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Raw Materials Activities of the Manhattan Project on the Colorado Plateau

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The Manhattan Project was a highly secret project during World War II to develop the atomic bomb, and included the acquisition of raw materials. It was carried out by the Army's Corps of Engineers Manhattan Engineer District. In the United States, 2,698,000 pounds of uranium oxide were acquired at various vanadium mills on the Colorado Plateau, mainly from the treatment of tailings. Geologic investigations conducted by a contractor, Union Mines Development Corporation, laid the ground work for the exploration activities of the Atomic Energy Commission which succeeded the Manhattan Engineer District in 1947.

KEY WORDS: Uranium; Manhattan project; Colorado plateau.

INTRODUCTION

Soon after the United States dropped atomic bombs on Hiroshima and Nagasaki, Japan on August 6 and 9, 1945, the public became aware of atomic energy and the Manhattan Project. The Manhattan Project was the code name used by the Army's Corps of Engineers for the development of atomic weapons and the procurement of the necessary raw materials during World War II. It was carried out under the direction of the Corps' Manhattan Engineer District (MED).

Prior to the establishment of MED, the nation's atomic research program was undertaken by the Office of Scientific Research and Development. With the entry of the United States into World War II, the work was assigned to the Corps of Engineers on June 19, 1942 (Jones, 1958). The Corps immediately began plans to form a new district to carry on the work. DSM (Development of Substitute Materials) was first proposed as the name for the new district (Jones, 1958). To many, DSM seemed likely to arouse attention and curiosity, and instead the Manhattan Engineer District was established on August 13, 1942.

The name was taken from District Engineer, Colonel James C. Marshall's office, in New York City (Jones, 1958). In mid-August of 1943 the headquarters of MED was transferred to Oak Ridge, Tennessee, and Lieutenant Colonel Kenneth D. Nichols was made District Engineer (Jones, 1958). Brigadier General Leslie R. Groves in Washington, D.C., was responsible for the entire project.

The names of places such as Oak Ridge, Tennessee; Los Alamos, New Mexico; and Hanford, Washington, that were associated with the project became well known. The raw materials activities of the undertaking were largely overlooked. This brief historical review summarizes those activities on the Colorado Plateau.

URANIUM PROCUREMENT

Raw materials for the project were critical. In 1942 the largest available sources of uranium were the Shinkolobwe Mine in the Belgium Congo (now Zaire) and the Eldorado Mine at Port Radium on Great Bear Lake, Northwest Territories, Canada. In the United States, uranium was known to occur in the carnotite deposits in the Salt Wash Member of the Morrison Formation on the Colorado Plateau.

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These deposits, principally in southwestern Colorado and southeastern Utah, had been mined for radium from about 1910 to 1926, with some uranium and vanadium recovered as byproducts. Since 1936 the same deposits had been mined for vanadium. At the Naturita and Uravan, Colorado vanadium mills, large tonnages of tailings containing low concentrations of uranium were stockpiled.

Due to the uncertainty of foreign supplies and the need for vanadium for war armaments, the federal government formed the Metals Reserve Company in December 1941. Metal Reserve's objective was to acquire five million pounds of vanadium for the War Production Board's stockpile. Metal Reserve, which was part of the Reconstruction Finance Corporation (RFC), began an ore-purchasing program, increasing the base price paid for vanadium ore. At Durango, Colorado, Metals Reserve spent $95,000 to equip an abandoned lead smelter for the production of 1.5 million pounds of vanadium oxide (V_2O_5) per year. At Monticello, Utah, Metals Reserve took over the operation of a vanadium mill (Metals Reserve Company, 1943).

Sources of Uranium

In September 1942, MED created a Materials Section to oversee the procurement of uranium. Lieutenant Colonel Thomas T. Crenshaw was in charge of the Section. In August 1943, the Madison Square Area Office was formed to carry on this function. Colonel Crenshaw was transferred to Oak Ridge and Lieutenant Colonel John C. Ruhoff was appointed Area Engineer. In early 1945, he was succeeded by Major Wilber E. Kelley (Jones, 1958).

A survey of the vanadium activities on the Colorado Plateau by Materials Section personnel in December 1942, led to contracts with the two largest vanadium producers, United States Vanadium Corporation and Vanadium Corporation of America, and with the Metals Reserve Company. The uranium-producing activities of these organizations are discussed in the following section by geographic locality.

Grand Junction, Colorado

On March 23, 1943, Second Lieutenant Philip C. Leahy arrived in Grand Junction to establish the Colorado Area Engineer Office. Leahy's orders were to contact Blair Burwell, General Manager of U.S. Vanadium Corporation (USV). Burwell informed Leahy the Army and USV were to build tailings treatment plants at Durango and Uravan, Colorado, and acquire land at Grand Junction for a uranium refinery (P.C. Leahy, personal communication, 1993). Also with his orders was a letter from General Groves stating "to whom it may concern—if this officer asks for help, please assist."

A 55.71 acre tract of land was leased between the Gunnison River and the Denver and Rio Grande Western Railroad, two miles south of the city. The site was a gravel pit with a railroad spur line and contained a log cabin. On this site, MED contracted with USV to build and operate a small uranium refinery on a cost-plus-fixed fee basis. The Stearns-Roger Manufacturing Company of Denver, Colorado, designed and built the refinery. The log cabin became the refinery's office. A plan of the Grand Junction refinery is shown in figure 1.

The purpose of the refinery was to further concentrate uranium and to remove vanadium from the green sludge which was received from tailing treatment plants at Durango and Uravan. A low grade uranium concentrate from the refinery was shipped to Tonawanda, New York for further processing into black oxide (Hewlett and Anderson, 1962). The flowsheets of the tailings plants and the refinery are shown in figure 2.

On August 14, 1943, the War Department purchased the Grand Junction site. A Mr. L. H. Hall was paid $10,500 for the property, which was to be used for Project X, according to the deed in the Mesa County Courthouse.

The Grand Junction plant operated from 1943 to 1946. The green sludge shipped to the refinery from Durango and Uravan came from the processing of some three million tons of tailings. The Grand Junction refinery recovered more vanadium from the green sludge than the entire Metals Reserve program actually purchased (P. C. Leahy personal communication, 1993). The acquisition of land along the Gunnison River and the establishment of an office in Grand Junction in 1943 by the federal government would have a great economic impact on the city for many years afterward.

Uravan, Colorado

The mill at Uravan had operated since about 1914, first for radium, and then for vanadium processing. It

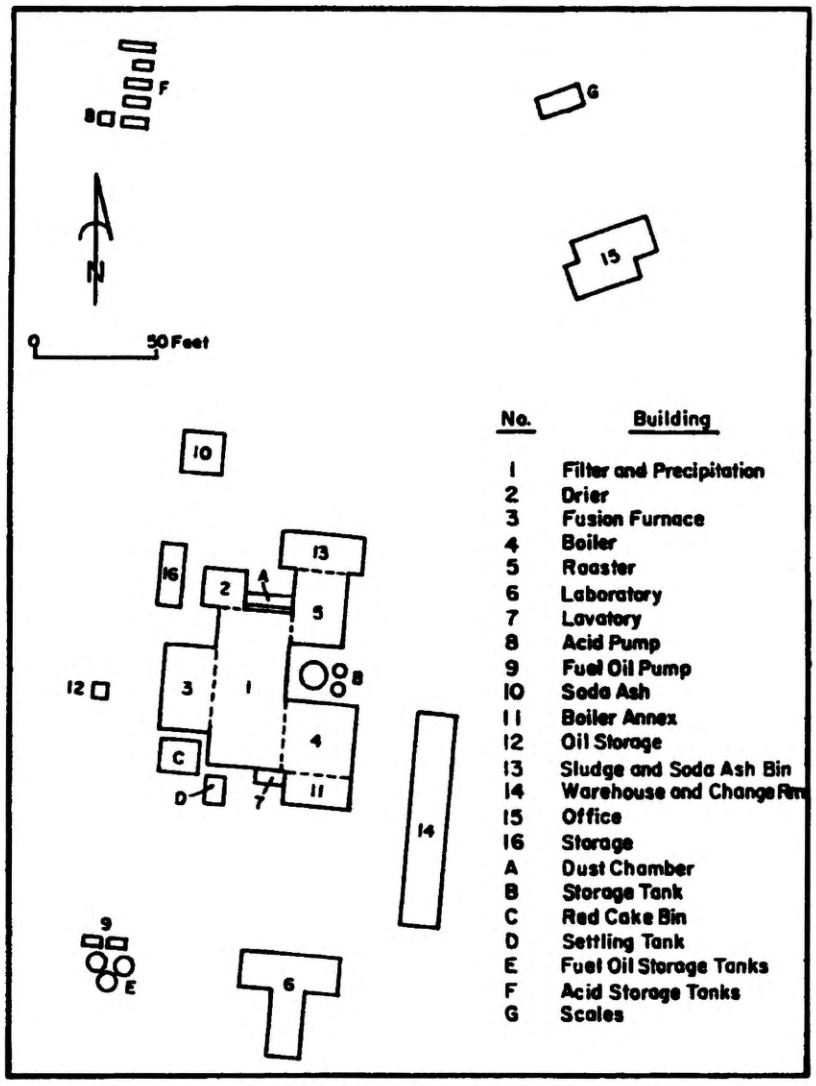

Figure 1. Map of the Grand Junction refinery, from AEC files.

was acquired by United States Vanadium Corporation (USV) in 1928 from Standard Chemical Company (Huffard, 1929).

In 1939, prior to the establishment of MED, USV built a small pilot plant at the Uravan mill which could produce a 20% uranium oxide (U_3O_8) sludge from the treatment of tailings (Merritt, 1945). Late in 1942, MED contracted with the Linde Air Products Company to build a pilot refinery at Tonawanda, New York, and to produce black uranium oxide from the Uravan sludge (Merritt, 1945). MED would purchase the sludge on a unit price basis as received at Tonawanda. Both USV and Linde were subsidiaries of Union Carbide and Carbon Corporation, a major contractor to MED at Oak Ridge, Tennessee. Late in 1943 the Linde refinery was enlarged to process low-grade Belgium Congo ores until the end of 1944 (Hewlett and Anderson, 1962).

In order to increase production, MED contracted with USV to build and operate, at their own expense, a uranium-vanadium sludge plant. This plant would replace the pilot plant in mid-1943. Feed for the plant would be stockpiled tailings and tailings from the current USV vanadium operations (Manhattan District Engineers, 1948a). Also at Uravan, the MED contracted with USV to construct and operate a uranium-

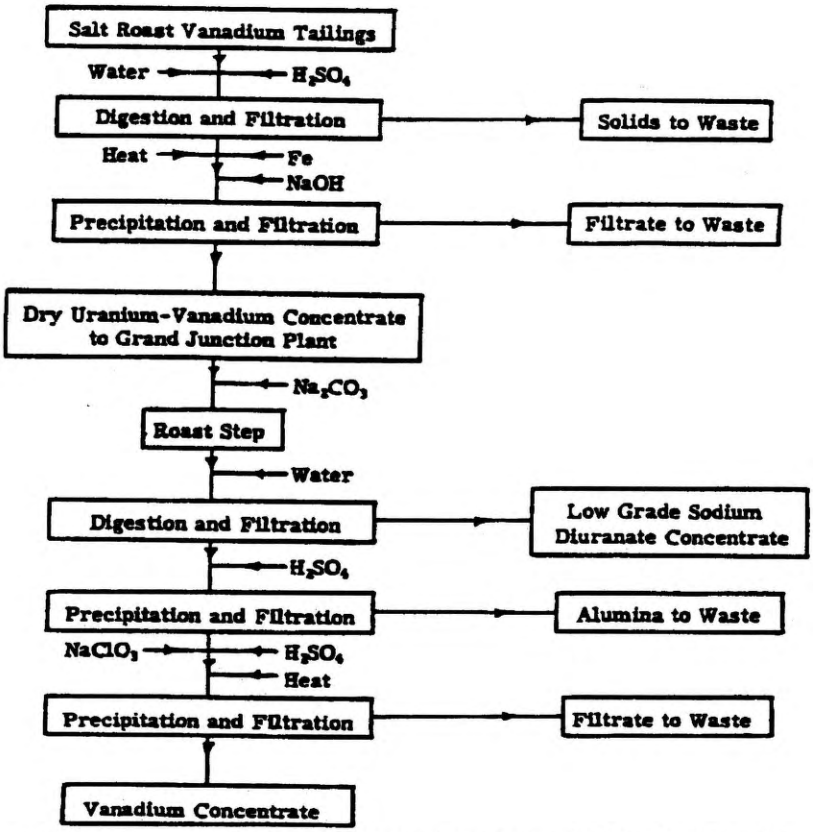

Figure 2. Flowsheets of the MED tailings treatment plants and refinery, from Lunquist and Lake (1955).

vanadium sludge plant on a cost-plus-fixed-fee basis. The plant was designed and built by the Stearns-Roger Manufacturing Company. Feed for the plant consisted of stockpiled tailings at Uravan, tailings purchased from the Vanadium Corporation of America (VCA) at Naturita, and tailings purchased from other small vanadium mills (Manhattan District of Engineers, 1948a). The tailings were purchased by MED at a unit price, based on recoverable U_3O_8 and vanadium oxide (V_2O_5) obtained the MED's refinery in Grand Junction. The tailings treatment plants operated from 1943 to 1945.

Naturita, Colorado

Built by the Rare Metals Company about 1930, the Naturita plant was operated until about 1939 when it was purchased and rebuilt for vanadium production by the Vanadium Corporation of America (Merritt, 1971). In 1942, the MED contracted with VCA to produce a uranium–vanadium sludge from their existing operations at the Naturita mill. The sludge, containing 45%–50% U_3O_8, was sold to MED on a unit price basis and was shipped to the Vitro Manufacturing Company at Canonsburg, Pennsylvania. At Vitro, a substantial portion of the high-grade Belgian Congo ores and all the VCA sludge were processed (Hewlett and Anderson, 1962). The tailings, at Naturita, resulting from the manufacture of the sludge, were considered too low-grade for further processing (Merritt, 1945). MED also contracted with VCA to buy the stockpile of vanadium tailings from past operations. These tailings were treated at the MED plant at Uravan, Colorado (Manhattan District Engineers, 1948a).

Durango, Colorado

In 1942, the Reconstruction Finance Corporation, a government agency, contracted with USV to convert

and operate an old lead smelter for vanadium production. The vanadium was supplied to Metals Reserve Company. USV operated the plant for the government until February 29, 1944, when the government vanadium purchasing program was terminated because of adequate stocks. USV purchased the facilities from the Reconstruction Finance Corporation in August and operated them for the production of vanadium for commercial sales until August 31, 1945, when the plant was closed (Albrethsen and McGinley, 1982).

During the 1943–1945 period, USV operated a uranium–vanadium sludge plant at the Durango site, under a cost-plus-fixed-fee agreement with the MED. Stearns-Roger also built this plant. Feed for the plant consisted of vanadium tailings from past and current operations. During the time Metals Reserve controlled the plant, MED purchased the tailings for USV to reprocess. The sludge was shipped to the MED refinery at Grand Junction, Colorado (Manhattan District Engineers, 1948a).

Gateway, Colorado

MED purchased some 3,000 tons of tailings owned by Metals Reserve at a mill at Gateway, Colorado (Merritt, 1945). The tailings were trucked to Uravan for reprocessing at the MED plant.

Rifle, Colorado

MED determined that the tailings at USV's Rifle vanadium mill were too low in uranium for reprocessing (P.C. Leahy, personal communication, 1993).

Monticello, Utah

In late 1940, the VCA opened a vanadium ore buying station at Monticello, Utah, in order to stimulate mining in the area. Within a short time, ore production increased sufficiently to justify construction of a vanadium mill. In September 1941, the War Production Board approved VCA's proposal to build a mill. Funding was provided through the government's Defense Plant Corporation. The plant was to be operated by VCA for Metals Reserve. Actual construction started in February, and on August 24, 1942, the first vanadium was produced (Albrethsen and McGinley, 1982).

In January 1943, Metals Reserve Company (MRC) agreed to produce a uranium–vanadium (U–V) sludge at Monticello that was sold to MED on a unit price basis. The sludge which contained 45–50% U_3O_8 and about 25% V_2O_5 was shipped to the Vitro Manufacturing Company at Canonsburg, Pennsylvania, for additional processing (Hewlett and Anderson, 1962). Tailings from the Monticello mill were considered to be too low in uranium for additional processing (Merritt, 1945). On February 29, 1944, MRC closed the Monticello mill and ceased production of both fused vanadium oxide (V_2O_5) and the U–V sludge. During its vanadium program on the Colorado Plateau, MRC acquired six million pounds of V_2O_5 for the government stockpile (Metal Reserve Company, 1943).

In 1945, VCA leased the Monticello mill from the Defense Plant Corporation and purchased the remaining ore stockpiles from MRC. VCA processed the stockpiled ore plus ore from other sources, and sold a U–V sludge to the MED until the mill closed again in 1945 (Albrethsen and McGinley, 1982).

Moab, Utah

The Vitro Manufacturing Company, through its local ore buyer, Howard Balsley, had been acquiring high-grade carnotite ores for the manufacture of ceramic colors, etc. MED contracted with Vitro to purchase their Moab stockpile of high-grade ore containing approximately 52,000 pounds of U_3O_8 (Manhattan District Engineers, 1948a). This high-grade ore was processed at the Grand Junction refinery (P.C. Leahy, personal communication, 1993).

Other Areas

MED contracted with vanadium mills at Blanding, Utah, Loma, and Slick Rock, Colorado to purchase their tailings for reprocessing at Uravan.

By January 1, 1947, the MED had acquired 2,648,000 pounds of domestic uranium oxide at a cost of $2,072,330 (Table 1). This calculates to an average price of $0.77 per pound U_3O_8.

MED acquired a total of 18,938,000 pounds U_3O_8 for the Manhattan Project (Table 2). Domestic sources on the Colorado Plateau accounted for 14% of the total uranium acquired. Lieutenant Leahy had no idea what the uranium was being used for. On July 17, 1945, the day after the first bomb was exploded in New Mexico,

Table 1. Domestic Sources of Uranium[a]

Company	Pounds U_3O_8	Cost
U.S. Vanadium Corporation	1,782,000	$ 941,800
Vanadium Corporation of America	460,000	692,350
Metals Reserve Company	270,000	216,300
Vitro Manufacturing Company	52,000	71,880
Others	134,000	150,000
TOTAL	2,698,000	$2,072,330

[a] Manhattan District Engineers (1948a).

Leahy's office and USV's office received telegrams from General Groves stating "MED's mission had been accomplished" (P.C. Leahy, written communication, 1994). Only after the bombing of Japan did they learn of the atomic bombs. After the war ended, the sludge plants at Durango and Uravan were torn down and the equipment sold. The Colorado Engineer's office was closed in March 1946. At that time, the refinery still had six months work to do on the sludges (P.C. Leahy, written communication, 1994).

URANIUM RESOURCE INVESTIGATIONS

In February 1943, MED decided it needed to learn as much as possible about the uranium and thorium resources of the world. Rather that establish a new agency, MED decided to use the services of an existing organization (Groves, 1962). Union Carbide and Carbon Corporation was a prime contractor to MED at Oak Ridge, Tennessee. A subsidiary, United States Vanadium Corporation was a supplier of uranium to the project. With such a background, Union Carbide agreed to undertake the resource evaluation assignment (Groves, 1962), and Union Mines Development Corporation (UMDC) was created. A contract No. W-7405 Eng-78, effected May 11, 1943, provided that all costs should be reimbursed by the government, with no fixed fee or profit to UMDC (Manhattan District Engineers, 1948b).

To oversee the resource appraisal activities of UMDC, the MED created the Murray Hill Area Office in New York City on June 15, 1943. Lieutenant Colonel Paul L. Guarin served as Area Engineer from June 1943 until March 1946. He was succeeded by Lieutenant Colonel A.W. Oberbeck who served as Area Engineer for about one month, until the Murray Hill Area was absorbed by the Madison Square Area in April 1946 (Manhattan District Engineers, 1948b).

Table 2. Sources of Uranium[a]

Area	Pounds U_3O_8	Cost
Colorado plateau	2,698,000	$ 2,072,330
Eldorado mine	2,274,000	5,082,300
Shinkolobwe mine	13,966,000	19,381,600
TOTAL	18,938,000	$26,072,330

[a] Manhattan District Engineers (1948a).

Organization of Union Mines Development Corporation

Union Mines set up offices in June 1943 on the 18th floor at 50 East 42nd Street in New York City and immediately began the recruitment of personnel. James R. Van Fleet was selected as president of Union Mines. Due to the extreme secrecy of the project, UMDC operated under the pretense of a large international mining company, interested in tungsten, molybdenum, and vanadium (Manhattan District Engineers, 1948b).

Operations of UMDC were performed by four divisions: bibliographic search, field exploration, exploration research, and metallurgical research.

The Bibliographic Search Division did the examination of all available literature and the preparation of reports on all recorded occurrences of uranium ores. About 67,000 volumes were examined, more than half were in foreign languages.

The Field Exploration Division sent out field parties of geologists and mining engineers who made examinations in more than 20 foreign countries and in 36 states in this country.

The Exploration Research Division dealt with the development of information and methods for field exploration, in two principal fields: research as to the applicability of geophysical methods of prospecting, and mineralogical research.

The geophysical research was concerned with the development of improved portable models of Geiger-Muller counters for field use, procedures for the use of these counters for quantitative or semiquantitative assaying, laboratory counters for accurate quantitative assays, and radioactive methods of locating and measuring ore reserves.

The mineralogical research was carried out first in the laboratories of the Union Carbide and Carbon

Corporation at Niagara Falls, New York, and later, in a laboratory established at the New York offices. This work resulted in the development of a device for measuring the maximum sensitivity of the bead test, which was the standard chemical method of testing for the presence of uranium. Research determined that lithium fluoride be used instead of sodium fluoride as a flux in the bead test.

The Metallurgical Research Division devoted its first efforts to the development of suitable processes for concentrating carnotite ores from the Colorado Plateau region, but before their work was finished, they had done work on nearly every type of uranium ore occurring throughout the world. The Division made a working agreement with the Denver Equipment Company, Denver, Colorado, whereby the research investigations were carried on in that company's laboratories, with the use of the company's facilities and many of its personnel.

Geologic Studies

The majority of the work of the Field Exploration Division was carried out on the Colorado Plateau. A field office was established in Grand Junction, Colorado, in July 1943, with Benjamin N. Webber, as Chief Field Geologist (Van Fleet, 1944). The MED liaison person in the UMDC office was Frank Belina, a civilian mining engineer.

After a brief geological training period by geologists of USV, fieldwork by UMDC geologists began on July 28, 1943, on the Navajo Indian Reservation. By February 1, 1944, the Grand Junction Field Office had a staff of 48 geologists and engineers, divided into 11 field parties, plus a small administrative force (Van Fleet, 1944).

Geologic work on the Colorado Plateau was limited to the Salt Wash Member of the Morrison Formation, and the Entrada Sandstone in the areas where the uraniferous vanadium deposits were located, such as Rifle, Placerville, and Rico, Colorado. The Chinle Formation was studied only in the Temple Mountain, Utah area, since it was the sole area of radium production in the 1910s and 1920s from the Chinle (Murphy, 1944).

All known exposures of the Salt Wash Member were prospected and mapped. Exposures of carnotite-bearing minerals, prospects, and mines were all mapped and described. Ore reserves were calculated from samples collected from outcrops and mines. Areas where reserves could be developed by additional drilling were especially noted. Stratigraphic sections of the Morrison and adjacent formations were measured throughout the Colorado Plateau. All of this work was done under the disguise of looking for vanadium.

Although the reports of the UMDC geologists were classified as SECRET by the MED, they could not contain the word uranium. Hence, special codes were used: S-37 were uranium minerals; SOM was uranium; and SOQ was uranium oxide (U_3O_8). A typical description of an occurrence was, "... 31 ft. long outcrop, avg. thickness 3.2 ft. of vanadium with some weakly disseminated S-37. Avg. grade estimated to be better than 1% V_2O_5 and 0.25% SOQ. Horizon about 42 ft. above base of Salt Wash. Sample 3513 cut."

UMDC geologists also collected historical production information on the mines which had been active during the radium and vanadium eras. From all available information, Union Mines personnel estimated the pre-1946 vanadium production of the Colorado Plateau had been 1,348,942 tons of ore averaging 1.87% V_2O_5 and containing 50,336,225 pounds V_2O_5 (Webber, 1947, fig. 59).

Using information from chemical assays of 3,000 channel samples and a limited amount of drill holes provided by U.S. Vanadium Corporation and North Continent Mines, Inc., Union Mines geologists calculated ore reserves for the Colorado Plateau. Reserves were classified as positive, indicated or inferred. Individual blocks were tabulated by their average grades. Grade 1 was 0.15% U_3O_8 or better; Grade 2 was 0.08–0.15% U_3O_8; and Grade 3 was 0.005–0.08% U_3O_8.

The combined total of Grades 1 and 2 for the positive, indicated and inferred blocks for the Colorado Plateau was 4,125,128 tons of ore with an average grade of 0.20% U_3O_8 and containing 16,500,512 pounds U_3O_8 (Webber, 1947, fig. 73). Webber also indicated that he believed the geologic potential could add an another four million pounds U_3O_8 to the Colorado Plateau resources.

The ore reserves were distributed as follows: Colorado, 12,370,826 pounds U_3O_8; Utah, 3,679,311 pounds; Arizona, 441,135 pounds; and New Mexico, 9,240 pounds U_3O_8 (Webber, 1947). All of the reserves were in the Salt Wash Member of the Morrison Formation with the exception of a small amount in the Chinle Formation at Temple Mountain, Utah and a smaller amount in the Entrada Sandstone at Rifle, Placerville, and Rico, Colorado. Since Union Mines was known to be affiliated with U.S. Vanadium Corporation, their competition, Vanadium Corporation of America, would not give Union Mines geologists access to their

mines. Hence, no reserves were calculated for VCA properties. UMDC recommended areas to be drilled to increase the ore reserves, but MED never approved this exploration.

Fieldwork on the Colorado Plateau was curtailed in early 1946. When the work was completed later that year, some 44 separate geological reports had been written for the Colorado Plateau localities. These included three reports for Arizona, 18 for Colorado, one for New Mexico, and 22 for Utah. The geologic investigations of UMDC were summarized in a report by Webber (1947).

Land Acquisition

As part of their investigations, UMDC geologists recommended areas that should be acquired by the federal government for the development of uranium resources. On the Colorado Plateau, UMDC acquired three properties: a 960-acre Navajo Indian lease in the Carrizo Mountains of northeastern Arizona, held by Curran Brothers and Wade-USV; 42 unpatented claims of Gateway Alloys Co. on Calamity Mesa, in Mesa County, Colorado; and the holdings of North Continent Mines, Inc. at Slick Rock, San Miguel County, Colorado. The latter included a campsite, small mill, 82 patented and unpatented claims, and miscellaneous mining equipment. The total acquisition cost of the three properties was $276,000 (Manhattan District Engineers, 1948b).

Although the U.S. Vanadium's and Lt. Leahy's offices were only two blocks away from the UMDC offices, in downtown Grand Junction, he did not know of the activities of UMDC until the war was over (P.C. Leahy, written communication, 1986). This shows the "need to know" attitude that was prevalent during the Manhattan Project.

SUMMARY

During World War II, the Manhattan Engineer District, under the direction of the Army Corps of Engineers, was charged with the development of atomic weapons. Its activities included research and development, engineering and design, the operation of production facilities for weapons materials and components, and the acquisition of uranium for the production of nuclear weapons.

All of these MED functions, and the numerous government-owned facilities in which many of them were performed, were transferred to the U.S. Atomic Energy Commission (AEC) by Executive Order 9816, effective at midnight, December 31, 1946 (Jones, 1958). The creation of the AEC transferred the development of atomic energy from a secret military organization to a civilian agency, whose general activities were a matter of public record.

Uranium procurement that was done secretly by the MED was continued by the AEC, but that agency's need for uranium was made public. The price schedules, bonuses, and other incentives of the AEC, created a prospecting effort unsurpassed in any other metal.

The geologic reports and maps of UMDC provided the foundations of the exploration activities of the newly created AEC. These documents were found to be extremely thorough by AEC geologists, as very few mineralized outcrops in the Salt Wash were missed by UMDC. Recommendations by UMDC geologists were the basis of planning many AEC drilling projects throughout the Colorado Plateau.

When the AEC first published historic ore reserve information, the agency (U.S. Atomic Energy Commission, 1968) listed the reserves for the United States in 1947 as 4,400,000 pounds U_3O_8. The AEC apparently used only Union Mines' positive and indicated classes of Grades 1 and 2 to arrive at this conservative figure.

Unfortunately, the maps and reports were not declassified and made available to the public until the late 1950s and early 1960s. By that time, the uranium boom had peaked, and it was too late for the prospector or company geologist to benefit from this massive compilation of geological data. Since Union Mines Development Corporation was connected to U.S. Vanadium Corporation, Section 68, of the Atomic Energy Act of 1946, prohibited USV and its successor, Union Carbide Nuclear Corporation, to use any information developed by Union Mines to acquire public lands for uranium exploration.

The Navajo lease in Apache County, Arizona and the claims in Mesa and San Miguel Counties, Colorado, were leased for mining by the AEC in 1949. The Navajo lease was canceled in June 1961 and the land returned to the Navajo Nation. The claims in Colorado are now controlled by the Department of Energy and are leased to mining companies. The mill site at Slick Rock was never used by the AEC and was sold to Union Carbide Corporation in November 1957 (Albrethsen and McGinley, 1982). The Gunnison River

site became the headquarters for the AEC's uranium procurement and exploration activities in the western United States. The refinery was dismantled, but the log cabin (figure 1, no. 15) became the manager's office, and is still in use today by the Department of Energy. The former warehouse and change room (figure 1, no. 14) also are in use today as offices.

ACKNOWLEDGMENTS

Recollections by Major (retired) Philip C. Leahy, Colorado Area Engineer for the Manhattan District, greatly augmented the uranium procurement section of this report. He passed away on February 11, 1996 in Boise, Idaho at the age of 83.

REFERENCES

Albrethsen, Holger, Jr., and McGinley, F. E., 1982, Summary history of domestic uranium procurement under U.S. Atomic Energy Commission contracts, final report: U.S. Department of Energy, Report GJBX-220(82), 162 p.

Groves, L. R., 1962, Now it can be told, the story of the Manhattan Project: Harper and Brothers, New York, New York, 484 p.

Hewlett, R. G., and Anderson, O. E., Jr., 1962, The new world, 1939–1946, volume 1, a history of the United States Atomic Energy Commission: The Pennsylvania State University Press, University Park, Penn., 766 p.

Huffard, J. B., 1929, Corporation acquires additional vanadium property in Colorado: Union Carbide and Carbon Corp., The Carbidea, February 1929, p. 5–6.

Jones, V. C., 1958, United States Army in World War II, special studies, Manhattan: the Army and the atomic bomb: U.S. Army Center of Military History, Washington, D. C., 660 p.

Lunquist, A. Q. and Lake, J. L., 1955, History and trends of uranium plant flowsheets: Mining Congress Journal, v.41, n.11, p. 35–42.

Manhattan District Engineers, 1948a, Manhattan District history, book VII, volume 1, feed materials and special procurement: U.S. Army Corps of Engineers Report, Declassified by AEC in 1961.

Manhattan District Engineers, 1948b, Manhattan District history, book VII, volume 2, geographical exploration: U.S. Army Corps of Engineers Report 43 p., Declassified by AEC in 1961.

Merritt, P. L., 1945, Resume of production of uranium products for Manhattan District in the Colorado Plateau area: War Department, U.S. Engineer Office Report RMO-974, 6 p., Open-filed by DOE, 1983.

Merritt, R. C., 1971, The extractive metallurgy of uranium: Colorado School of Mines, Research Institute, Golden, Colorado, 576 p.

Metal Reserve Company, 1943, Vanadium commitments: Metals Reserve Company report in the National Archives, 4 p.

Murphy, F. M., 1944, Report on Temple Mountain district, San Rafael Swell area, Utah: Union Mines Development Corp. Report RMO-468, 72 p., Declassified by AEC in 1958.

U.S. Atomic Energy Commission, 1968, Statistical data of the uranium industry, January 1, 1968: U.S. Atomic Energy Commission Report GJO-100, 27 p.

Van Fleet, J. R., 1944, Summary of Union Mines Development Corporation investigations to February 1, 1944: Union Mines Development Corp. Report, 15 p., Declassified by AEC in 1961.

Webber, B. N., 1947, Geology and ore resources of the uranium–vanadium depositional province of the Colorado Plateau region: Union Mines Development Corp. Report RMO-437, 279 pl, 73 figs., Declassified by AEC in 1959.