CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 58-48

# MINERALOGY OF A URANIUM ORE SAMPLE (Ref. No. 1/58-9) FROM KLERKSDORP CONSOLIDATED GOLDFIELDS LIMITED, SOUTH AFRICA, SUBMITTED BY WRIGHT ENGINEERS LIMITED, VANCOUVER, B. C.



by

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RADIOACTIVITY DIVISION

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COPY NO. 1

APRIL 17, 1958

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## ABSTRACT

Radioactivity occurs in finely disseminated form in the matrix of the pebble conglomerate rock. The grains of uraninite, the main uranium-bearing mineral, are usually less than 200 mesh in size. Zircon, coffinite and monazite account for a small proportion of the radioactivity.

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CONTENTS



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# INTRODUCTION

A sample of uranium-bearing ore from the Klerksdorp Consolidated Goldfields Limited, South Africa, weighing approximately 100 lb, was received at the Mines Branch laboratories at Ottawa on January 22, 1958, following a letter to Dr. John Convey dated October 30, 1957, from Mr. H.M. Wright, Wright Engineers Ltd., 850 West Hastings St., Vancouver, B.C., requesting exploratory concentration tests. As received, the sample consisted of small lumps, 2 in. maximum size, contained in nine small separate bags.

The present report gives the results of a mineralogical examination which, together with chemical analysis, constituted the first part of this investigation. Other test work at present under way will be reported at a later date.

The mineralogical examination was carried out on lump specimens taken at random from each of the nine submitted bags of ore.

## CHEMICAL ANALYSIS

Chemical analysis of a representative head sample gave the following results:

(Analytical Ref: RD-3962)

| | | |
|---|---|---|
| $U_3O_8$ | - | 0.33% |
| $U_3O_8$ (probably secondary) | - | 0.04 |
| $ThO_2$ | - | 0.18 |
| Iron | - | 7.6 |
| Titanium | - | 0.65 |
| $CO_2$ (evolution) | - | 0.33 |
| $CO_2$ (combustion) | - | 0.76 |
| Total sulphur | - | 2.35 |
| Sulphate sulphur | - | 0.10 |
| Arsenic | - | 0.05 |
| $P_2O_5$ | - | 0.68 |
| Rare earth ($RE_2O_3$) | - | 1.40 |
| Gold | - | 0.045 oz/ton |
| Silver | - | 0.08 " |
| Specific gravity | - | 2.78 |

## ROCK COMPOSITION

The rock is siliceous in composition, grey (to red) in colour, and consists of a small-pebble conglomerate which grades into sandstone. The maximum size of the pebbles is approximately 3/4 in., but some lumps of rock contain no pebbles larger than 1/8 in. The rock is hard and brittle, and weathered portions, especially of the finer grained varieties, are earthy and extremely friable.

The pebbles consist mainly of quartz, with some garnet; the matrix is composed largely of very small quartz grains and fine-grained sericite. Coarser muscovite is rare. The quartz pebbles are

rounded to sub-rounded, glassy, and generally colourless to grey, but at times are red in colour because of iron oxide stain which occurs in fractures. The garnet pebbles are well rounded, typically fractured, and intermediate in size between the larger quartz pebbles and the fine grains in the matrix: the maximum size of the garnet pebbles is about 10 mesh.

Scattered bands and streaks of red colouration of the rock are due to staining by iron oxide, and may affect pebbles or matrix.

Sulphide minerals are present as fine grains or intergrowths, mainly in the matrix of the conglomerate and in the sandstone. Pyrite is the most abundant sulphide, but the following minerals have also been identified: marcasite, cobaltite, arsenopyrite, chalcopyrite, covellite, and galena. Pyrite occurs mainly as small euhedral to subhedral grains, often with corroded edges. The grains are usually confined to the matrix and only rarely are present within larger pebbles. Some pyrite also occurs as filling material in narrow sinuous fissures which cut across both pebbles and matrix.

In addition to quartz, sericite, garnet and sulphides, the following minerals are present in the fine grained matrix: rutile (and anatase), monazite*, uraninite*, zircon*, and minor amounts of goethite, coffinite*, columbite, gold, etc. Rutile is fairly common in the radioactive areas of the matrix. In polished sections it appears as

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*See Radioactive Minerals section of this report, page 4.

light grey, opaque to translucent grains, often intergrown with siliceous gangue and more or less altered to translucent shreds and laths of anatase. Goethite is usually associated with pyrite. It fills fissures in the rock and also occurs intergrown with uraninite (Figure 4). Columbite was identified in a gravity concentrate. Only three occurrences of native gold were noted in the polished sections studied; the largest, an irregular, elongated fragment approximately 8 x 30 microns in size, was identified by x-ray diffraction.

Calcite was observed on the surface of several of the lump specimens. It forms a thin crust which probably represents fissure filling in the rock. Although the analyses of the head sample indicate the presence of a carbon-bearing mineral other than calcite (possibly graphite or a hydrocarbon mineral), none was recognized.

## RADIOACTIVE MINERALS

Autoradiographs of lump samples (Figure 1) and of polished sections show that most of the radioactivity in the rock is due to very fine grains disseminated in the matrix of the conglomerate and in the sandstone and only a small proportion of these grains are as large as 100 mesh in size. Those areas of rock which are weathered to yellowish-grey friable material are usually strongly radioactive. Higher radioactivity is often associated with high sulphide content. Radioactive grains at times are concentrated close to the surface of larger pebbles and along thin yellow seams.

The most abundant radioactive mineral present is uraninite. Monazite, zircon and coffinite account for a small proportion of the total radioactivity.

Uraninite occurs as discrete, small, rounded to angular grains, and occasionally as small clusters (Figure 3). At times the grains show square outlines in polished section (Figure 2). The grains are frequently fractured and the fractures contain galena (Figures 2 and 3). Some of the uraninite appears to be altered: the grains are darker grey under reflected light, and often exhibit a fairly thick coating of translucent yellow material. The grains are often frayed at the edges. Many are brecciated (Figures 2 and 4) and some of the finely diffused radioactivity may be due to disseminated fine fragments. The size of the uraninite grains is mainly between 200 mesh and 325 mesh, and the maximum size is about 100 mesh.

Some uraninite occurs in the friable weathered rock as small, irregular, brecciated grains intimately intergrown with goethite and siliceous gangue (Figure 4). In this association the uraninite appears to be altered, and the greater the degree of alteration and brecciation, the lower the radioactivity.

In several of the sections studied, uraninite occurs as short, discontinuous, very fine veinlets and shards of medium grey opaque mineral in sericite, in fractures within small pebbles, and in pyrite. The colour and texture suggest that this is probably a secondary form of uraninite.

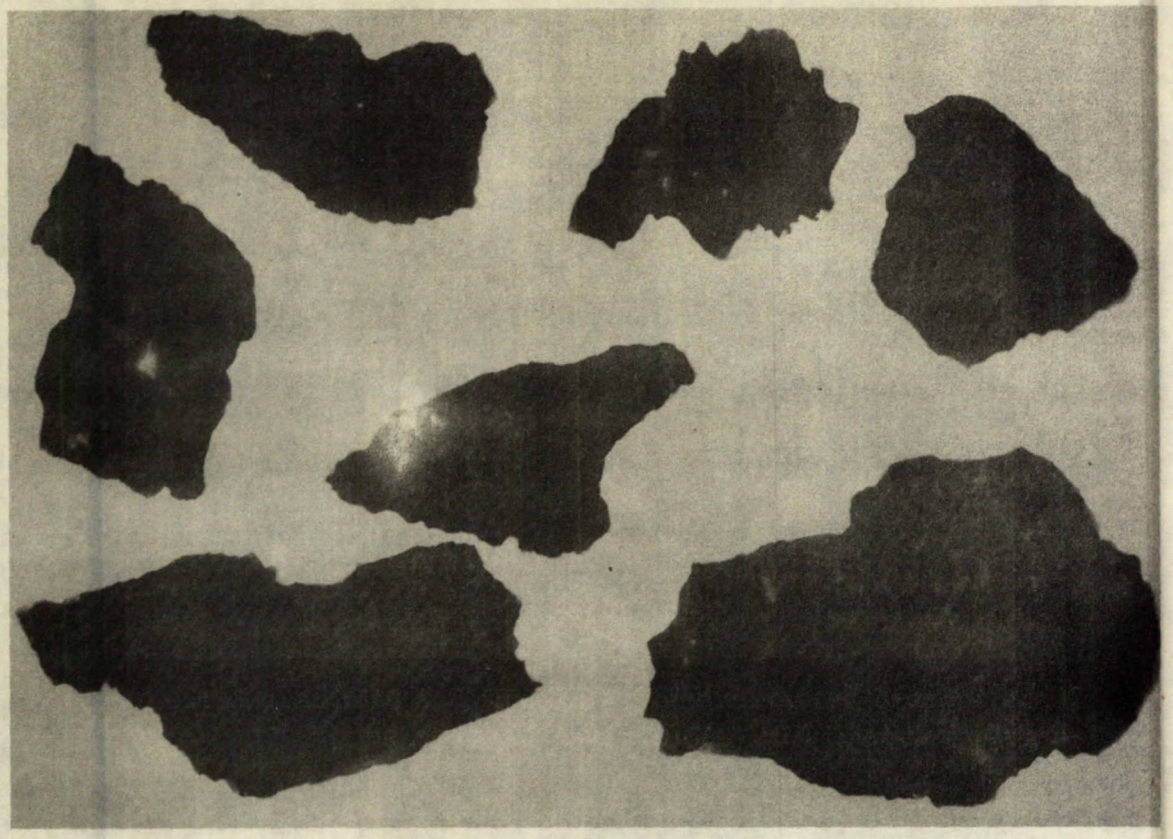


Fig. 1. Autoradiograph of flattened lump specimens to show distribution of radioactivity. (Approx. actual size).

Photomicrographs of Polished Sections

A 200-mesh screen opening is outlined on each.

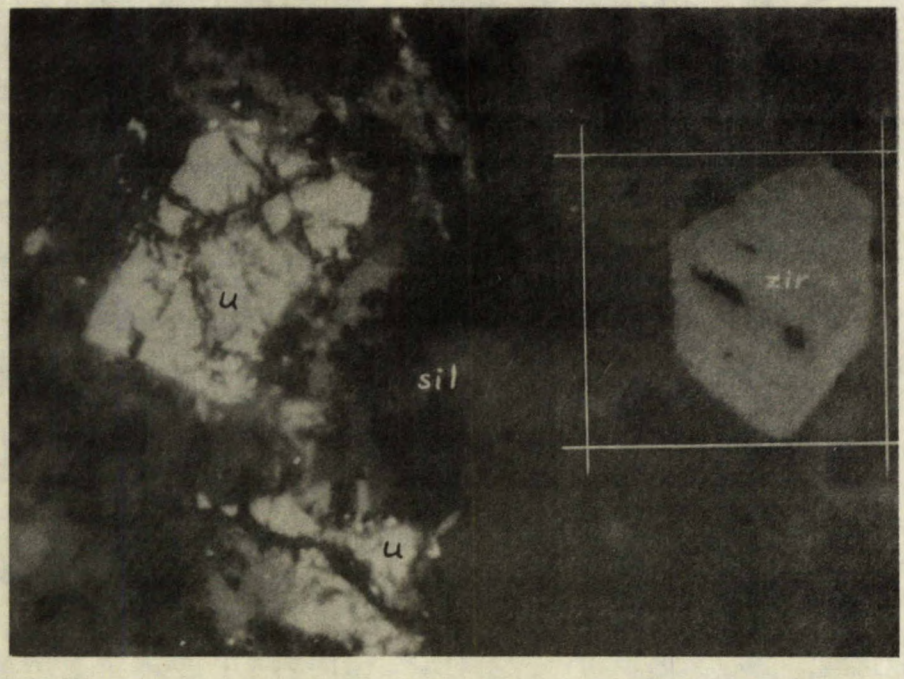



Fig. 2. Euhedral uraninite and fragments of brecciated uraninite (u), as well as a zoned crystal of zircon (z) in siliceous gangue (sil). (X 510)

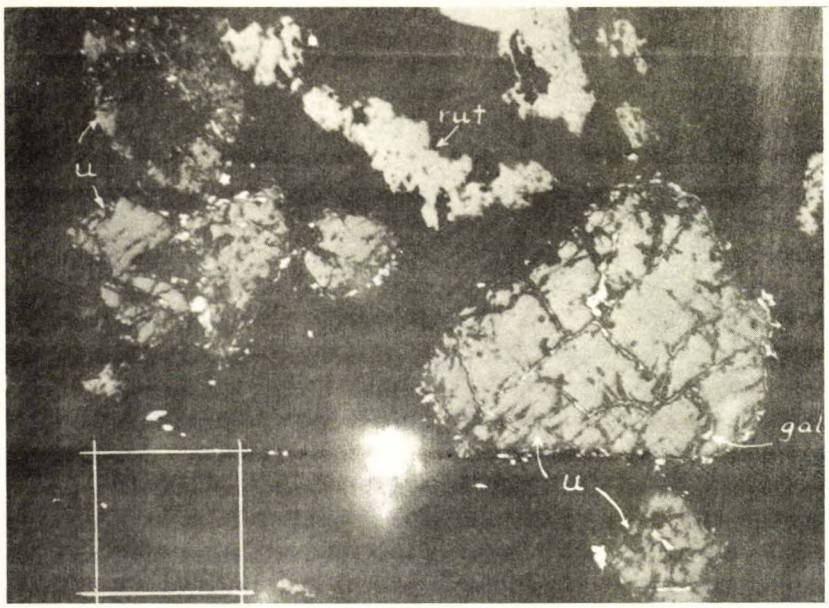
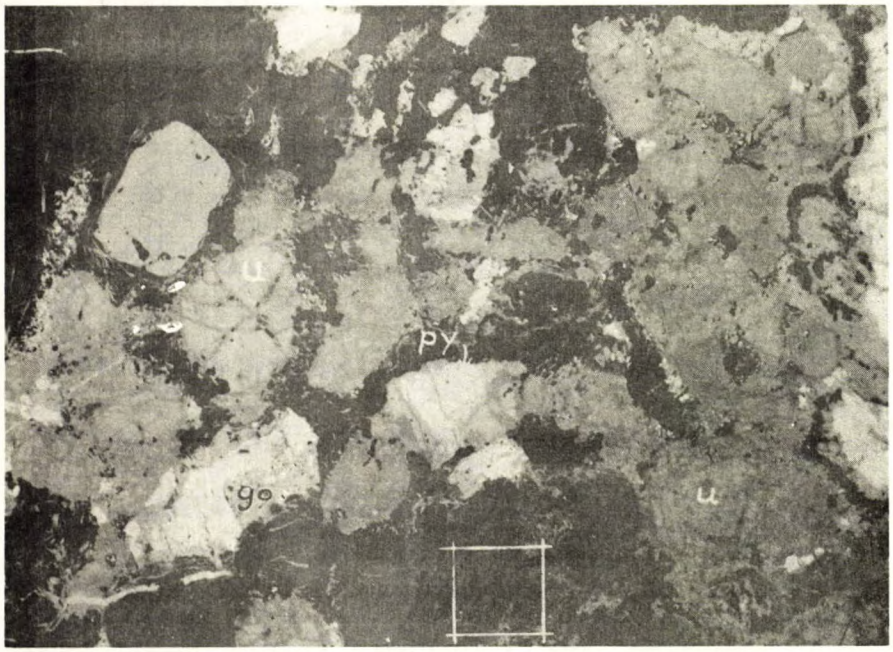
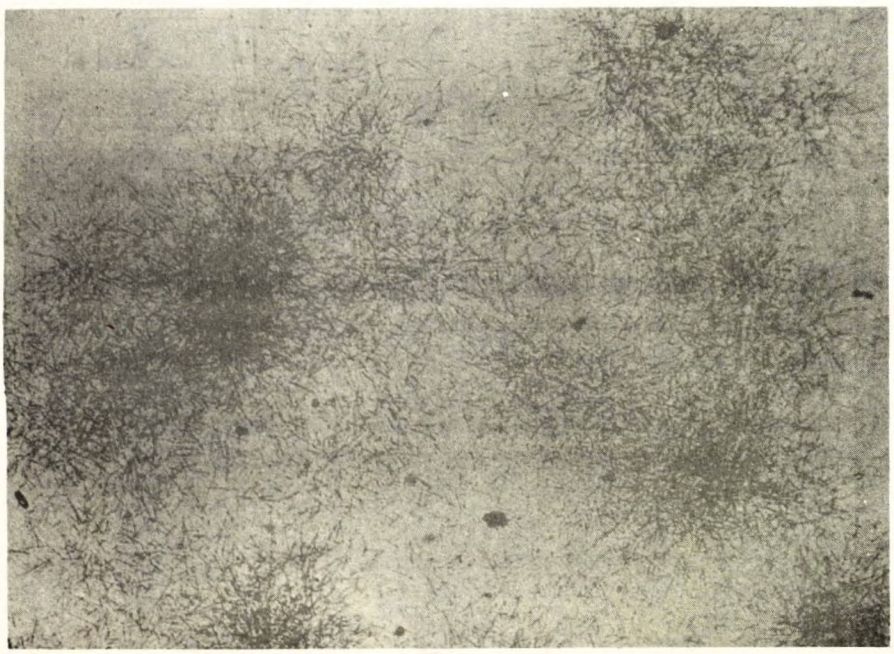



Fig. 3. - Cluster of unusually large grains of uraninite (u) containing galena (gal) in fractures. Rutile (rut) occurs in siliceous gangue.

(X 245)




A



B

Fig. 4. - Photomicrograph A, and alpha track autoradiograph B, showing brecciated uraninite (u), pyrite (py), and goethite (go).

(X150)

Monazite was first noted in a gravity concentrate. The grains are rounded and light green to light brown in colour. Spectrographic analysis of a pure sample of the mineral yielded the following results: Th, 2%; U, <0.2%. It is estimated that there is approximately 2.5% of monazite in the sample.

Coffinite was observed in several of the polished sections but it does not appear to be present in more than trace amounts. Under reflected light the grains are dark grey and gangue-like, opaque to slightly translucent, rounded to angular, and contain numerous very fine inclusions of metallic minerals (usually galena). The grains average 150 to 200 mesh in size. By visual estimation of alpha tracks on nuclear emulsions, the radioactivity of the coffinite appears to be about 1/4 to 1/3 that of uraninite.

Cyrtolite (radioactive zircon) is fairly abundant. It occurs as small, zoned, prismatic crystals, many of them less than 200 mesh in size. Spectrographic analysis of a pure sample showed 1.5% U and 0.3% Th.

## SUMMARY AND CONCLUSIONS

The radioactive minerals occur in the fine-grained siliceous matrix of the pebble conglomerate. Uraninite, the most abundant uranium-bearing mineral, and zircon, coffinite and monazite, are all present as fine grains; the uraninite grains are mainly less than 200 mesh in size.

Acid leaching may be expected to effect good extraction of the uranium contained in the uraninite, especially since it is altered to a moderate degree. However, due to the small grain size of the radioactive mineral constituents, especially of the uraninite, it may be anticipated that uranium values in leach residues will be due to unliberated grains as well as to the refractory nature of zircon, coffinite, and monazite.

As compared with Blind River conglomerate this ore has smaller pebbles (of quartz mainly, and garnet), and no feldspar was noted in the matrix. While the uranium content is approximately three times as high as in Blind River ore, no brannerite was identified and the most abundant radioactive mineral present is uraninite.

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