RAW MATERIALS ACTIVITIES OF THE MANHATTAN PROJECT IN NEW MEXICO

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INTRODUCTION

Forty years ago, after the detonation of three atomic bombs, 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. The project was carried out under the direction of the Corps' Manhattan Engineer District (MED).

The MED was established in August 1942. The name was taken from District Engineer, Colonel John C. Marshall's office, in New York City (Hewlett and Anderson, 1962, p. 81). In the summer of 1943 the headquarters of MED was transferred to Oak Ridge, Tennessee, and Lieutenant Colonel Kenneth D. Nichols was made District Engineer (Hewlett and Anderson, 1962, p. 117). Brigadier General Leslie R. Groves in Washington, D.C., was responsible for the entire project.

In New Mexico, the names of places such as Los Alamos and Mockingbird Gap that were associated with the project, became well known. The raw materials activities of the project were largely overlooked. This brief historical review summarizes those activities in New Mexico.

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, and the Eldorado Mine on Great Bear Lake, Northwest Territories, Canada. In the United States, uranium was known to occur in the carnotite deposits in the Morrison Formation on the Colorado Plateau.

These deposits, principally in southwestern Colorado and southeastern Utah, had been mined for radium from about 1910 to 1924, 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 had been stockpiled.

A survey of the vanadium activities on the Colorado Plateau by MED in December 1942, led to contracts with the two largest vanadium producers, United States Vanadium Corporation and Vanadium Corporation of America, and with the government agency, the Metals Reserve Company, which was part of the Reconstruction Finance Corporation (U. S. Department of Energy, 1982, p. 1).

Due to the uncertainty of foreign supplies and the need for vanadium for war armaments, the federal government formed the Metals Reserve Company (MRC) in 1942. The company began an ore-purchasing program and increased the base price paid for vanadium ore. At Monticello, Utah, the Defense Plant Corporation, a government agency, funded the construction of a vanadium plant to be operated by the Vanadium Corporation of America (VCA) for Metals Reserve. Actual construction started in February, and on August 24, 1942, the first vanadium was produced (Albrethsen and McGinley, 1982, p. A-91).

In January 1943, Metals Reserve Company agreed to produce a uranium-vanadium (U-V) sludge at Monticello that was sold to MED on a unit price basis. The sludge contained 45 to 50% U_3O_8 and about 25% V_2O_5 and was shipped to the Vitro Manufacturing Co. at Canonsburg, Pennsylvania, for additional processing. Tailings from the Monticello mill were considered by the MED to be too low in uranium for additional processing (Merritt, 1945, p. 4). In February 1944, MRC closed the Monticello mill and ceased production of both fused vanadium oxide (V_2O_5) and the U-V sludge.

In 1945 VCA leased the Monticello mill from the Defense Plant Corporation and purchased from MRC the remaining ore stockpiles. 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 1946. (Albrethsen and McGinley, 1982, p. A-92). The price paid by MED for the Monticello sludges were $1.10 per pound for U_3O_8 and $0.90 per pound for V_2O_5 (U.S. Department of Energy, 1982, p. 4).

Since the government had established a market for vanadium, and the Navajo Indian Reservation was once again open for prospecting and mining, the carnotite deposits in the Morrison Formation of the Carrizo Mountains were of interest to mining companies. At a competitive lease sale held in June 1942, VCA was the highest bidder for some 104 square miles of land in the eastern Carrizo Mountains. Ores from this lease were hauled to the MRC plant at Monticello, Utah which was operated by VCA.

Records of the General Services Administration (1981) show that between August 1942 and August 1944, some 10,201 tons of ore containing 503,617 pounds vanadium oxide (V_2O_5) were mined from the eastern Carrizo Mountains, with an exception of a minor amount; all came from New Mexico.

By using a uranium to vanadium ratio of 1:8, based on the 1948 shipments from this same lease, and an estimated recovery factor of 70%, I estimate that some 44,000 pounds of uranium oxide (U_3O_8) from New Mexico vanadium ores went into the manufacture of the first atomic weapons.

ORGANIZATION OF UNION MINES DEVELOPMENT CORPORATION

Early in 1943, MED decided it needed to learn as much as possible about the uranium and thorium resources of the world. Rather than establish a new agency, MED decided to use the services of an existing organization (Groves, 1962, p. 180). 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, p. 180), 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, 1947, p. 1.1.).

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, 1947, p. 5.5-5.6).

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. Due to the extreme secrecy of the project, UMDC operated under the pretense of a large international mining company, interested in tungster, molybdenum and vanadium (Manhattan District Engineers, 1947, p. 1.6).

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. Minerals of New Mexico (Northrop, 1942) was the principal source of information on New Mexico.

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. A field test of a portable geiger counter in New Mexico is described by Keith (1945b).

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 floride be used instead of sodium fluoride as a flux in the bead test. Studies on the mineralogy of the White Signal district ore are given in a report by George (1955).

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 Co., 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. The results of work on samples from New Mexico are contained in reports by Handley (1945, 1946).

The majority of the work of the Field Exploration Divisior was 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, p. 4).

After a brief geological training period by geologists of the United States Vanadium Corporation, field work 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, p. 4).

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 it contained vanadium deposits, such as at Rifle, Placerville, and Rico, Colorado. The Chinle Formation was not studied, although carnotite deposits were known in this formation in southeastern Utah and northeastern Arizona.

All known exposures of the Salt Wash Member were prospected and mapped. Exposures of carnotite-bearing minerals, prospects, and mines were mapped and described. Ore reserves were calculated from samples collected on outcrops and in mines. Areas where reserves could be developed by additional drilling were especially noted. 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.

Field work 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, including one for New Mexico.

GEOLOGIC STUDIES IN NEW MEXICO

Colorado Plateau

Eastern Carrizo Mountains Investigations--Party No. 1 under the leadership of Alfred H. Coleman began field work in the eastern Carrizo Mountains during the 1944 field season. The exposures of the Salt Wash between Red Rock and Beclabito Trading Posts were mapped at a scale of 1:24,000. Some 128 exposures of uranium-vanadium minerals were located and described, and 19 stratigraphic sections of the Salt Wash and adjacent units were measured. Only the Syracuse Mine of Wade, Curran and Co. was both completely mapped and sampled. Of the 128 exposures, 59 were on vanadium leases of the Vanadium Corporation of America and the Wade, Curran and Co. Coleman considered the remaining 69 exposures to be poor and relatively unimportant, and estimated they might produce a combined total of 1,500 tons of ore averaging 2.00% V_2O_5 and 0.28% U_3O_8.

The results of the 1944 reconnaissance (Coleman, 1944) were considered preliminary, and UMDC planned additional mapping and sampling in order to make detailed ore reserve estimates. Unfortunately, no follow-up work was done in the eastern Carrizos, due to Coleman's untimely death in 1945. Hence, the eastern Carrizo project is not as complete as other UMDC district studies (J. W. Harshbarger, personal comm., 1983).

Morrison Formation Reconnaissance--Party No. 7 under William Gruenerwald made a regional reconnaissance study of the Morrison Formation on the perimeter of the San Juan Basin in New Mexico and Arizona. A total of 13 stratigraphic sections of the Morrison and adjacent formations were measured (Gruenerwald and Dalton, 1944).

The information from these sections was incorporated into a regional synthesis of the Morrison Formation that was prepared by the UMDC staff in Grand Junction (Webber, 1947).

Areas Outside the Colorado Plateau

With the exception of the Huerfano Park area in Colorado, areas outside the Colorado Plateau were examined by UMDC geologists reporting to the New York office. Initial reconnaissance activities of this group were directed to areas where uranium minerals had been reported in the literature (Northrop, 1942). In New Mexico, the pegmatites of the Petaca area of Rio Arriba County, and the gold, silver, and copper veins of the White Signal district, Grant County, ranked high on the list of occurrences to be examined.

Pegmatite Investigations--Pegmatites of the Petaca-Ojo Caliente area in Rio Arriba, County were investigated by C. N. Apsouri in the fall and winter of 1943. Of the 250 known pegmatites, only about half of the mines were open for examination. Apsouri (1944) found uranium minerals to be exceedingly sporadic at 6 mines and received reliable reports of occurrences at 7 unaccessible mines. He concluded that, under optimum conditions, one ton of uranium minerals, principally samarskite, might be obtained annually as a byproduct of mica mining.

Apsouri (1945) also studied the Harding pegmatite in the Picuris area of Taos, County. He calculated that 1,000 pounds of uranium oxide could be obtained from 150 tons of microlite concentrate from the Harding pegmatite. The Harding was the only pegmatite in the Picuris area found to contain uranium minerals.

Hill (1945, p. 22) found that minerals in two pegmatites in the Pecos Mountains (Rincon Range) of northwestern San Miguel County showed positive bead tests for uranium.

While in the Pecos Mountains, Hill (1945, p. 23) received a report of a carnotite occurrence in the Morrison Formation in the central part of T.20 N., R.24 E., Mora County. He did not visit the location, but turned the information over to UMDC's Grand Junction office.

After these preliminary investigations, UMDC did not consider the pegmatites of New Mexico to warrant any additional work.

White Signal District Investigations--The mines and prospects of the White Signal district, Grant County, were initially examined on March 31, April 1 and 2, 1944, by Stanton B. Keith. He concluded that the district had definite uranium production possibilities and it warranted a detailed examination (Keith, 1944, p. 1-5).

After receiving approval from the New York office, Keith (1945a) made a detailed study of the district and of the Apache Trail Mine in the nearby Burro Mountains. The study lasted from July 1944, to May 1945. All accessible mines, pits, and open cuts were mapped and sampled. The lowest level of the Merry Widow Mine was unwatered, and 11 other workings that showed evidence of uranium minerals were cleaned out. One hundred eighty-two channel samples were cut in the Merry Widow Mine, and one hundred fourteen channel samples were cut in other surface and underground workings. Twenty-three samples were taken from the Merry Widow dump, and three bulk metallurgical samples were collected for testing.

As the result of the sampling, Keith (1945a) calculated a reserve of 980 tons of rock averaging 0.34% U_3O_8 and an additional 14,245 tons of material averaging 0.08% U_3O_8. Most of this reserve occurred in three mines, and nearly half in the Merry Widow alone.

Other Areas with Reported Uranium Minerals--Uranium in the form of torbenite and autinite had been reported in association with oxidized copper minerals in a fault zone in the San Lorenzo district, five miles west of San Acacia in Socorro, County. A reconnaissance of the district by Keith (1944, p. 10-12) did not observe any uranium minerals and all samples give negative bead tests.

Carnotite had been reported in the volcanic rocks of the Bland (Cochiti) district of Sandoval County. Hill (1945, p. 29) could not find this occurrence, but he received reports of carnotite occurrences southwest of Jemez Springs, near Senorita, Youngsville, Coyote, and Gallina. All of these reported occurrences were turned over to UMDC's Grand Junction office.

The nickle-colbalt-native silver veins in the Black Hawk (Bullard Cone) district of Grant County were reported to contain torbenite, autinite, and pitchblende. An initial reconnaissance by Keith (1944, p. 6) noted torbenite and autinite in monzonite dikes near the Black Hawk Mine, and dump material

recorded a positive bead test. Later, Keith (1945a, p. 25) observed meta-torbenite on the dump of the Hobson Mine. A traverse with a Geiger-Muller counter detected minor radioactivity on the Black Hawk dump.

Investigations with Negative Results--Using a Geiger-Muller counter and/or bead tests on samples, the following metallic districts and/or mines were found to be barren of uranium:

Grant County--Pinos Altos and Tyrone (Keith 1944, p. 26-27), Chloride, Fierro, Hanover, Santa Rita, and Silver City (Hill, 1945, p. 24-26).

Hildalgo County--Lordsburg and Carbonate King Mine (Hill, 1945, p. 27-28).

San Miguel County--Pecos Mine (Hill, 1945, p. 23).

Keith (1944, p. 14-15) examined the Swanson-Lauer property, four miles northeast of Organ, in Dona Ana County. What the property owner thought to be carnotite turned out to be yellowish limonite.

During 1944 and 1945, three UMDC geological field parties examined some 1,500 square miles of north central and southwestern New Mexico for uranium resources. Only the White Signal district of Grant County was found to have uranium production possibilities.

SUMMARY

During World War II, the Manhattan Engineer District, under the direction of the Army Corps of Engineers, had been 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 being performed, were transferred to the Atomic Energy Commission (AEC) by Executive Order 9816, effective at midnight, December 31, 1946. The creation of the AEC transformed the development of atomic energy from a secret military organization to a civilian agency, who's general activities were a matter of public record.

Uranium procurement which was done secretly by the MEC 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, and very few mineralized outcrops in the Salt Wash were missed by UMDC. Coleman's work in the eastern Carrizo Mountains was the basis of planning AEC drilling projects in the area. Off the Colorado Plateau, Keith's work at White Signal was given to the U.S. Geological Survey to commence their investigations on behalf of the AEC (Granger and Bauer, 1952).

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.

ACKNOWLEDGEMENT

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