

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF RADIATION PROGRAMS-LAS VEGAS FACILITY  
P.O. BOX 15027, LAS VEGAS, NEVADA 89114  
(702) 736-2969 • FTS 585-2969

55212

DATE: FEB 16 1979

SUBJECT: Radium Refineries

FROM: Donald W. Hendricks, Director  
Office of Radiation Programs-LVF

*Donald W. Hendricks*

TO: Paul B. Smith  
Regional Radiation Representative  
U.S. EPA, Region VIII

This is to confirm our discussions of February 2, 1979, and subsequent days on the above subject. While looking for a reference in the University of Nevada library, I ran across three Bureau of Mines publications discussing early radium and uranium production in the Colorado Plateau region. These publications are:

1. A Preliminary Report on Uranium, Radium and Vanadium by R. B. Moore and K. L. Kithil. Bulletin 70. U.S. Bureau of Mines. October 1913.
2. Mining and Concentration of Carnotite Ores by K. L. Kithil and J. A. Davis, Bulletin 103. U.S. Bureau of Mines. October 1917.
3. Extraction and Recovery of Radium, Uranium, and Vanadium from Carnotite by C. L. Parsons et al. Bulletin 104. U.S. Bureau of Mines. November 1915.

Because these references mentioned several uranium ore processing locations and a Denver radium refinery of which I had no prior knowledge, I checked with you to see if you were aware of them. Review of these documents indicates the following items which seem to be noteworthy:

Bulletin 70

Page 19 Leaching vats were used in 1900 by Poulot and Voilleque to extract uranium at a copper mine at Cashin in Paradox Valley. They also built a small mill in the McIntyre District south of Paradox Valley. The mill produced at least 15,000 pounds of uranium oxide. It ran until 1902. In 1903 and 1904 it was operated by Western Refining Company. A new mill was built shortly afterwards by the

USR 001 0039

Delores Refining Company a short distance from the old mill and ran for a few years. The concentrate, which was obtained by the Engle process, retained uranium and vanadium but not radium. The mill was acquired by American Rare Metals Company from Delores Refining Company in 1912 and was operating in 1913.

Page 21 Standard Chemical Company had its headquarters and a large ore house at Coke Ovens (4 miles from Naturita). See map on Page 22.

Page 25 Standard Chemical Company had an ore house at Long Park.

Page 40 The author suggests that several operators could combine and treat their ore in a central plant. (In 1913 yet!!)

Page 43 In Gilpin County, near Central City, Colorado, five mines which were originally gold mines have produced pitchblende. The mines are the Kirk, the Wood, the German, the Belcher, and the Calhoun. Stamp mills and smelters were operated here.

Page 44 The Kirk lode carried gold, silver, copper, and pitchblende. Ore grade was up to 60 to 80 percent  $U_3O_8$ . Most of the high grade ore was sent abroad. Gold and pitchblende were not found in the same vein.

Page 45 The German mine produced some ore containing up to 80 percent while the Belcher produced some 30 percent ore. Gold and pitchblende were also not found in the same vein. The ore contains iron and copper pyrites as well as lead and zinc sulphides carrying gold and silver.

Page 46 The Calhoun was worked for gold. Only a small amount of pitchblende had been produced. The Wood mine was also mining primarily gold although some high grade pitchblende had been removed. The ore also carried lead, copper, silver, and zinc. Rejected low grade ore in the German mine carried 12 percent  $U_3O_8$ . A Kirk mine dump composite sample assayed 0.8 percent  $U_3O_8$ .

Page 56 All but a few tons of the uranium ore mined in this country was shipped abroad.

Page 74 The American Rare Metals Company of Denver used the Fleck process which appears to be a primitive acid leach process at its plant in the McIntyre district south of Paradox Valley. Uranium, vanadium, and radium concentrates were produced. The Primos Chemical Company of Newmire, Colorado, and Primos, Pennsylvania, roasted roscoelite ore which was stated to contain almost no uranium. (Since it is not clear what the authors' definition of low uranium content means, these locations may be worth examining.)

Bulletin 104

Page 10 The National Radium Institute began preliminary operation of its plant in Denver in March 1914 and began regular production of radium in 1914.

Page 11 Up to October 10, 1915 nearly 5 grams of radium element had been extracted.

Page 13 The radium produced was not for sale or distribution but was used in the Howard A. Kelly Hospital in Baltimore and the General Memorial Hospital in New York. \*  
7/55 F... H...  
"Lead... E..."

Pages 30-33 It is not clear from the text if the USBM process described was actually carried out at another location or at the National Radium Institute.

Page 34 Photographs of the plant are shown and a description of the buildings is given.

Page 44 "The main chemical control work and radium measurements, as well as the final refining of the radium has been done in the laboratories of the Bureau of Mines."

Page 73 The radium-barium sulphates were heated in a graphite crucible in an oil furnace and ground in ball mills. (One would expect the whole building to be thoroughly plated and dusted.)

Page 74 The radium bearing sulphide was leached with hydrochloric acid in an earthenware pot placed just outside the building.

Page 86 "...no serious losses of radium have ever occurred. Although a hood is not necessary, it would sometimes prove advantageous in carrying off acid fumes."

Page 107 "An average of 2.3 percent of the uranium oxide in the ore has remained in the residue, varying in different carload lots from a mere trace to about twice the average." Loss in the iron-calcium precipitate ranged from 5 percent of the uranium oxide in the original ore to 20 percent (in the early stages). The recovery of the uranium as sodium uranate ranged between 75 and 94 percent with a 10 carload average of 84.4 percent.

Page 109 "The unusually high recovery of 90 percent and over of the radium present gives the nitric acid method its real value."

Page 110 Ore averaged (for 21 carloads) 2.66 percent  $U_3O_8$ . (This would equate to about 7400 pCi/gram of radium. Percent radium recovery appears to have averaged about 91.3 percent. Residuals therefore should have about 640 pCi/gram of radium).

Page 112 "The total amount of radium discarded in connection with the fractionation of the first 1,646.26 milligrams of element crystallized was 5.13 milligrams, or 0.31%." In handling and drying the sulfates some small loss through loss of material as dust takes place. In reducing the sulphate with charcoal the evolved gases carry a small amount of sulfate with them. Liquors are occasionally spilt, and "creeping" sometimes takes place in the porcelain and silica vessels in the laboratory. ... with care the total losses may be kept down to between 1 and 2 percent. With less careful work they may rise as high as 3 percent."

Page 113 Probable radium losses are estimated at less than 2 percent.

Page 116 Up to August 1, 1915, 4,258 milligrams of radium sulphate was produced. All the uranium and vanadium was recovered by the National Radium Institute plant as sodium uranate or uranium oxide and iron vanadate.

Page 117 There was extracted 31,650 pounds of uranium oxide and 11,528 pounds of vanadium oxide.

### Bulletin 103

Page 7 The National Radium Institute which operated from June 1914 to January 1917 extracted about 8 1/2 grams of radium.

Page 39 Ore was sorted to two grades only: milling ore running from 0.5 to 1.25 percent  $U_3O_8$ , and shipping ore, averaging about 2 percent.

Page 40 Facing page shows photographs of concentrating uranium mill at Long Park, Colorado.

Page 48 Facing page shows additional photos of Long Park mill.

Page 52 The ore and concentrates shipped to the National Radium Institute contained about 69,000 pounds of  $U_3O_8$  and about 8.8 grams of radium.

Page 54 During the early stages of the mining operations, the National Radium Institute had its ore ground and sampled by other firms.

Page 55 The dust collected from a carload of 80,000 pounds of ore amounted to 1500 pounds or about 2 percent. The dust averages about 8 percent uranium oxide whereas the ore treated averages about 2.5 percent.

Page 61 A uranium mill was erected on the Maggie C claim (58 miles from Placerville and 15 3/4 miles from Naturita at the extreme western end of Long Park) by the National Radium Institute.

Page 64 The Long Park (Maggie C) mill was a dry concentrator.

Page 68 This page shows a flow sheet for the Long Park mill.

Page 72 The Long Park mill had a capacity of a little over 1 ton per hour. The milling ore had an average  $U_3O_8$  content of 0.85 percent  $U_3O_8$ . The total average of its four concentrates was 2.92 percent  $U_3O_8$ .

Page 73 The Long Park concentrator tailings averaged 0.37 percent  $U_3O_8$ .

Page 76 Up to August 1916 when operations were closed, 596,769 pounds of concentrates were produced at the Long Park mill.

Page 77 Since operations ceased at the Long Park mill because of contract expirations, tailings were left on the dump.

In an attempt to gather further information on the above milling and refining operations, I subsequently reviewed the radium and uranium sections of the U.S. Bureau of Mines yearbooks in the Minerals Resources of the United States series for the years 1910 through 1931.

From these I gleaned the following:

1910 Prior to 1910 there was no known U.S. radium extraction except on a small scale. At Newmire, Colorado, the Primos Chemical Company operated a plant and mill they took over from Vanadium Alloys Company in 1909. The mill processed roscoelite which was reported to have a low uranium content.

1911 The Standard Chemical Company shipped uranium ore to be treated at Cannonsburg, PA.

1912 At Central City, Colorado, ore with a 37.5 percent  $U_3O_8$  content was mined and sold for specimens and experimental purposes.

1913 The Standard Chemical Company of Pittsburgh, PA, and the Radium Company of America of Sellersville, PA, produced radium.

1914 The National Radium Institute, the Standard Chemical Company, and the Radium Company of America produced radium. Dr. W. A. Schlesinger started a radium refinery in Denver.

1915 Dr. W. A. Schlesinger established a radium reduction plant in Denver. He treated 5,000 pounds of  $U_3O_8$  containing 640 milligrams of radium from the Copper Prince and other claims. The Carnotite Reduction Company made up of Dr. H. N. McCoy (of the University of Chicago) and associates bought ore which was to be extracted in Chicago.

1916 It was thought that the National Radium Institute in Denver would probably be taken over by Pittsburgh Radium Company.

1917 The following companies engaged in the isolation of radium in 1917:

Carnotite Reduction Company (Dr. H. N. McCoy) 2600 Inglehart Court, Chicago, Ill.

Chemical Products Company, 616 Majestic Building, Denver, Colorado.

Colorado Radium Company, P.O. Box 1316, Denver, Colorado.

W. L. Cummings Chemical Company, Lansdowne, PA.

Radium Luminous Materials Corp., 55 Liberty Street, New York, NY. \*

Standard Chemical Company, Pittsburgh, PA.

U.S. Metals Reductions Company, Cheswick, PA.

1918 At Lusk, Wyoming, uranium was found in an old silver mine dump. Several cars of uranium ore were shipped to the Radium Company of Colorado at Denver. Chemical Products Company of Denver continued to isolate radium from uranite from Temple Rock, Emery County, Utah. The Standard Chemical Company was investigating the possibility of moving its radium plant from Pittsburgh to Denver. U.S. Metals Reduction erected a dry concentrator for carnotite ores on its claims just inside the Utah line not far southwest of Gateway, Colorado. Pitchblende was found in fluorspar deposits near Jamestown, Boulder County, Colorado. The ore contained 0.1 percent  $U_3O_8$  and 2 percent Pb.

1919 Tungsten Products Company of Boulder, Colorado began making ferrovandium and bought a considerable quantity of tailings from the Denver National Radium Institute from which the radium had been extracted. Standard Chemical Company made ferrovandium as a byproduct of radium ores.

1920 The Carnotite Reduction Company of Chicago was absorbed by the Radium Company of Colorado. A sampling plant for carnotite ores was built by Radium Ore Sampling Company at Montrose, Colorado.

1921 Tungsten Products Company was acquired by Carnotite Products which combined with Radium Company of Colorado. Radium was produced by Standard Chemical Company of Pittsburgh

Radium Company of Colorado, Denver \*

United States Corporation, 58 Liberty Street, New York

W. L. Cummings Chemical Company, Sixteenth and Arch Streets, Philadelphia

Keystone Metals Reduction Company, Cheswick, PA

1922 Four companies produced radium in 1922.

Standard Chemical Company, Pittsburgh, PA \*

U.S. Radium Corp., New York (plant at Orange, NJ)

Radium Corporation of Colorado, Denver, Colorado

Keystone Metals Reduction Company, Pittsburgh, PA, Keswick, PA

1923 The Standard Chemical Company isolated radium from accumulated material. It operated experimentally its mill (location not stated) for the concentration of radium bearing sandstone associated with the carnotite deposits. Bunker and Holmes isolated 1900 milligrams of radium from ores and residues which the company had on hand (location unstated). Pittsburgh Radium Corporation shipped its ores from Thompsons, Utah, to a plant it had established in the old cotton mill in Denver.

1924 The United States Company took over part of the claims controlled Radium Corporation of Colorado on the south side of Dry Wash, 22 miles NE of Monticello and 40 miles SE of Moab and erected a 20 ton/day capacity mill. The Standard Chemical Company had a mill on the San Miguel River 65 miles west and north of Placerville.

From the foregoing it would seem that there may be several mills and refineries that we have not previously identified. There would seem to be considerable work ahead in locating these sites and identifying any possible hazards at them.

cc:

Dr. W. A. Mills, ANR-458

Dr. R. J. Augustine, ANR-458

Mr. F. L. Galpin, ANR-461

Mr. R. Scarano, NRC

Mr. J. Deal, DOE/HQ

Mr. A. Hazel, Colorado

Mr. L. Anderson, Utah

Mr. P. Tedeschi, Region V

Mr. D. Langford, Region III

Mr. P. Giardina, Region II

Mr. D. Duncan, Region IX