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MINERALOGY OF URANIUM ORE SAMPLES FROM THE FAY AND VERNA MINES, ELDORADO BEAVERLODGE DIVISION, ELDORADO, SASKATCHEWAN

by

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MINERALOGY OF URANIUM ORE SAMPLES FROM THE FAY AND VERNA MINES, ELDORADO BEAVERLODGE DIVISION, ELDORADO, SASKATCHEWAN SAMPLE No. 10/58-6

by

S. Kaiman*

SUMMARY OF RESULTS

Fine-grained radioactive minerals occur in red-stained feldspathic rock. Pitchblende was identified in the Fay ore. The main radioactive mineral in the Verna ore was not determined but some brannerite is believed to be present.

(17 pages, 1 table, 10 figures)

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INTRODUCTION

In a letter dated October 15, 1958, Mr. E.G. Joe of Eldorado Mining and Refining Limited, Ottawa, requested that a mineralogical study be made of eight samples of ore from the Eldorado Beaverlodge Mine. The samples, which consisted of small chips approximately 1/2" to 3/4" in size, originated from different stopes in the Ace-Fay Mine and the Verna Mine of Eldorado, and were designated as follows:

Sample No.	Source
1109A	Fay
1109B	Fay
909A	Fay
909B	Fay
1101	Fay
744	Verna
644	Verna
544	Verna

This report is based on a mineralogical examination of polished sections of 25 specimens selected from the submitted samples. The specimens were chosen on the basis of their content of radioactivity as indicated by preliminary autoradiographs of 60 representative chips of ore. With one exception, at least two polished sections were prepared of each submitted sample.

The mineralogy of earlier samples of Eldorado's Beaverlodge ore has been described in the following reports issued by the Radioactivity Division: SR 183/53, SR 227/54, SR 258/54, SR 288/55, and IR 166/55.

The eight samples were recorded as our sample No. 10/58-6.

CHEMICAL ANALYSES

Partial chemical analyses of the eight samples were supplied by Mr. E.G. Joe and are shown in Table 1.

TABLE 1

Analyses of Samples

Sample No.	U_3O_8 %	S %
1109A	0.11	0.06
1109B	0.10	0.08
909A	0.15	0.04
909B	0.09	0.12
1101	0.16	0.36
744	0.11	0.019
644	0.12	0.13
544	0.16	0.1

ROCK COMPOSITION

The samples consist of a hard, red, cherty, fine-grained, siliceous rock, composed mainly of hematite-impregnated, plagioclase feldspar. The rock appears to have been subjected to intense brecciation. Small proportions of calcite and chlorite occur in the rock.

Fine-grained sulphide minerals(mainly pyrite, with smaller proportions of galena and chalcopyrite) are present in small amounts only. Pyrite was observed particularly in sections from sample 1101. Microscopic grains of galena occur closely associated with the radioactive mineral and especially in the pitchblende-bearing sections.

Hematite occurs as microscopic inclusions in the rock and imparts the characteristic red colour to the ore. Also, fine specular hematite is present in some samples often as the major constituent of narrow fracture-filling veins. This is characteristic of some sections of Verna samples.

URANIUM MINERAL OCCURRENCES

Autoradiographs of flattened ore specimens show that radioactivity occurs in small concentrations or diffusely disseminated in gangue minerals. In the Fay ore, the radioactivity tends to be in small discrete masses and some sections contain sizeable concentrations of these masses. In the Verna ore, the radioactivity is often in narrow fracture-filling veins and may be disseminated in thin seams, or in small concentrations in the veins (Figure 1).

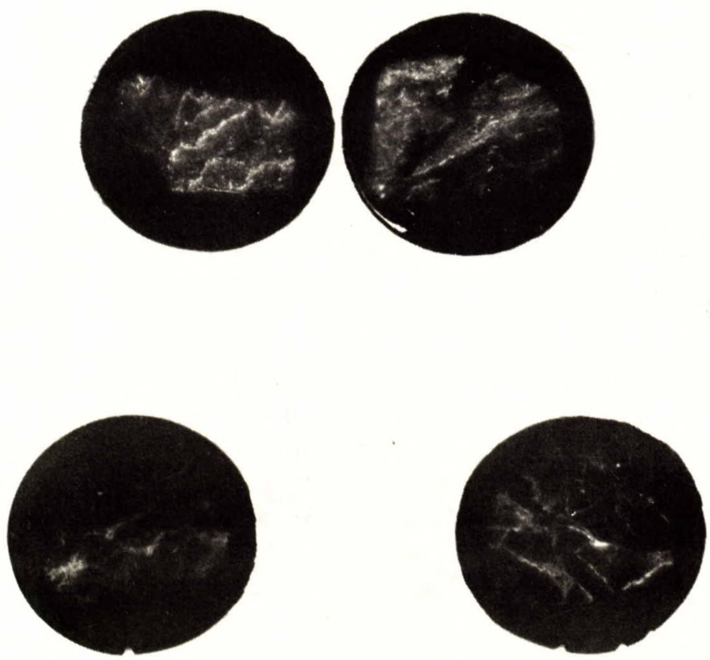


Figure 1 - Alpha autoradiograph of polished sections to show occurrence of radioactivity in Fay ore, upper sections, and Verna ore, lower sections. X1.

The following is a description of the uranium mineral occurrences in the eight samples.

<u>Sample 1109A</u> Radioactivity occurs in small more or less discrete masses or clusters in unstained gangue. The radioactive mineral, believed to be altered pitchblende, is dull grey, opaque, isotropic, and contains a moderate to high proportion of radioactivity. The areas are irregular in shape and usually consist of an intergrowth with anatase and gangue (calcite or chlorite) and often contain fine inclusions of galena. The maximum size of the radioactive areas is approximately 65 mesh and the average size is less than 200 mesh.

<u>Sample 1109B</u> The sections consist of (a) sheared red rock which consists of a fine-grained intergrowth of plagioclase and calcite and (b) dark rock containing abundant chlorite which cements the brecciated rock.

In the sheared rock, the radioactive areas are less than 325 mesh in size (some are smaller than 10 microns) and occur disseminated in calcite as irregular fine grains or aligned in thin seams. At times, the grains are subhedral and intergrown with gangue or with anatase. Fine inclusions of sulphides are common. The radioactive mineral is believed to be altered uraninite or pitchblende.

In the brecciated rock the radioactive mineral occurs in irregularly shaped clusters in calcite (Figure 2). The clusters often coalesce to form a lacy network of radioactivity. The mineral occurs as isotropic grains which are usually less than 5 microns in diameter and appear to be subhedral crystals or angular fragments, and also as small areas of dull grey isotropic mineral. Fine inclusions of galena are present and are concentrated in the dull grey areas. X-ray diffraction analysis yields patterns which correspond to those of uraninite or pitchblende and indicate that the dull grey mineral is an alteration product of the light grey grains. The average size of the individual radioactive areas is approximately 150 mesh and in one section the network of radioactive areas is more than 1/4 inch in size.

Sample 909B Radioactivity is associated with anatase in tiny discrete areas in chlorite. The size of the areas is often 20-40 microns; the maximum size is approximately 100 microns (150 mesh). The radioactive mineral, believed to be altered uraninite or pitchblende, occurs as irregular, dull grey masses or subhedral grains but often is not visible in the radioactive intergrowth.

Sample 909A The sections examined contain a considerable amount of radioactivity. Some occurs in fairly pure masses up to 200 mesh in size; it is very dull grey, opaque, isotropic, with corroded edges and contains inclusions of gangue mineral and galena. Some activity also occurs in small irregular areas of anatase, as in the previous sample, with the anatase aligned in discontinuous veinlets or scattered in the rock. The radioactive mineral is either intergrown with the anatase or closely associated with it. The maximum size of the intergrowths with anatase is about 65 mesh, and the maximum size of the areas of radioactive mineral is approximately 200 mesh. At times the areas are rounded and show a core of anatase (Figure 3). It is believed that the mineral is mainly uraninite or pitchblende which has been altered and replaced by anatase.

Some radioactivity occurs over wide areas of the section as shreds and fine prismatic grains associated with anatase in calcite gangue. The mineral is opaque to translucent (Figure 4). The grains, at times, are present in irregular aggregates and the amount of radioactivity is proportional to the concentration of the prismatic grains.

In areas of low concentration the radioactive constituent is not visible in polished section although the autoradiograph indicates that it occurs with fine anatase and acicular hematite.

Sample 1101 Masses of pitchblende (or uraninite) up to a maximum size of about 28 mesh, occur as intergrowths with unstained gangue and fine pyrite (Figure 5). The pitchblende shows no characteristic texture. At times it is intergrown with anatase in a lacy network and appears to be somewhat altered (the cell edge is reduced).

Some radioactivity occurs in thin fracture-filling veinlets of gangue which contain small concentrations (at times less than 20 microns in diameter) of radioactive mineral associated with anatase. Wider, sinuous veins, which vary in width up to a maximum of about 65 mesh, contain the radioactive intergrowth with anatase as well as pyrite and fine-grained galena in unstained gangue (Figure 6). The radioactive mineral in these veins appears to be altered pitchblende.

In some sections small concentrations of radioactivity are present in a network of veins which consist of calcite or chlorite. Fine-grained anatase appears to fill spaces between small grains of gangue and the radioactive constituent occurs with the anatase. It is present in such small amounts that no discrete radioactive areas could be seen (Figure 7).

Sample 744 Radioactivity occurs in fracture-filling veins of gangue which contain fine-grained specular hematite mainly, anatase, and varying proportions of the radioactive mineral. The highest concentrations usually occur in those veins which contain the lowest proportions of hematite. The uranium mineral is very fine-grained, translucent and, at times, prismatic (Figure 8). The widest veins noted are approximately 35 mesh and the radioactive constituent is present as disseminations or in a narrow seam within the vein. The mineral also occurs in short stringers and isolated small areas, associated with anatase. Rare small irregular areas of stronger activity up to 1/2 mm in size are also present. The identity of the radioactive mineral could not be determined by x-ray diffraction analysis.

Sample 544 The mineralogy is similar to the previous sample. The radioactive mineral occurs sparsely disseminated or as thin veinlets in fracture-filling veins of unstained calcite. The veins are single and very thin or in networks; the single veins are usually less than 100 microns (150 mesh) in width.

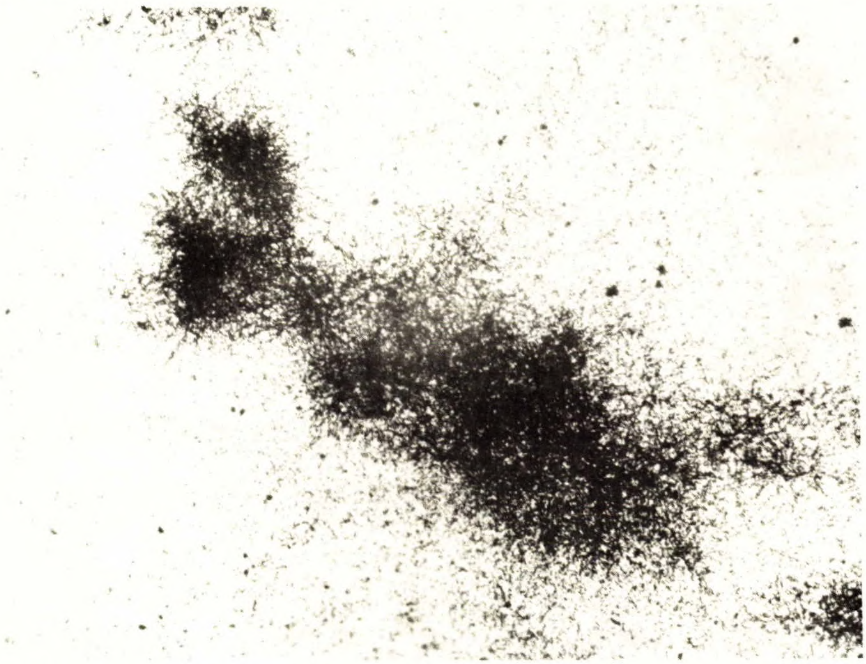
The radioactive mineral occurs in varying proportions and is usually intimately intergrown with anatase and hematite. It is translucent, shows no regular form, and often cannot be distinguished from the anatase.

Sample 644 Narrow fracture-filling veins contain the radioactive mineral in fine-grained intergrowths with anatase in calcite gangue (Figure 9). The maximum size of the intergrowths is approximately 100 mesh. Small areas of very low uranium content, often less than 325 mesh in size, are present; these areas contain a few disseminated radioactive grains intergrown with gangue, anatase, and at times, hematite.

One moderately radioactive section contained abundant specular hematite and blocky grains of anatase. The radioactive veins are sinuous and discontinuous and consist of a dull- to medium-grey, fine-grained, sub-translucent mineral, often intergrown with anatase, hematite, chlorite, and minor chalcopyrite (Figure 10). The uranium mineral is often in fine prismatic to acicular crystals. The maximum width of the radioactive veins is approximately 150 mesh. At times the vein contains an intergrowth of the uranium mineral with chlorite. An x-ray diffraction photograph of the mineral in the more strongly radioactive areas yielded a pattern (after ignition) which is similar to that of ignited brannerite (uranium titanate).

PHOTOMICROGRAPHS

The square outlined on each of the following photomicrographs of polished sections represents a 200-mesh screen opening. Alpha autoradiographs of Figures 2, 3 and 8 are included to show the distribution of radioactivity.



Alpha Autoradiograph of the Polished Section Below

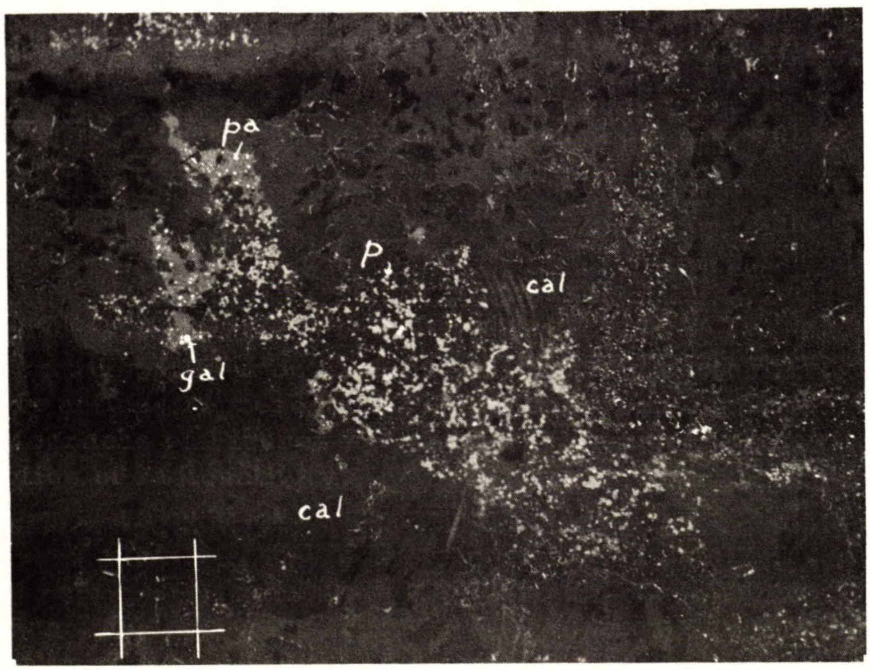
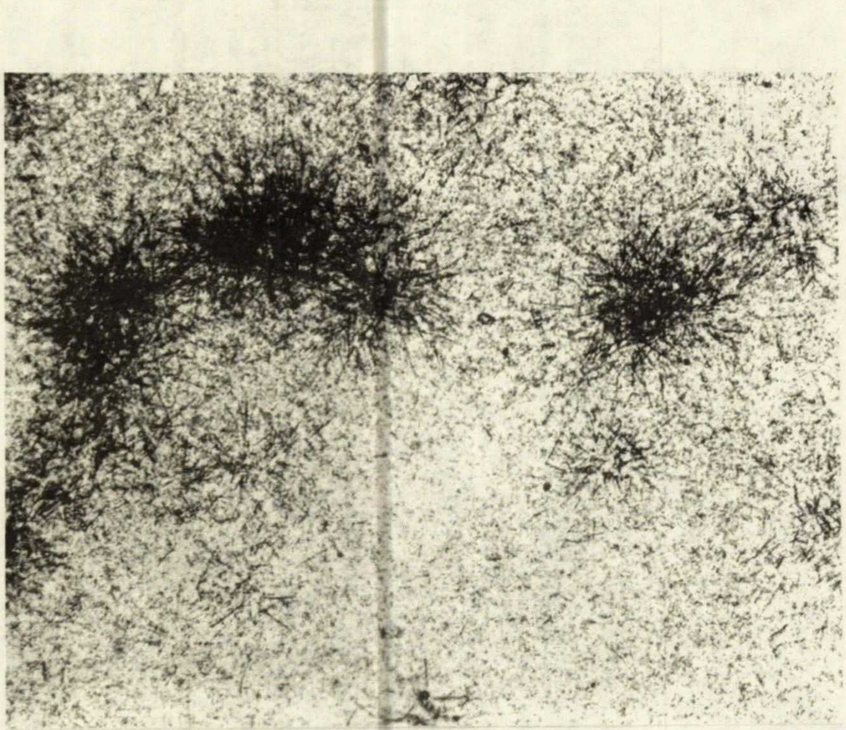


Figure 2 - Cluster of fine grains of uraninite or pitchblende (p) and altered pitchblende (pa) in calcite (cal). Fine-grains of galena (gal) are present. Sample 1109B



Alpha Autoradiograph of the Polished Section Below

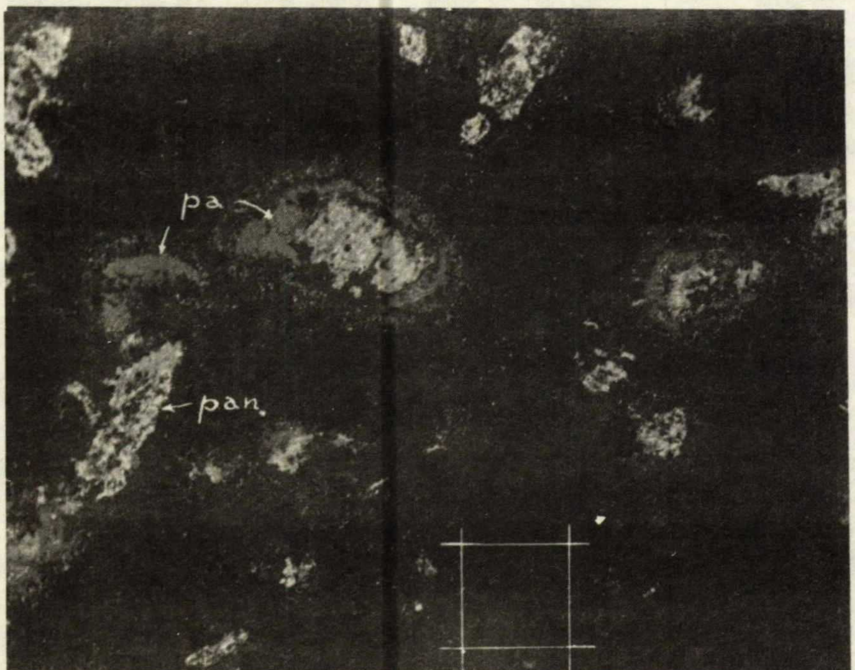


Figure 3 - Fine grains of altered pitchblende (pa) and pitchblende-anatase intergrowth (pan) Sample 909A.

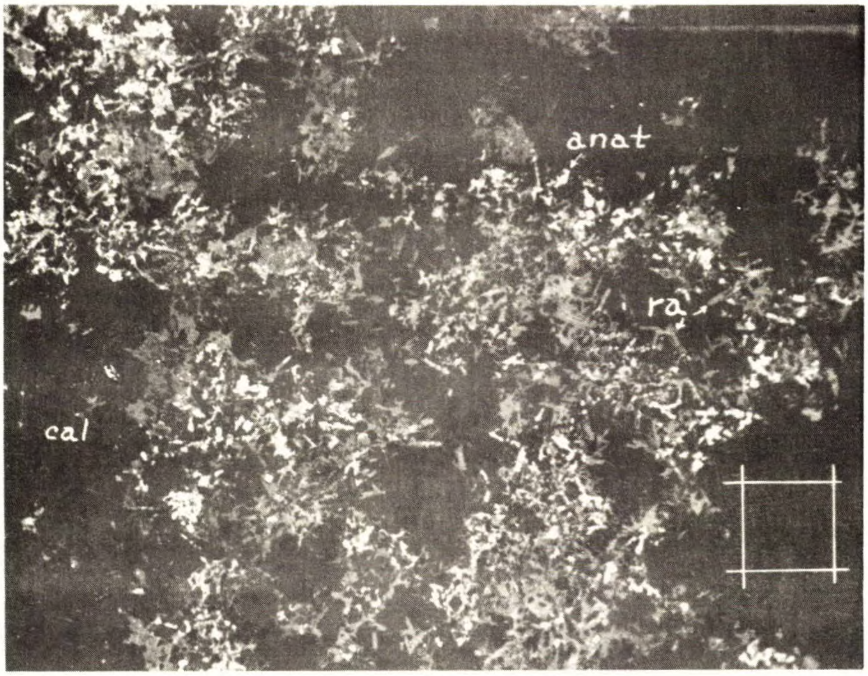


Figure 4 - Prismatic grains of unidentified radioactive mineral (ra) with anatase (anat) in calcite (cal). Sample 909A.

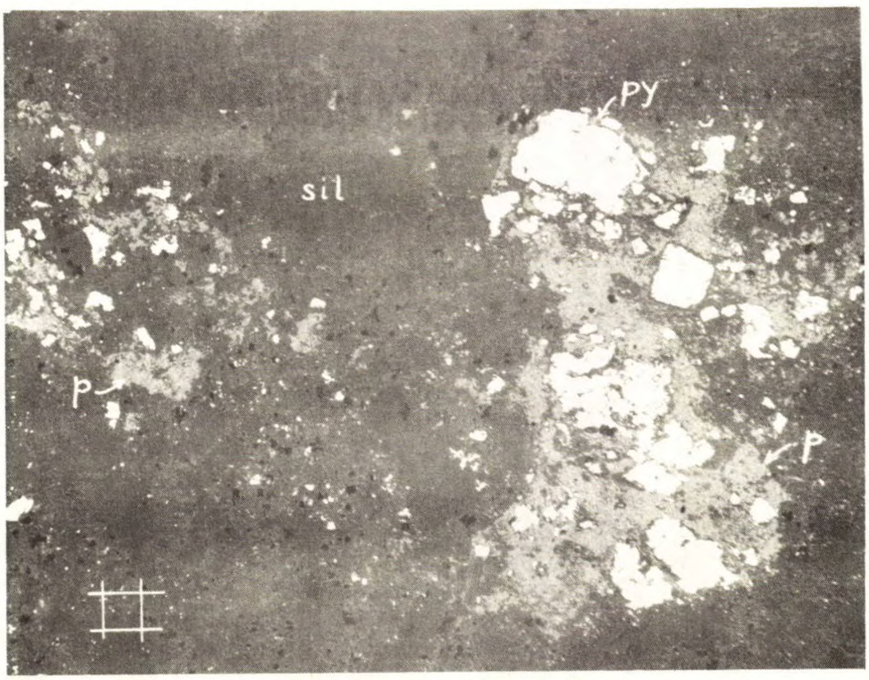


Figure 5 - Irregular masses of pitchblende (p) with inclusions of pyrite (py) in siliceous gangue (sil). Sample 1101.

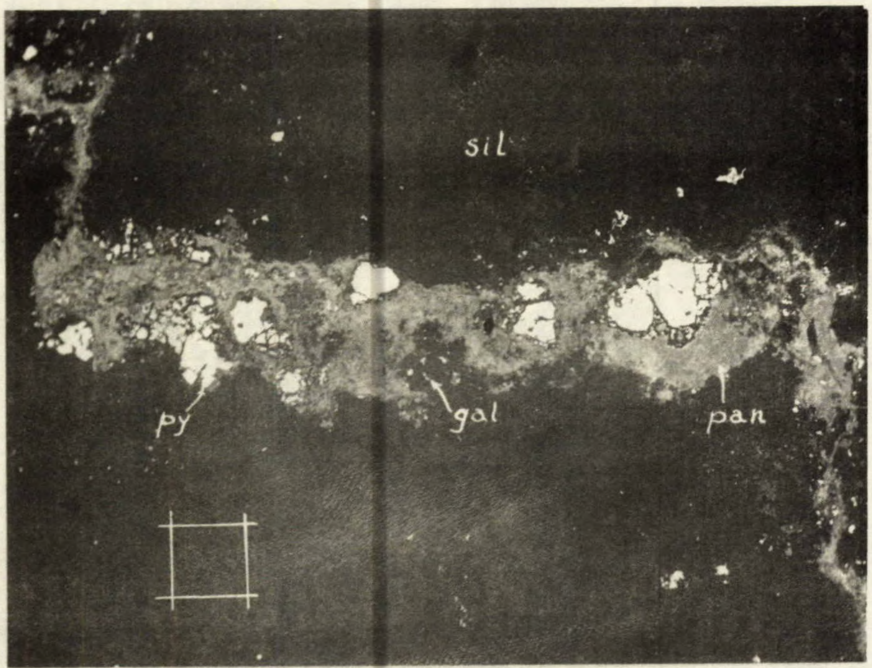


Figure 6 - Sections of radioactive vein in siliceous rock (sil) containing pitchblende intergrown with anatase (pan), pyrite (py) and fine-grains of galena (gal). Sample 1101.

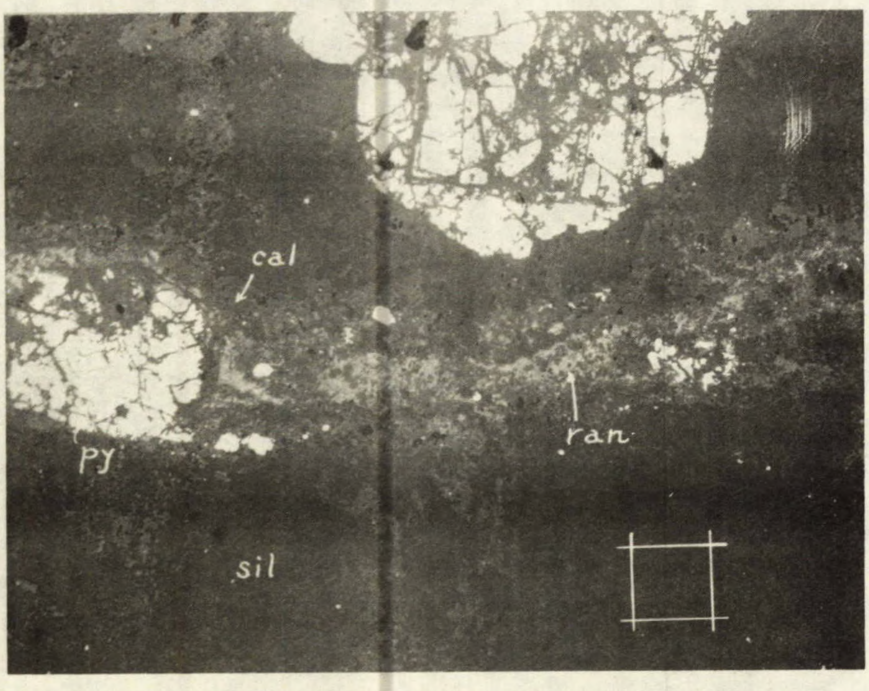


Figure 7 - Weakly radioactive vein consisting of calcite (cal), radioactive mineral intergrown with anatase (ran) and pyrite (py) in siliceous gangue (sil). Sample 1101.

Alpha Autoradiograph of the Polished Section Below

Figure 8 - Vein in siliceous rock (sil) containing fine-grained intergrowth of uranium mineral with anatase (ran) **and hematite** (hem). Sample 744.

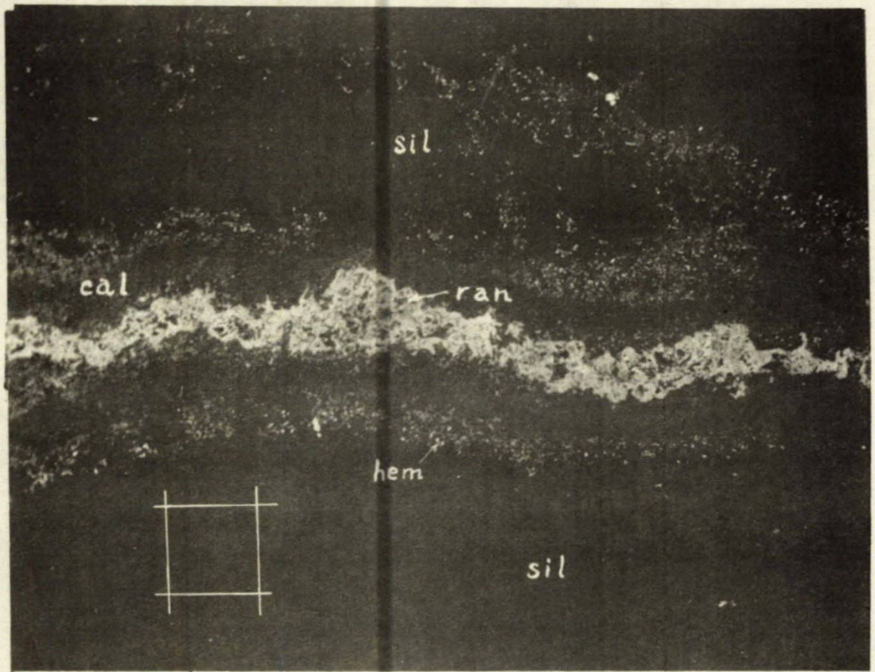


Figure 9 - Fracture-filling vein of calcite (cal) contains central seam of radioactive anatase (ran). Fine grains of hematite occur at contact of vein with siliceous rock (sil). Sample 644.

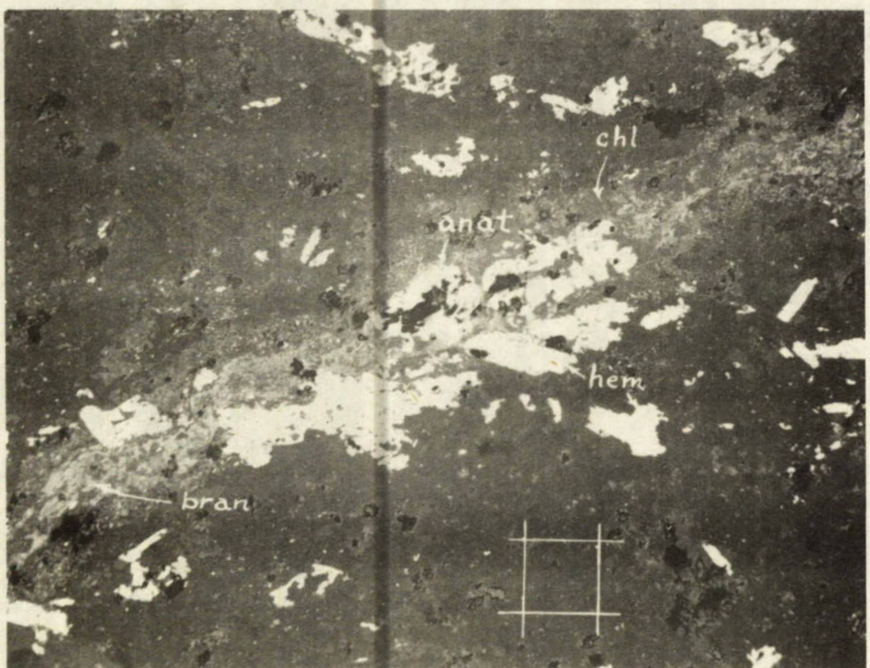


Figure 10 - Vein containing anatase (anat), hematite (hem) and brannerite (bran) in chlorite (chl). Sample 644.

SUMMARY AND CONCLUSIONS

The radioactive minerals usually occur in unstained calcite or chlorite and are usually intergrown or closely associated with anatase (TiO_2). Generally, the individual radioactive masses are very small in both the Fay and Verna ore, but in the Verna samples, they are somewhat less concentrated than in the Fay samples. Pitchblende (or uraninite) was identified in Fay samples 1101 and 1109B. In Fay samples 1109A, 909A and 909B, the presence of altered pitchblende, as the main uranium-bearing mineral, is indicated. The polished sections of Verna samples 744, 544 and 644 as well as some sections from Fay samples 1101 and 909A contain a radioactive mineral constituent which could not be identified, except in one instance, by x-ray diffraction analysis.

The failure of x-ray diffraction to yield a pattern may be due in part to the fine grained nature of the mineral and to its intimate intergrowth with other minerals which makes it difficult to obtain a sample which is not contaminated by the associated minerals. However, the presence of an amorphous radioactive mineral would also explain the absence of a characteristic x-ray pattern. Thus, altered pitchblende would yield a poor pattern, or no pattern, as would a metamict mineral.

The radioactive mineral in some sections of Fay ore do produce an x-ray pattern after being ignited, and the resulting pattern indicates that the mineral is oxidized pitchblende. The presence of minute inclusions of galena also suggests that original pitchblende has been altered.

In the Verna sections, the close association of a fine-grained translucent to opaque radioactive constituent with anatase indicates a possible genetic relationship with anatase and suggests a uranium-titanium compound. Since brannerite was indeed identified in one section (of sample 644) it is possible that brannerite, or a similar metamict uranium compound, in addition to pitchblende, is a major constituent of some of the radioactive areas.

The presence of a fine-grained metamict mineral such as brannerite may account, in part, for the refractory nature of the Verna ore when it is treated by a leaching method which is effective on similar ores in which pitchblende is the major uranium constituent. The occurrence of finely disseminated radioactivity in acid-soluble gangue indicates that acid leaching may effect improved extractions of the uranium values from these refractory ores.

SK/dm