Radium, Uranium, and Vanadium

By Frank L. Hess

The demand for radium, uranium, and vanadium, like that for most other substances, was small in 1932. During the year 61 short tons of carnottite-bearing ores were sold carrying 481 milligrams of radium and 3,755 pounds of uranium oxide, U₃O₈ (3,186 pounds of elemental uranium), also concentrates, both chemical and mechanical, carrying 231,461 pounds of vanadium pentoxide (109,092 pounds of elemental vanadium). The uranium ores were valued at $6,150, and the vanadium concentrates at $102,527.

No exports of uranium or radium are known to have been made, and records of vanadium concentrates, salts, or ferrovanadium were not kept separately. Imports are shown in the following tables.

Vanadium ore (steel-hardening) imported for consumption in the United States, 1928–32

<table>
<thead>
<tr>
<th>Year</th>
<th>Pounds</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1928</td>
<td>1,104,320</td>
<td>$49,771</td>
</tr>
<tr>
<td>1929</td>
<td>19,519,360</td>
<td>794,754</td>
</tr>
<tr>
<td>1930</td>
<td>11,576,320</td>
<td>401,033</td>
</tr>
</tbody>
</table>

1 No imports reported for 1931–32.

Uranium and radium salts imported for consumption in the United States, 1929–32

<table>
<thead>
<tr>
<th>Class</th>
<th>1929</th>
<th>1930</th>
<th>1931</th>
<th>1932</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantity</td>
<td>Value</td>
<td>Quantity</td>
<td>Value</td>
</tr>
<tr>
<td>Uranium oxide and salts of</td>
<td>pounds</td>
<td>$344,548</td>
<td>pounds</td>
<td>$306,566</td>
</tr>
<tr>
<td></td>
<td>272,913</td>
<td></td>
<td>231,194</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.69</td>
<td>570,055</td>
<td>16.86</td>
<td>924,532</td>
</tr>
<tr>
<td></td>
<td>183</td>
<td>(9)</td>
<td>971</td>
<td>(9)</td>
</tr>
<tr>
<td>Radium salts</td>
<td>grams 1</td>
<td>(1.94)</td>
<td>(1.94)</td>
<td>(1.94)</td>
</tr>
<tr>
<td></td>
<td>923,816</td>
<td>1,222,389</td>
<td>965,072</td>
<td>627,592</td>
</tr>
<tr>
<td>Radioactive substitutes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1929, 165 grains; 1930, 260 grains; 1931, 207 grains; 1932, 141 grains.

The production of ferrovanadium in 1932 was 109 gross tons containing 89,624 pounds or an average of 36.73 percent of vanadium (metal). The shipments of ferrovanadium in 1932, amounting to 283 tons, contained 235,118 pounds of vanadium, and the average value per pound of contained vanadium was $2.99 f.o.b. furnaces compared with $3.13 in 1931.
Prices.—During 1932 prices were largely a matter of bargaining—entirely so as far as uranium ores were concerned. Vanadium ore was quoted by the Engineering and Mining Journal through the year at about 26 cents per pound for the $V_2O_5$ contained, f.o.b. shipping point, but this quotation was nominal.

Ferrovanadium was quoted at $3.05 to $3.30 per pound of contained vanadium, delivered, the price depending upon the quality. In December the quotations were $2.60 to $2.80. Fused vanadium oxide containing 86 to 92 percent $V_2O_5$ was nominally priced at 65 cents to $1.25 per pound of contained $V_2O_5$.

USES

Radium.—The uses of radium are few, but the value of radium for these uses is largely determined not in the ordinary terms of dollars and cents but in terms of human misery saved and human knowledge acquired. From such a viewpoint radium has been invaluable.

The principal use of radium is therapeutic. It has become a standard remedy for the removal of birthmarks, the cure of fibroid tumors, and the alleviation or cure of certain cancers. It has also been used successfully in certain cases of leukemia, tubercular glands of the neck, and other diseases.

In a hearing before a subcommittee of the Committee on Mines and Mining in 1930, Dr. Howard A. Kelly ¹ said that if radium had no more value than as a palliative “it would be well worth all our efforts”, and it has also been said that radium would be worth its whole cost as a cure for fibroid tumors.

The service that the discovery of radium has rendered science and through science the electrical industry (including the radio industry), by the new conceptions of the constitution of matter that it has given, cannot be valued in dollars but is very great.

Radium has been used recently in the examination of steel for flaws. Radium in a tube is placed on one side of the metal, and a photographic plate in a holder is held on the other side. After developing the plate, flaws in the metal will be shown by differences in exposure.

The use of radium for ionizing air, thus making it a conductor that prevents the accumulation of static charges of electricity in rolling or molding rubber, has been reported.

Uranium.—There are few if any practical uses for uranium as a metal. In the form of various salts it is used for coloring ceramic glazes. Large quantities are used to give a creamy tint to heavy glazed building tile for facing large structures, cornices, etc. A small quantity of salts is used in chemistry.

Vanadium.—Vanadium is used for making tough steels, but its use undoubtedly would increase much faster if the price could be lowered. As an illustration, it has been said that in the highly competitive manufacture of automobiles makers of one machine refused to use certain steel because the added cost was 11 cents per car.

In high-speed steels there is apparently a tendency to increase the vanadium content. One such steel contains tungsten, 17 percent; chromium, 4 percent; vanadium, 1.75 to 2.3 percent; carbon, 0.8 percent; remainder, iron.

¹ Manufacture of One Gram of Radium, Hearing before a Subcommittee of the Committee on Mines and Mining, House of Representatives, 71st Cong., 3rd sess., on H.R. 4511, Feb. 11 and 26 and Mar. 4, 11, and 25, 1930, p. 94.
In adding vanadium to steel the practice is usually to introduce it in the form of ferrovanadium, but steel makers have added some vanadium to steel by adding vanadium oxide to the molten slag.

In the contact process of manufacturing sulphuric acid and in the making of certain organic chemicals the use of vanadium is apparently increasing.

**THE DOMESTIC SITUATION**

The largest American operator, the United States Vanadium Corporation, exhausted its roscoelite (vanadium mica) mine on East Rifle Creek 11 miles north and a little east of Rifle, Colo., and closed both the mine and the reduction plant at Rifle about July 1, 1932. The ore deposit had been measured so carefully that the approximate date of stopping operations had been known for a considerable time. The company owns many of the claims formerly held by the Standard Chemical Co. in and near Long Park, Montrose County, and by the Radium Co. of Colorado near Gateway, Mesa County, but no mining was done on them during 1932. The claims of the Vanadium Corporation of America at Long Park also remained idle. All of these claims carry carnotite (hydrous potassium uranium vanadate, K₂O₂(UO₂)₃·H₂O), roscoelite, and a group of less-common vanadium minerals, and it seems probable that when they are worked it will be desirable to save radium as a byproduct. During the year only one company mined ore for the isolation of radium. The Shattuck Chemical Co. of Denver mined ore from claims along Dolores River in the McIntyre district (Colo.) for radium and uranium and for vanadium. Some radium was made in the form of high-grade bromide and some in the form of low-grade chloride. The work was largely experimental in an endeavor to save all three products—radium, uranium, and vanadium.

The following shipped small quantities of carnotite ore in 1932: Sullivan Bros. at Nucla, Colo.; H. W. Balsley (Yellow Circle Mining Co.), Moab, Utah, with deposits on the southwest side of La Sal Mountains, about 16 miles east of Moab; Shumway Bros., Blanding, Utah; and R. E. Adams, 331 Pitkin Avenue, Grand Junction, Colo.

Shumway Bros. claims in the Blue (Abajo) Mountains were discovered during the year, surprisingly late after so many years of prospecting in the general area.

About the close of the year the property of the International Vanadium Corporation on the south side of Dry Valley 55 miles southeast of Moab, Utah, was acquired by the Molybdenum Corporation of America, and a quantity of fused vanadium oxide made in 1931 was taken over. The ore on these claims is of lower grade than the roscoelite deposits exhausted on East Rifle Creek and carry some carnotite, of which rich pockets are found here and there.

The Garfield Vanadium Co. did some development work on its roscoelite property on the west side of East Rifle Creek opposite the United States Vanadium Corporation property. The United Vanadium Corporation reported the mining and concentration of a considerable tonnage of low-grade vanadinite-bearing rock at Dripping Springs northwest of Christmas, Ariz.

The Kingman Refining & Smelting Corporation mined and concentrated some higher-grade ore at Good Springs, near Kingman, Ariz.

No vanadinite is known to have been sold during the year.
FOREIGN COUNTRIES

Canada.—Although not yet a formidable competitor of the Belgian company, Union Minière du Haut Katanga, the pitchblende deposits discovered early in 1930 by Gilbert LaBine of the Eldorado Gold Mines, Ltd., on the east side of Great Bear Lake, Mackenzie district, Northwest Territories, Canada, have such a dramatic appeal that they attracted considerable attention.

The Arctic Circle crosses the lake a short distance north of the deposits. The country has been heavily glaciated and is exceedingly inhospitable, but it has the lure of potential wealth reached with great difficulty.

The area is reached from Edmonton by a train that runs to Waterways (285 miles), and the trip requires about a day. Thence an airplane trip of 850 miles lands one at LaBine Point or other places in the vicinity in another day.

The climate is severe. Airplanes fitted with skis can make the trip during about 3 winter months. Darkness at Great Bear Lake makes landing bad during part of the winter. Ordinarily, the ice breaks up on the bays about the last of June, but the lake is not free of ice until the second half of July. Freezing begins after August 15.

In 1931 the Canadian Government dispatched topographers, a geologist, and a representative from the Mines Branch to the area, and all have issued valuable reports. The Mines Branch investigated the isolation of radium from the ores and made flotation tests for removing the sulphides but did not find the process very satisfactory. Analyses of two samples gave:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UO₂</strong></td>
<td>percent</td>
<td>56.91</td>
<td>63.94</td>
<td><strong>Bi</strong></td>
<td>percent</td>
</tr>
<tr>
<td><strong>Th</strong></td>
<td>do</td>
<td>Nil</td>
<td>Nil</td>
<td><strong>As</strong></td>
<td>do</td>
</tr>
<tr>
<td><strong>UO₃</strong></td>
<td>do</td>
<td>Trace</td>
<td>Nil</td>
<td><strong>Fe</strong></td>
<td>do</td>
</tr>
<tr>
<td><strong>Cu</strong></td>
<td>do</td>
<td>0.70</td>
<td>0.66</td>
<td><strong>S</strong></td>
<td>do</td>
</tr>
<tr>
<td><strong>Ni</strong></td>
<td>do</td>
<td>Trace</td>
<td>Trace</td>
<td><strong>Ag</strong></td>
<td>ounces per ton</td>
</tr>
<tr>
<td><strong>Co</strong></td>
<td>do</td>
<td>12.00</td>
<td>12.13</td>
<td><strong>Au</strong></td>
<td>do</td>
</tr>
</tbody>
</table>

An analysis by J. P. Marble⁴ of carefully selected material from the deposit of the Eldorado Gold Mines, Ltd., gave the following data: Average results of five analyses, percent: Lead, 10.48; uranium, 52.06; thorium, none; approximate age, 1,375,000,000 years.

The age is therefore pre-Cambrian. These data are valuable in that they show the age of mineralization which otherwise could not be determined even approximately owing to the absence of fossils, and it places it at a definite time in the pre-Cambrian.

The following papers deal with the Great Bear Lake pitchblende area:


COOPER, COURTNEY R. The Trail of '32. Saturday Evening Post, Nov. 12, 1932, pp. 8, 9, 47–49. A popular account of the country.


By the summer of 1932 more than 2,000 claims had been staked and filed. According to Kidd 35 tons of pitchblende were shipped in 1932 and 20 tons in 1931. Both lots were awaiting treatment. Ten tons of rich silver ore were also shipped by the Eldorado Gold Mines, Ltd. The geology of the district was studied by Kidd.3

Concerning the pitchblende deposits, Kidd says: 4

1. Eldorado deposit, LaBine Point. This is the original discovery and has received most development to date and the most study. The pitchblende has been found in three shear and shatter zones cutting altered sedimentary and volcanic rocks near their contact with intrusive granite. The zones trend east-northeast and are several hundred feet apart. In the middle one pitchblende and native silver have been found at intervals for 1,400 feet from the lake shore back to a small pond. In the northernmost zone pitchblende only has been found. It has been mined from two lenses 350 feet apart. Two lenses of pitchblende have been found in the northernmost zone, but no mining has been done. The mineralization, particularly in the middle zone, is highly complex, some 27 metallic minerals, exclusive of surface alteration products, having been found so far. Preliminary studies indicate that pitchblende is one of the earliest formed minerals of the deposit and that the silver is fairly late in the mineral sequence.

During 1932, surface mining was done, and between April and August 35 tons of pitchblende ore and 10 tons of silver ore were obtained from open pits. This was shipped out by boat. Little more exploration was done except in the autumn of 1931 when at a point approximately 3,800 feet from the easternmost discoveries, in the edge of a pronounced gully, silver mineralization was reported to have been found over a width of 22 feet with values from 30 to 150 ounces of silver.

In the latter part of August a mining plant arrived by boat, and a crosscut tunnel has been commenced to intersect the north end of the middle zone at a depth of 80 feet.

2. Bear Exploration and Radium, Ltd. This company is developing the discovery made by N.A.M.E. in 1931 at Contact Lake.

A zone of fracturing and some shearing, striking northeast with a steep dip and 1½ to 3 feet wide, cuts massive diorite. At one point in it a lens of pitchblende, probably containing several tons, is present together with native silver which at one place is visible as scattered wires across a width of 1 foot. In a pit further along the zone more silver is present, in spots abundantly, and at this place an adit has been started along the zone into the base of a hill.

It is remarkable that only the two discoveries of pitchblende have been made.

4 Work cited, pp. 5-6.
During the year the Eldorado Gold Mines, Ltd., erected a plant for the isolation of radium at Fort Hope, Ontario. It is estimated that 1 gram of radium will be produced from each 10 tons of ore.

R. J. Traill and W. R. McClelland, of the Mines Branch at Ottawa, devised a system for the extraction of radium from the ore, but to what extent the system is used in the new plant is unknown. No radium had been produced by the end of the year.

News items stated that the Canada Radium Mines, Ltd., and International Radium and Resources, Ltd., made preparations to concentrateuraninite from pegmatite at Wilberforce, Haliburton Township, Ontario.

Another news item states that the University of Toronto had installed apparatus for the gathering and sale of radium emanation (radon).

The discovery of carnitite on Quadra Island was reported, and the announcement was made that it would be exploited. More information is desirable.

Belgian Congo.—The Belgian Congo has dominated radium production and marketing since 1923 and still holds the leading position. Throughout these years it has owned the largest and richest uranium deposits in the world and has had the Belgian Government as a partner in the enterprise, giving it all possible advantages as to Government contacts.

The principal uranium workings are at Chinkolobwe, but apparently there are a number of smaller deposits.

The company radium plant at Oolen, Belgium, began work in 1922 and turned out its first radium (2.7 grams) in December of that year. Sales began in 1933 when 20 grams were marketed, and by the end of 1931, 315 grams had been sold. Besides the sales various quantities had been loaned or given to Government agencies or institutions and the output by the end of 1932 probably had exceeded 400 grams.

Kenya.—Pitchblende is reported to have been found in the Loldaiga Hills 30 miles from Nanyuki, but no details are at hand.

Czechoslovakia.—The first radium isolated—that extracted by the Curies in 1898—was produced from pitchblende mined at St. Joachimsthal, Austria, known since the Great War as Jachymov in the newly formed country of Czechoslovakia. The making of uranium pigments and other salts had been carried on there for many years, and the production of radium was begun by the Austrian Government in 1906; the first recorded production—0.7217 gram—was made in 1909. The production to 1930, had been 39.039 grams. In 1932 the production of elemental radium contained in salts was about 4 grams, and 3.750 grams (in 8.650 grams of salts) had been produced in 1931, so that a total of about 46.789 grams (approximately 1 ½avoirdupois ounces) had been produced to the end of 1932. In 1932 1.876 grams and in 1931 0.797 gram were sold. In 1931, 15 grams of radium had been retained by the Ministry of Public Works and 7.4337 grams by physical laboratories, the Ministry of Health, and various state, university, and municipal hospitals—a total of

---

2 Toronto Mail and Empire, Mar. 19, 1933, p. 19.
4 Mining Truth (Spokane), Nov. 15, 1932, p. 9; Dec. 15, p. 4.
5 Cullen, William, The Northern Rhodesia Copper Fields: Min. Mag., vol. 48, 1933, p. 211.
8 Bliss, Don C., commercial attaché, Prague: Econ. and Trade Notes No. 204, Mar. 9, 1933.
22,4337 grams. As only 2,673 grams were exported of the 7,750 grams produced in 1931 and 1932 the quantity now in the country is apparently more than 27 grams.

In 1931 the ore required for the 3,750 grams of radium produced was 232 metric tons,\(^{13}\) which apparently was hand-picked to 28.65 metric tons. If similar ore was produced in 1932 about 248 tons would have been required. In 1930, 20.267 metric tons and in 1931, 19.063 metric tons of uranium pigments were made. Export sales are said to be made through a sales office at Frankfurt am Main, Germany "jointly with the Belgian products, on a quota scheme. The Belgian production contingent for ore is twice the amount of the Czechoslovak quota."\(^{14}\)

Australia.—Efforts are still being made to work the uncertain radium deposits on Mount Painter in the desert of South Australia. The Australian Radium Products, Ltd., was to take over the assets of the older Australian Radium Corporation, N.L.

Six tons of concentrates were made and sent to a reduction plant at Dry Creek, and "70 milligrams of radium salt" have been extracted and sold.\(^{15}\) The concentrates are said to carry 8 percent \(U_2O_8\).

Before the end of the year another reorganization was proposed after which the company was to be called Radium Products, Ltd., with a capital of £300,000 and to which the leases on the Mount Painter property were to be sold for £110,000 in paid-up shares.

The uranium minerals are autunite and torbernite. Little is known of the unoxidized minerals.

Germany.—A report from Consul Sydney B. Redecker, Frankfurt am Main, dated March 29, 1933, gives the following information:

Germany has a small output of radium salts, which is secured entirely from radioactive mineral springs rather than ore deposits.

The entire German output of radium from springs is furnished by the mineral springs at Kreuznach, in southwestern Germany, well known for their curative waters. These springs yield a deposit of silt or mud, and it is from this deposit that the radium salts are secured. On an average of around 20 tons of silt, or radio-barium, accumulate each year, and this deposit yields around 1.75 milligrams of radium per ton and in addition certain quantities of thorium and actinium.

Inasmuch as the deposits must in any case be removed from the curative waters, no special costs are involved in procuring them so far as radium recovery is concerned. It is profitable, therefore, despite the low yield, to work the deposits for the securing of radium salts and radium preparations. It is stated that other radioactive substances are not removed since they enhance the value of the medicinal preparation.

A second mineral spring containing radioactive substances is known to exist at Baden-Baden, the "Kloster" Spring, but the exploitation of radium has not been found profitable in the case of these springs due to their restricted flow and insufficient deposits of the radium-containing mud.

Russia.—It was announced that the "Moscow rare-metals plant has succeeded in producing radium on a factory scale" and that "the Commissariat for Heavy Industry has passed a resolution providing for further scientific research work in the field of rare metals."\(^{16}\)

The ore is tyuyamunite (\(CaO.2UO_3.V_2O_5+H_2O\))-bearing material from Tyuya Muyun Mountain, Fergana, Russian Turkestan.

\(^{13}\) 1 metric ton equals 2,204.6 pounds or 1,1028 short tons.
\(^{14}\) Don C. Bisson, commercial attaché, Prague. Quotation from "Narodin Listy", Mar. 7, 1933.
\(^{16}\) Economic Review of the Soviet Union, Mar. 1, 1932, p. 115.
It is also said that 5 tons of vanadium were produced in November at a plant in Kertch, Crimea by a process worked out by the Institute of Applied Mineralogy. The vanadium is extracted from titaniferous magnetite used in blast furnaces. The deposits in the Urals and in the Kuznetz Basin are said to be very large. Titanium also is extracted from the ores.

Nothing is known of the production of vanadium from the tyuymunite ores of Fergana.

Northern Rhodesia.—At Broken Hill, Northern Rhodesia, the Rhodesia Broken Hill Development Co., Ltd., late in 1930, completed a plant with a capacity of 50 tons per month for the production of fused vanadium oxide. The ore mineral used is mostly descloizite, but there is also some vanadinite; these minerals are found in the oxidized parts of the great lead-zinc deposits. Large stock piles of high-grade vanadium ore had been accumulated before the vanadium plant started operation. Operation began in January 1931 with an output of 10 long tons of fused oxide for the month. In July the output had increased to 25 long tons (28 short tons) per month and by January 1932 to 51 short tons of fused vanadium oxide carrying 90 percent $V_2O_5$. A monthly output of 100 tons of concentrates carrying 16 percent $V_2O_5$ was reached in the second half of the year.

The fused vanadium oxide and vanadium concentrates are sold in Germany and France and have furnished sufficient profit to carry the expense (£6,000 per month) of caring for the entire lead and zinc plant and to leave a small surplus.21

The output for the year 1932 was 676,806 pounds of contained vanadium in fused vanadium oxide carrying 90 percent $V_2O_5$ (about 671 short tons of fused oxide), nominally valued at 13s. ($2.28) a pound. In 1931, the output was 335,971 pounds of vanadium contained in 333 tons of fused oxide valued at £226,000.

Southwest Africa.—No data are at hand on the production of vanadium in Southwest Africa during 1932. In 1931 the production of concentrates amounted to 4,602 long tons (5,154 short tons) containing 17 percent vanadium pentoxide ($V_2O_5$). Exports of vanadium concentrates were 3,940 long tons in 1931 and 3,835 long tons in 1930.

Peru.—No shipments of vanadium ores are known to have been made from Peru either in 1931 or 1932.

RADIUM MEDICAMENT

Almost since the discovery of radium efforts have been made to use it in the treatment of disease, and many radium-bearing substances have been placed on the market for the treatment of bodily ills, for use as cosmetics, and particularly for use in drinking water.

During 1932 considerable public attention was attracted by a newspaper account of a wealthy man who died from drinking water into which a radioactive element had been introduced, and the tragedy focused attention on the fact that comparatively little is known either of the value or the danger of such preparations.

---

18 Mining Magazine (London), vol. 45, 1931, p. 128.
20 Rhodesian Mining Journal (Johannesburg), vol. 6, 1932, p. 159.
Schlundt, Fulton, and Bruner\textsuperscript{23} published the results of a study of three radium-water generators from which they concluded that the risk was "rather remote." No statement was made of any possible benefit to be derived from the use of radioactive water.

No experiments on the quantity of radium that might be beneficial or harmful are known to have been made\textsuperscript{24} on large animals, but Dr. Schlundt is now experimenting with white rats.

During 1932 prosecutions initiated by the Federal Trade Commission against makers of allegedly radioactive medicaments caused 2 or 3 companies to go out of business, and 2 cases were pending.

Dr. R. R. Sayers, former chief surgeon of the Bureau of Mines, canvassed the hospitals and physicians of the United States to learn how much radium was in use and how much more was thought to be needed.\textsuperscript{24} He found "710 individuals, companies, and hospitals, owning 124.7 grams of radium, estimate that they need 117.4 grams more. From the reports it is estimated that approximately 80,000 patients are treated annually with radium."


\textsuperscript{24} Sayers, R. R., Radium in Medical Use in the United States: Information Circ. 6667, Bureau of Mines, October 1932, 6 pp.