Uranium-bearing minerals in placer deposits of the Red River Valley, Elk City district, Idaho County, Idaho

By F. C. Armstrong and P. L. Weis

Trace Elements Investigations Report 562

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

IN REPLY REFER TO:

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WASHINGTON 25, D. C.

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February 10, 1956

Mr. Robert D. Nininger, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEI-562, "Uranium-bearing minerals in placer deposits of the Red River Valley, Elk City district, Idaho County, Idaho," by F. C. Armstrong and P. L. Weis, August 1955.

On December 13, 1955, Mr. Hosted approved our plan to publish Part I of this report as a Geological Survey bulletin.

Sincerely yours,

for John H. Eric

W. H. Bradley
Chief Geologist

Geology and Mineralogy

This document consists of 21 pages, plus 1 figure.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

URANIUM-BEARING MINERALS IN PLACER DEPOSITS OF THE RED RIVER VALLEY, ELK CITY DISTRICT IDAHO COUNTY, IDAHO*

By

F. C. Armstrong and P. L. Weis

August 1955

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This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

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By F. C. Armstrong and P. L. Weis

ABSTRACT

Uranium-bearing multiple oxide minerals were first recognized in the jig-bed concentrate of the Tyee Mining Company's gold dredge on the Red River about 10 miles south of Elk City, Idaho County, Idaho, in late 1951 or early 1952. The gravels of the placer deposits were derived from the Idaho batholith and a roof pendant of Precambrian rocks in the batholith.

Three samples taken for analysis show that the jig-bed concentrate contains 0.134 percent uranium. The nonmagnetic, non-radioactive fractions of the samples assayed 0.2 percent niobium, but no columbite was recognized in the samples.

The uranium-bearing placer minerals are brannerite, euxenite, davidite, betafite, and samarskite. Euxenite, samarskite, and betafite also contain niobium; ilmenite in the gravels may also contain some niobium. Pegmatites are believed to be the source of the uranium- and niobium-bearing minerals, but the possibility of finding a pegmatite in the area that can be mined economically for uranium or niobium is remote.

INTRODUCTION

The Elk City district lies approximately 40 miles east of Grangeville in Idaho County, Idaho, where the Red and American Rivers join to form the South Fork of the Clearwater River. This district makes up a part of the large and productive central Idaho gold-placer area which was discovered about 1860. Capps (1941), Lorain and Metzger (1938), Reed (1934), Shenon and Reed (1934 a and b), and Thompson and Ballard (1924) have studied the geology of the area. Much of the general and detailed geologic information in this report has been taken from these sources.

In 1951 the Tyee Mining Company _/ of Seattle, Wash., dredged gravels along the Red River a few miles south of Elk City for gold. Jigs were used, and in processing the Red River gravels for gold, a considerable quantity of coarse, heavy, black minerals accumulated in their jigs. The Tyee Mining Company gave these heavy minerals to Mullen Mines to use as jig-bedding in their scheelite concentrating experiments. In the concentrating experiments Mullen Mines had difficulty in separating the heavy mineral jig-bed material from the coarse scheelite that accumulated in the jigs and, therefore, sent samples of the scheelite-bearing jig-bed material to the U. S. Bureau of Mines laboratory at Albany, Ore., for tungsten analyses and further separatory experiments. It was in these samples that uranium-bearing multiple oxide minerals were recognized in late 1951 or early 1952 by the Bureau of Mines, and it was later determined that the uranium-bearing minerals were in the Tyee Mining Company's jig-bed concentrate. The Tyee Mining Company did not try to recover the uranium-bearing minerals, but discarded them in piles along with the rest of the jig-bed concentrate when the jigs were emptied at the time of each clean-up for gold.

To determine whether it might be worthwhile to attempt to recover the uranium-bearing minerals as a byproduct, the writers visited the Tyee Mining Company dredge on October 15, 1953, and collected samples of the jig-bed concentrate. Because this was the first reported occurrence of uranium-bearing multiple oxide minerals north of the Salmon River in Idaho that might be an economic source of uranium, and because these minerals are hard to identify, the samples were examined in some detail.

The writers are indebted to Mr. Kenneth Coates of Elk City, manager of the Tyee Mining Company dredge, for information about the dredging operation. The U. S. Bureau of Mines and U. S. Atomic Energy Commission provided analytical and mineralogic information on samples and other such information was furnished by the Denver and Washington laboratories of the U. S. Geological Survey. The work described in this report was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

_/ Tyee Mining Company, permission to publish.

GENERAL GEOLOGY

The Elk City district is in a roof pendant in the northern part of the Idaho batholith about midway between its east and west margins. The oldest rocks in the area (fig. 1) are a series of intensely folded quartz-mica schists (Shenon and Reed, 1934 a) that locally grade upward into quartzites. Overlying the quartzites and schists is a thick sequence of gneisses and augen gneisses. All the metamorphic rocks are thought to be of late Precambrian age and are tentatively correlated with the Belt series (Shenon and Reed, 1934a, p. 10). The metamorphic rocks have been intruded, deformed, and recrystallized by granite, quartz monzonite, and quartz diorite of the Idaho batholith. Pegmatite and aplite dikes related to the batholith are locally abundant. Gold-bearing quartz veins, presumably also related to the batholith, are the source of the gold found in the placer deposits in the vicinity of Elk City.

After intrusion of the Idaho batholith in Cretaceous time, the central Idaho area was eroded to a surface of relatively low relief. By the beginning of Miocene time, this surface had been uplifted and deeply dissected. During, or perhaps in part shortly after, the extrusion of the Miocene Columbia basalts to the west, the area again underwent deformation with some uplift accompanied by faulting and warping which produced large, basin-like depressions such as the Elk City basin. As the basins formed, deposits of clay, sand, and gravel accumulated and formed deposits of considerable thickness and areal extent.

A pre-Pleistocene uplift rejuvenated the area and marked the beginning of the present cycle of erosion. Major streams such as the Salmon and the Clearwater deepened their canyons, and the smaller tributaries, in turn, began to deepen their valleys and cut into the basin sands and gravels. The sands and gravels were, in part, carried out of the watershed by the streams, but in some places temporary halts in downcutting resulted in the formation of local deposits of reworked material. When downcutting resumed in such areas, some of the reworked gravels were left behind as terraces representing a second generation of gravel deposits.

Following the start of the present erosion cycle, the higher parts of the area were glaciated. The streams draining glaciated valleys superimposed glacial debris on the two generations of gravels already present, adding a third type of deposit.

During and after glaciation, transported material eroded from exposures of bedrock was added to the basin gravels, the reworked gravels, and the glacial debris, forming a fourth type of deposit along most of the smaller streams of the area.

It can be seen from the above that a specific gravel deposit in the Elk City district may consist of one of four types of deposits or of any combination of types. As might be expected, the geologic history of the gravels is locally complex, and it appears probable that as a result of their geologic histories, each of the four types are likely to have certain peculiarities of composition other than those traceable to nearby source rocks.

No study of the origin of the Red River gravels was made. However, the gravels in that part of the Red River Valley covered by this report are believed to be flood plain gravels of the present stream and to consist dominantly of reworked terrace gravels and post-glacial gravels. It should be emphasized that because of the complex geology of the gravel deposits of the region as a whole, any conclusions drawn from this study do not necessarily apply to gravel deposits elsewhere in the district.

SAMPLES

After the discovery of uranium-bearing minerals in the gravels of the Red River, the U. S. Bureau of Mines and the U. S. Atomic Energy Commission examined other samples of the Tyee Mining Company's jig-bed concentrate containing these minerals. The results of those examinations are given in table 1.

The writers collected three samples of jig-bed concentrate. On the dredge the river gravels are passed through a trommel with one-half inch openings. The oversize is returned to the river, and the undersize is fed to jigs that are bedded with steel shot and have 10-mesh screen bottoms. The tails from the jigs are the light minerals and are carried out the tops of the jigs. The heavy minerals are concentrated in the jigs and those less than 10-mesh in size pass through the bottom screens to form the hutch product. The heavy minerals larger than 10-mesh in size accumulate in the jigs and are the jig-bed concentrate. The jigs do not make a perfect size separation and, therefore, some minus 10-mesh material remains in the jig-bed concentrate. At clean-up time the steel shot is separated magnetically from the jig-bed concentrate which is then discarded in a pile. It was from three such piles, located at the dredge, 0.3 mile downstream from the dredge, and about 0.3 mile below the mouth of Dawson Creek (fig. 1), that the writers took three samples. One thirty-pound sample was taken from each pile.

Table 1.--U. S. Bureau of Mines and U. S. Atomic Energy Commission analyses of uranium-bearing minerals from Red River placer samples.

Agency	Sample Weight lbs.	Heads 6/ Percent eU*	Heads 6/ Percent U	Concentrate 7/ Percent U	Radioactive Minerals identified
USBM 1/	11.5		.23	10.8	samarskite
AEC 2/	5.5	1.0	1.1 1.2		brannerite, davidite, betafite, euxenite (X-ray)
AEC 3/		0.1	0.055		monazite, xenotime "radioactive blacks"
USBM 4/				0.539 8/	
USBM 5/	10.1	0.2		1.66 5.56 9/ 4.47 9/	euxenite, davidite, brannerite, thorite, samarskite, xenotime, monazite

*Determined by radiometric analyses. This consists of measuring the radioactivity of an unknown sample and comparing it with a standard sample. It assumes that all radioactivity in the unknown sample is due to uranium and its daughter products in equilibrium.

1/ Memorandum from P. H. Floyd, U. S. Bur. Mines, to H. G. Poole, U. S. Bur. Mines, dated Feb. 2, 1952. Published with permission of the U. S. Bureau of Mines.

2/ Correspondence from M. L. Reyner, U. S. Atomic Energy Commission, to James Collard, Golden, Idaho, dated June 3, 1952.

3/ Report of analysis from L. D. Jarrard, U. S. Atomic Energy Commission, to James Collard, Golden, Idaho, dated Sept. 29, 1952.

4/ Memorandum from J. A. Bardill, U. S. Bur. Mines, to S. M. Shelton, U. S. Bur. Mines, dated Oct. 13, 1952. Published with permission of the U. S. Bureau of Mines.

5/ Memorandum from J. W. Pressler, U. S. Bur. Mines, to G. C. Ware, U. S. Bur. Mines, dated Feb. 25, 1953. Published with permission of the U. S. Bureau of Mines.

6/ Heavy, coarse jig-bed concentrate.

7/ Product from treatment of the heavy, coarse jig-bed concentrate.

8/ Reported as 0.635 U_3O_8

9/ Hand-picked radioactive grains, from concentrated product.

On the dredge the material in the jigs was tested with scintillation counters for radioactivity. Radioactivity of sufficient intensity to register through the layer of water and light minerals was noted. The hutch product and tails from the jigs did not show enough radioactivity to warrant taking samples.

Analysis of samples

Ten-pound splits of each of the three samples were examined in detail. The splits were first sieved _/ and plus 3-mesh, minus 3- plus 6-mesh, minus 6- plus 8-mesh, minus 8- plus 14-mesh, and minus 14-mesh fractions were separated and weighed.

A hand magnet was used to separate magnetic and nonmagnetic fractions coarser than 14-mesh of samples Nos. FCA-16A and FCA-17A. Only the plus 8-mesh fractions of sample No. FCA-18A were separated magnetically. All splits were weighed. A geiger counter was used to pick the radioactive grains from the nonmagnetic fractions; no radioactive grains were found in the magnetic fractions. The radioactive grains from the plus 8-mesh fractions were weighed and their chemical uranium content determined. Radioactive grains in the minus 8-mesh fractions were too small to hand-pick; therefore, the minus 8-mesh fractions were analyzed in bulk for chemical uranium. The percentage distribution of total uranium and the average uranium content in each size fraction was calculated for each sample. Results of these separations, analyses, and calculations are given in tables 2, 3, and 4. Table 5 is a weighted compilation of tables 2, 3, and 4, and shows the weighted uranium content of the three samples and its distribution in the different size fractions.

Because the minus 14-mesh material makes up such a small part of the total sample, and because the average uranium content in that fraction is much lower than the average of the coarser fractions, the uranium in the minus 14-mesh material was not added into the totals shown on the tables, nor was it considered in computing percentages and grades.

_/ American Society for Testing Materials, Tyler U. S. Standard Sieve Series.

SAMPLE		SIEVED FRACTIONS			HAND MAGNET SEPARATION				HAND-PICKED RADIOACTIVE GRAINS				URANIUM CONTENT			
No.	Wt. (ozs.)	Size (A.S.T.M. sieve sizes)	Wt. (ozs.)	Wt. percent of total sample	Fraction	Wt. (ozs.)	Wt. percent of size fraction	Wt. percent of total sample	Wt. (ozs.)	No. of grains	Wt. percent of non-magnetic fraction	Wt. percent of total sample	Wt. percent U in radioactive grains	Calculated wt. U in fraction indicated (oz.)	Wt. percent U in size fraction	Distribution of total uranium in weight percent
FCA-16A	160	+ 3	42.35	26.4	Non-magnetic	18.2	43.0	11.4	0.5	11	2.8	0.31	9.5	0.0475	0.112	23.8
					Magnetic	23.95	56.6	15.0	NOT RADIOACTIVE							
		- 3 + 6	103.8	64.8	Non-magnetic	47.2	45.5	29.5	1.2	72	2.54	0.75	12.0	0.1440	0.139	72.3
					Magnetic	56.6	54.5	35.4	NOT RADIOACTIVE							
		- 6 + 8	8.95	5.6	Non-magnetic	2.9	32.4	1.8	0.05	10	1.7	0.03	13.1	0.0066	0.074	3.3
					Magnetic	6.25	69.8	3.9	NOT RADIOACTIVE							
		- 8 +14	4.05	2.5	Non-magnetic	1.75	43.2	1.1	NOT HAND-PICKED					0.0010	0.058**	0.5
					Magnetic	1.50	37.03	0.93	NOT RADIOACTIVE						0.001**	
		-14	0.15	0.09	NOT SEPARATED										0.005	
SUB-TOTALS					Non-magnetic	70.05		43.8								
					Magnetic	88.30		52.06								
TOTALS* & WEIGHTED AVERAGES			159.30	99.39		158.35			1.75	93	2.49	1.09	11.3	0.1991		99.9

* Do not include fractions that were not separated.
** Weight percent uranium in fraction indicated.

TABLE 2. - URANIUM CONTENT AND DISTRIBUTION IN JIG-BED CONCENTRATE -- SAMPLE NO. FCA-16A

Average grade of sample = 0.124 percent U.

SAMPLE		SIEVED FRACTIONS			HAND MAGNET SEPARATION				HAND-PICKED RADIOACTIVE GRAINS				URANIUM CONTENT			
No.	Wt. (ozs.)	Size (A.S.T.M. sieve sizes)	Wt. (ozs.)	Wt. percent of total sample	Fraction	Wt. (ozs.)	Wt. percent of size fraction	Wt. percent of total sample	Wt. (ozs.)	No. of grains	Wt. percent of non-magnetic fraction	Wt. percent of total sample	Wt. percent U in radioactive grains	Calculated wt. U in fraction indicated (oz.)	Wt. percent U in size fraction	Distribution of total uranium in weight percent
FCA-17A	160	+ 3	15.0	9.4	Non-magnetic	9.65	64.4	6.0	0.3	7	3.1	0.19	7.7	0.0221	0.154	9.3
					Magnetic	5.25	35.0	3.3	NOT RADIOACTIVE							
		- 3 + 6	102.2	63.9	Non-magnetic	59.6	58.3	37.3	1.55	110	2.6	0.97	11.2	0.1736	0.170	72.7
					Magnetic	43.2	42.2	27.0	NOT RADIOACTIVE							
		- 6 + 8	21.0	13.1	Non-magnetic	9.1	43.3	5.7	0.25	41	2.7	0.16	14.6	0.0365	0.174	15.3
					Magnetic	11.6	55.3	7.2	NOT RADIOACTIVE							
		- 8 +14	16.9	10.6	Non-magnetic	6.8	40.2	4.2	NOT HAND-PICKED					0.0050	0.074**	2.1
					Magnetic	9.95	58.9	6.2	NOT RADIOACTIVE						0.001**	
		-14	5.2	3.2	NOT SEPARATED										0.005	
SUB-TOTALS					Non-magnetic	85.15		53.2								
					Magnetic	70.00		43.7								
TOTALS* & WEIGHTED AVERAGES			160.3	100.2		155.15			2.10	158	2.47	1.31	11.1	0.2372		99.4

* Do not include fractions that were not separated.
** Weight percent uranium in fraction indicated.

TABLE 3. - URANIUM CONTENT AND DISTRIBUTION IN JIG-BED CONCENTRATE--SAMPLE NO. FCA-17A.

Average grade of sample = 0.148 percent U.

SAMPLE		SIEVED FRACTIONS			HAND MAGNET SEPARATION				HAND-PICKED RADIOACTIVE GRAINS				URANIUM CONTENT			
No.	Wt. (ozs.)	Size (A. S. T. M. sieve sizes)	Wt. (ozs.)	Wt. percent of total sample	Fraction	Wt. (ozs.)	Wt. percent of size fraction	Wt. percent of total sample	Wt. (ozs.)	No. of grains	Wt. percent of non-magnetic fraction	Wt. percent of total sample	Wt. percent U in radioactive grains	Calculated wt. U in fraction indicated (oz.)	Wt. percent U in size fraction	Distribution of total uranium in weight percent
FCA-18A	160	+ 3	29.8	18.6	Non-magnetic	19.9	66.7	12.4	0.1	2	0.5	0.062	11.5	0.0115	0.039	10.6
					Magnetic	10.3	34.5	6.4	NOT RADIOACTIVE							
		- 3 + 6	85.0	53.1	Non-magnetic	38.2	44.9	23.9	0.65	60	1.7	0.406	9.3	0.0605	0.071	55.7
					Magnetic	46.7	55.0	29.2	NOT RADIOACTIVE							
		- 6 + 8	30.0	18.7	Non-magnetic	15.1	50.3	9.4	0.2	51	1.3	0.125	12.8	0.0256	0.085	23.6
					Magnetic	14.8	49.3	9.2	NOT RADIOACTIVE							
		- 8 +14	14.2	8.9	NOT SEPARATED									0.0111	0.078	10.2
		-14	0.9	0.6	NOT SEPARATED										0.005	
SUB-TOTALS					Non-magnetic	73.2		45.7								
					Magnetic	71.8		44.9								
TOTALS* & WEIGHTED AVERAGES			159.9	99.9		145.0			0.95	113	1.3	0.594	10.3	0.1087		100.1

* Do not include fractions that were not separated.

TABLE 4. - URANIUM CONTENT AND DISTRIBUTION IN JIG-BED CONCENTRATE -- SAMPLE NO. FCA-18A.

Average grade of sample = 0.068 percent U.

SAMPLE		SIEVED FRACTIONS			HAND MAGNET SEPARATION				HAND-PICKED RADIOACTIVE GRAINS				URANIUM CONTENT			
No.	Wt. (ozs.)	Size (A.S.T.M. sieve sizes)	Wt. (ozs.)	Wt. percent of total sample	Fraction	Wt. (ozs.)	Wt. percent of size fraction	Wt. percent of total sample	Wt. (ozs.)	No. of grains	Wt. percent of non-magnetic fraction	Wt. percent of total sample	Wt. percent U in radioactive grains	Calculated Wt. U in fraction indicated (oz.)	Wt. percent U in size fraction	Distribution of total uranium in weight percent
Composite FCA-16A FCA-17A FCA-18A	480	+ 3	87.1	18.2	Non-magnetic	47.75	54.8	9.9	0.9	20	1.89	0.187	9.0	0.0811	0.093	14.9
					Magnetic	39.5	45.3	8.2	NOT RADIOACTIVE							
		- 3 + 6	291.0	60.6	Non-magnetic	145.0	49.8	30.2	3.4	242	2.34	0.708	11.1	0.3781	0.130	69.4
					Magnetic	146.5	50.2	30.5	NOT RADIOACTIVE							
		- 6 + 8	59.9	12.5	Non-magnetic	27.1	45.3	5.6	0.5	102	1.84	0.104	13.7	0.0687	0.115	12.6
					Magnetic	32.65	54.5	6.8	NOT RADIOACTIVE							
		- 8 +14	35.1	7.3	NOT SEPARATED									0.0171	0.050	3.1
		-14	6.2	1.3	NOT SEPARATED										0.005	
SUB-TOTALS					Non-magnetic	219.85		45.8								
					Magnetic	218.65		45.55								
TOTALS* & WEIGHTED AVERAGES			479.3	99.9					4.8	364	2.18	1.000	11.0	0.5450		100.0

* Do not include fractions that were not separated.

TABLE 5. - AVERAGE URANIUM CONTENT AND DISTRIBUTION IN JIG-BED CONCENTRATE

Average grade of three samples = 0.114 percent U.

Analysis of the samples shows:

1. Approximately half of the jig-bed concentrate is magnetic and probably consists of magnetite and possibly some ilmenite. The other half of the jig-bed concentrate is nonmagnetic and consists of several minerals among which are the radioactive minerals.
2. Radioactive minerals make up 1.0 percent of the jig-bed concentrate and 2.18 percent of the nonmagnetic fraction.
3. The average uranium content of the radioactive minerals is 13.0 percent.
4. The average uranium content of the jig-bed concentrate is 0.134 percent.
5. Over two-thirds of the total uranium in the jig-bed concentrate is in the minus 3- plus 6-mesh size fraction.

It was thought that the jig-bed concentrate might also contain columbite recoverable as a byproduct of the gold dredging. To check this possibility one 10-pound split from each of the three samples was sent to E. P. Kaiser (written communication, 1954) of the U. S. Geological Survey who reports:

> "Several hundred grains of the nonmagnetic and non-radioactive fraction of the material in the bags were ground and analyzed for Nb; it contained 0.2 Nb. I have not been able to find anything that looks like columbite, and it is probable that the Nb is in ilmenite.--This is not an unusual concentration of Nb in accessory or pegmatite ilmenite, ..."

If it is in the ilmenite, the niobium may not be marketable.

Euxenite, samarskite, and betafite, listed in table 1, are uranium-bearing multiple oxides of niobium, tantalum, and titanium, and the combined niobium-tantalum oxide content of these minerals can range from 27.60 percent in euxenite to 60.68 percent in samarskite (Palache and others, 1946). The niobium and tantalum in the minerals is a potential source of these critically short metals, and the recovery of these metals also should be considered in any contemplated production of uranium from such minerals. However, because the writers know of no market for niobium-tantalum contained in such minerals, the radioactive minerals were not assayed for these metals.

Mineralogy

The identification of uranium-bearing multiple oxides is difficult and is complicated by intergrowth of these minerals with each other and with other metallic oxides. Intergrowths of these minerals with other metallic oxides were recognized _/ in a sample of the jig-bed concentrate, and Hutton (1953) found intergrowths of multiple oxides to be common in gravel samples from central Idaho. Identification is further complicated by the fact that all of these minerals are now metamict and must be heated before X-ray identification can be made.

The U. S. Bureau of Mines and the U. S. Atomic Energy Commission have reported the following nonradioactive and radioactive minerals from the jig-bed concentrate samples listed in table 1 (See footnotes 1, 2, 3, 4, 5, table 1.):

Nonradioactive minerals

barite	garnet	pyrite
biotite	goethite	quartz
chlorite	hematite	rutile
columbite	hornblende	sericite
corundum	ilmenite	sillimanite
epidote	limonite	titaniferous magnetite
feldspar	magnetite	tourmaline
	muscovite	

Radioactive minerals

Group I	Group II
monazite	betafite*
thorite	brannerite*
xenotime	davidite*
zircon	euxenite*
	samarskite**

* Identified by X-ray. Two specimens of brannerite identified.

** Method of identification not specified.

The minerals of principal concern to this report are the radioactive black minerals in the jig-bed concentrate listed under Group II above. These minerals are uranium-bearing multiple oxides of titanium, niobium, tantalum, iron, and rare earths.

_/ Memorandum from J. W. Pressler, U. S. Bureau of Mines, to G. C. Ware, U. S. Bureau of Mines, dated Feb. 25, 1953. Published with permission of the U. S. Bureau of Mines.

In a sample of the undersize material (hutch product) from the jigs, collected by the U. S. Bureau of Mines, D. L. Schmidt (written communication, 1954) of the Geological Survey identified;

allanite	monazite
apatite	pyrite
epidote	rutile
garnet	sphene
gold	tourmaline
ilmenite	xenotime
magnetite	zircon

Schmidt did not recognize any radioactive black minerals in the samples.

The radioactive minerals in the samples collected by the writers were examined under a binocular microscope. These minerals occur as slightly rounded, hard, heavy grains that break with a conchoidal fracture. Many are incompletely coated with a buckskin-brown alteration product; fresh surfaces are lustrous black to dark brown. None of the grains show recognizable crystal faces, but few have undergone enough abrasion to more than slightly round and polish the sharper edges and corners. A few reddish grains with nonmetallic luster, probably monazite or thorite, were noted.

X-ray identifications and semiquantitative spectrographic analyses were made on the samples sent to E. P. Kaiser (written communication, 1954) of the U. S. Geological Survey who reports:

> "From one of the Elk City placer samples, I picked 10 radioactive grains, of which 8 were black and 2 were brownish red. One of the black grains gave an x-ray pattern, after heating, of brannerite; its analysis was 0.0X + Ce, X. Y, 0.X+ Nb, 0.0X+ Ta, X, Ti, and X.+ U. This fits generally with the name brannerite.
>
> "The reddish material gave 0.X- Ce, 0.X Y, 0.0X-Nb, 0 Ta, 0.000X+ Ti, 0 U and high thorium; it is probably thorite ".

Because brannerite and euxenite are the minerals that have been identified most frequently, it is believed that they are the most abundant uranium-bearing minerals in the jig-bed concentrate.

Specimens FCA-3091 and FCA-1743 are two strongly radioactive grains from the jig-bed concentrate, but not from the 30-pound samples mentioned above, that were chosen for more detailed work. Their specific gravities as determined with a Berman balance are 5.225 and 5.178 respectively.

Powders of the two specimens appear to be the same under a petrographic microscope. The transparent thin edges are yellowish brown with a slight green tinge and are crowded with inclusions. The rest of the mineral is opaque and has a dark brown color in reflected light. Neither specimen is pleochroic. The refractive index of both specimens before heating was determined to be considerably above 2.008, the highest index oil available to the writers. The unheated minerals were isotropic, but upon heating, in a differential thermal analysis machine, they became anisotropic. Although the powders were anisotropic after heating, they were so finely crystalline that no optical data could be determined. In an attempt to make the specimens more coarsely crystalline they were heated in an electric furnace in an air atmosphere at 1000° F. for 21 hours, but this treatment did not noticeably coarsen the crystallinity of the specimens.

The powders were sent for X-ray identification to E. P. Kaiser (written communication, 1954) of the U. S. Geological Survey who reports:

> "Sample FCA-3091: X-ray pattern similar to that of brannerite; may be considered as brannerite or a very similar mineral.
>
> "Sample FCA-1743: pattern indeterminate, but generally similar to columbite, samarskite, euxenite".

Because metamict uranium-bearing multiple oxide minerals are hard to identify, a relatively simple, reliable field identification method is needed. One method that may offer some promise of filling this need is differential thermal analysis (DTA). A few attempts to identify these minerals by the use of DTA curves have been made (Kerr and Holland, 1951; Puig, 1954), but basic DTA data are still in the process of being compiled (Hutton, 1953). Because this method may become useful for differentiating among the uranium-bearing multiple oxide minerals, DTA curves (analyses made by F. C. Armstrong) for samples FCA-3091 and FCA-1743 are given in figure 2. The samples were run in a portable, three unit, 115 volt, AC-DC, 450 watt differential thermal analysis apparatus with an upper temperature limit of 1000°C., similar to that described by Hendricks and others (1946). Although the instrument has three sensitivities, both samples were run only on low sensitivity.

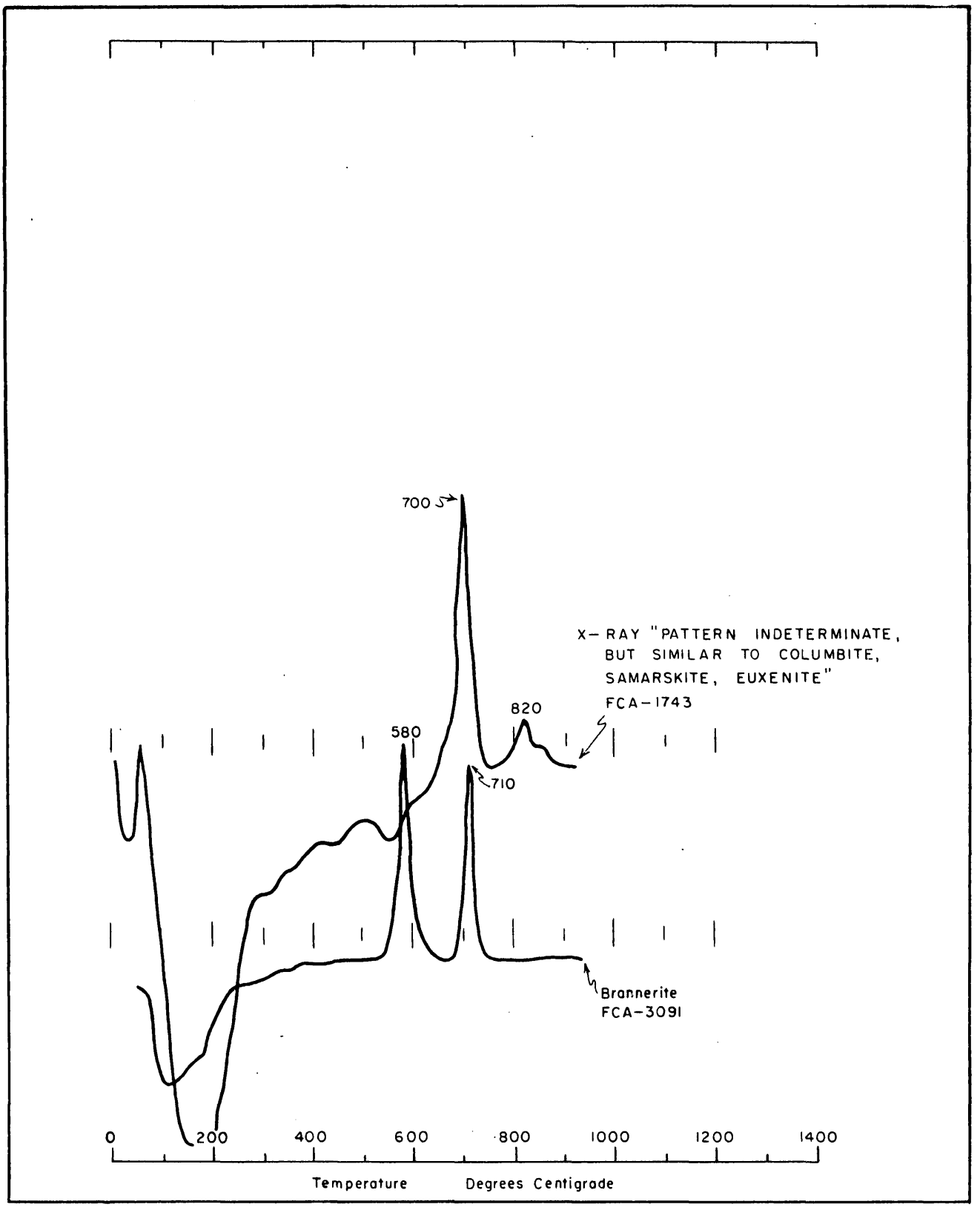

FIGURE 2 — DIFFERENTIAL THERMAL ANALYSIS CURVES OF TWO URANIUM-BEARING MULTIPLE OXIDE MINERALS FROM PLACER GRAVELS IN THE RED RIVER, ELK CITY DISTRICT, IDAHO COUNTY, IDAHO.

DISTRIBUTION OF THE URANIUM-BEARING MINERALS

There appears to be no great variation in the amounts of heavy minerals concentrated in the jig-bed over the area covered by the sampling. Similarly, there appear to be few significant differences in the percentages of the different size fractions or the proportions of magnetic to nonmagnetic minerals. However, the uranium content of sample FCA-17A is over twice that in sample FCA-18A.

The concentrate from which sample FCA-17A was taken had been shoveled out of the jigs at the time of a gold clean-up and, therefore, had been accumulating on the jig-bed for the entire time between clean-ups. On the other hand, the concentrate from which sample FCA-18A was taken was removed from the jigs after a run of only 8 hours since the last clean-up. Based on his operating experience in the area, Mr. Coates, superintendent of the dredge, believes that the difference in the uranium content of the samples can be explained on the basis of elapsed time between clean-ups. He believes that there is a progressive enrichment of the jig-bed concentrate in radioactive minerals with increased time between clean-ups. However, the difference in uranium content between the samples could also be explained by the relative positions of the samples in the stream. Not enough information is at hand to explain fully the reason for the difference in the uranium content of the samples.

It appears reasonable to assume that the average of the analyses (table 5) represents the correct order of magnitude of the uranium content in the gravels being dredged by the Tyee Mining Company.

ORIGIN OF THE URANIUM-BEARING MINERALS

The original source of the uranium minerals is not yet known. All characteristically occur widely disseminated in pegmatites, and it is assumed that pegmatites related to the Idaho batholith are the source of the minerals in the placers. This assumption is in part supported by the fact that the greatest proportion of the radioactive grains are coarse. None of the descriptions of these pegmatites by earlier workers make any mention of radioactive minerals. Similar suites of minerals, however, occur in pegmatites in Bear Valley, Valley County (Mackin and Schmidt, 1933), in Kelly Gulch, Custer County (V. C. Fryklund, 1954 oral communication), and in the Garden Valley district, Boise County (Fryklund, 1951), Idaho.

CONCLUSIONS

The niobium in the jig-bed concentrate is in minerals not known to be marketable under 1955 conditions for their niobium content. If at some future date economic conditions change enough to warrant recovering these metals as byproducts, the minerals that contain uranium and niobium, although hard to identify, may not be too difficult to separate from the gangue minerals because of their high specific gravities, different electromagnetic susceptibilities, and intense radioactivity.

The uranium-and niobium-bearing minerals are believed to be derived from pegmatites; but, because these minerals characteristically occur widely disseminated in pegmatites, the possibility of finding pegmatites in the Elk City area that contain sufficient concentrations of uranium- or niobium-bearing minerals to be mined at a profit is very small.

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