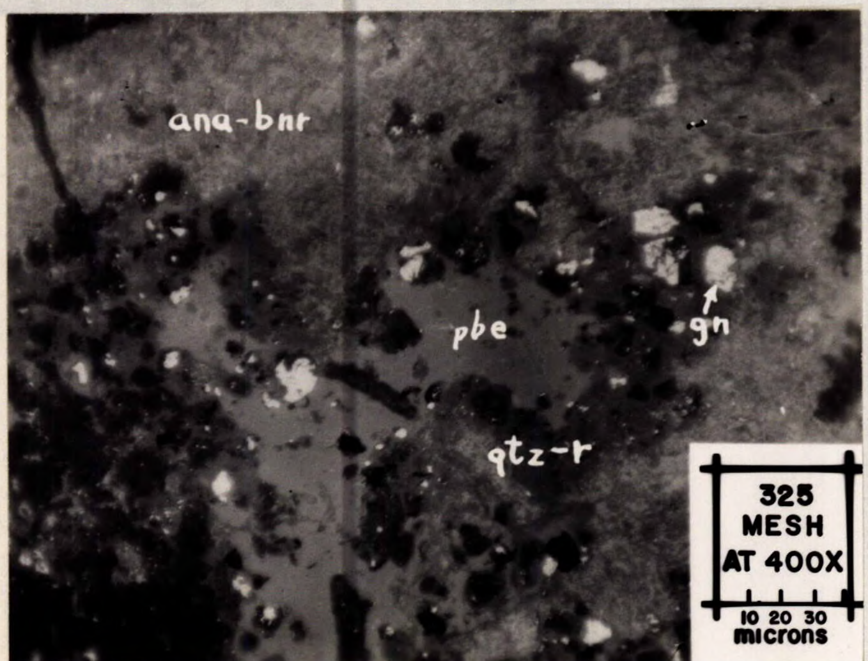

Figure 16. An enlarged view of the pitchblende (pbe) and anatase-brannerite (ana-bnr) shown in Figure 15. Small particles of galena (gn) are present and the gangue is red-stained quartz (qtz-r). Sample No. 172691.

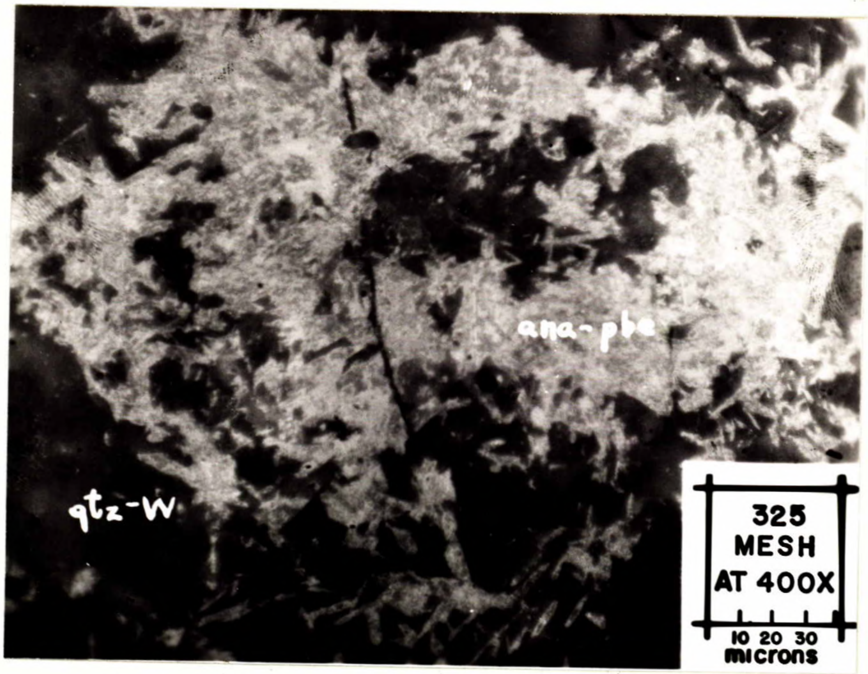

Figure 17. Lath-like intergrowth containing anatase-pitchblende (ana-pbe) in a white quartz vein (qtz-w). Sample No. 172691.

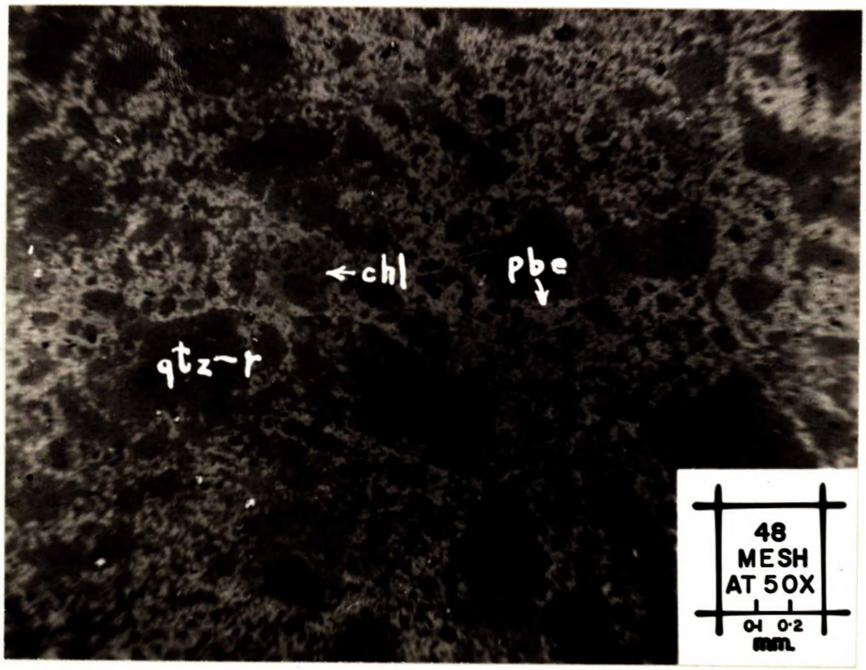

Figure 18. Pitchblende (pbe) in a system of chlorite veinlets (chl) in red-stained quartz rock (qtz-r). Sample No. 244191.

DISCUSSION AND CONCLUSIONS

Four uranium-bearing minerals were identified in lump ore samples from the deeper levels of the Fay mine, Eldorado Mining and Refining Limited at Beaverlodge, Saskatchewan. They are pitchblende, brannerite, coffinite, and sklodowoskite. Pitchblende is the most abundant of these minerals. Both pitchblende and brannerite are commonly associated with chlorite, and veins and masses of pitchblende intergrown with quartz are also present. Brannerite almost always forms an intergrowth with anatase. There are only traces of coffinite in a quartz vein in a specimen from sample No. 130924 and small amounts of sklodowskite on weathered surfaces of lumps from sample No. 120925. The occurrence of the uranium-bearing minerals in each sample is summarized in Table 1.

Pitchblende usually occurs as fine, irregular grains in narrow chlorite veinlets in red-stained quartz rock. The colour of the rock is due to the presence of finely divided hematite. In one sample (No. 140923) subhedral cubic crystals of pitchblende occur in the chlorite veinlets: this may be the uraninite form of UO_2. Pitchblende, intimately intergrown with red or unstained quartz, also forms veins up to one or two millimetres in width or large masses at least 3 centimetres across in the red-stained quartz rock. Sparsely disseminated grains of pitchblende occur in the red-stained rock of some specimens. They are seldom more than 1/10 mm across.

While the colour of the pitchblende is usually an even light grey, as seen in polished sections, in places it has a mottled appearance and in some cases is almost indistinguishable from the gangue. The mottled appearance is probably the result of alteration by oxidation of the UO_2 to UO_3. In these samples it is most commonly observed where the pitchblende is associated with anatase. The latter occurs as irregular grains or in the form of subhedral lath-like crystals and has been found with all types of pitchblende occurrences. Minute particles of galena are intergrown in much of the pitchblende.

The other major contributor of uranium is brannerite. It is almost always intergrown with anatase except in rare instances. Brannerite in these intergrowths is indistinguishable from the anatase and was identified by X-ray powder diffraction methods. Brannerite-anatase intergrowths have been found to occur with or without pitchblende in the chlorite veinlets and in veins or masses formed of intimate intergrowths of pitchblende and quartz. In sample No. 140920 grains comprised of aggregates of discrete lath-like brannerite crystals were observed.

In conclusion it is suggested that the presence of abundant chlorite in some of the rock may make it more friable than rock where little chlorite is present and thus facilitate liberation of the uranium-bearing minerals.

Table 1

Summary of Uranium Occurrences In Lump Ore Samples

Sample No.	Radioactive Minerals			Occurrence
	major	minor	trace	
120922	pitchblende	brannerite	-	pitchblende, brannerite-anatace, or pitchblende-brannerite-anatase in chlorite veinlets (1/10 mm) in red-stained quartz rock.
120925	pitchblende	brannerite	sklodowskite	similar to No. 120922 except sklodowskite on weathered surfaces
130920	pitchblende	brannerite	-	similar to No. 120922, also masses (1 1/2 mm) of pitchblende-brannerite-anatase in red-stained quartz rock.
130924	coffinite	-	-	thin seams in a white quartz vein in red-stained quartz rock.
140911	pitchblende	-	-	pitchblende-quartz veins (1 1/2 mm) and minor disseminated pitchblende (1/10 mm) in red-stained quartz rock
140920	pitchblende	brannerite	-	similar to No. 140911, also pitchblende-quartz masses up to 3 cm and lath-like brannerite (1/10 mm) in red-stained quartz rock
140923	pitchblende	brannerite	-	cubic pitchblende and pitchblende-brannerite-anatase in chlorite veinlets

Table 1 (continued)

Sample No.	Radioactive Minerals			Occurrence
	major	minor	trace	
172691	pitchblende	brannerite	-	similar to 140911, also pitchblende - brannerite-anatase-quartz
244191	pitchblende	-	-	similar to 120922 except brannerite appears to be absent