Exploration for Uranium Deposits in the Atkinson Mesa Area, Montrose County, Colorado

By D. A. Brew, 1950

Trace Elements Investigations Report 290

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EXPLORATION FOR URANIUM DEPOSITS IN THE ATKINSON MESA AREA, MONTROSE COUNTY, COLORADO*

By

D. A. Brew

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

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By D. A. Brew

ABSTRACT AND SUMMARY

The U. S. Geological Survey explored the Atkinson Mesa area for uranium- and vanadium-bearing deposits from July 2, 1951, to June 18, 1953, with 397 diamond-drill holes that totaled 261,251 feet.

Sedimentary rocks of Mesozoic age are exposed in the Atkinson Mesa area. They are: the Brushy Basin member of the Upper Jurassic Morrison formation, the Lower Cretaceous Burro Canyon formation, and the Upper and Lower Cretaceous Dakota sandstone.

All of the large uranium-vanadium deposits discovered by Geological Survey drilling are in a series of sandstone lenses in the upper part of the Salt Wash member of the Jurassic Morrison formation. The deposits are mainly tabular and blanket-like, but some elongate pod-shaped masses, locally called "rolls", may be present. The mineralized material consists of sandstone impregnated with a uranium mineral which is probably coffinite, some carnotite, and vanadium minerals, thought to be mainly corvusite and montroseite. In addition, some mudstone and carbonaceous material is similarly impregnated. Near masses of mineralized material the sandstone is light gray or light brown, is generally over 40 feet thick, and usually contains some carbonaceous material and abundant disseminated pyrite or limonite stain. Similarly, the mudstone in contact with the ore-bearing sandstone near bodies of mineralized rock is commonly blue gray, as compared to its dominant red color away from ore deposits. Presence and degree of these features are useful guides in exploring for new deposits.

INTRODUCTION

The U. S. Geological Survey explored the Atkinson Mesa area for uranium- and vanadium-bearing deposits during the period from July 2, 1951, to June 18, 1953, by drilling 397 diamond-drill holes which totaled 261,251 feet. The purposes of the exploration were to find uranium-bearing deposits which would

make new mines and to appraise the overall uranium and vanadium reserves of the area. The exploration tested ground away from known deposits--ground that probably would not have been tested by private interests due to the great risk of such exploration being unprofitable.

The Atkinson Mesa area is about 3 miles northwest of Uravan, Montrose County, Colo. (fig. 1) and includes the topographic features known as Atkinson Mesa and Little Atkinson Mesa. The area, which covers about 14 square miles, is roughly rectangular in outline and is bounded on the north by the Mesa Creek drainage system, on the west by the Dolores bench, bordering the Dolores and San Miguel Rivers, and on the south, southeast, and east by the Atkinson Creek drainage system. It includes all or parts of secs. 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19, and 20, T. 48 N., R. 17 W.; parts of secs. 1, 2, 11, 12, 13, and 24, T. 48 N., R. 18 W.; and parts of secs. 34 and 35, T. 49 N., R. 17 W.; New Mexico principal meridian.

The altitude of the area ranges from about 5,600 feet in the north-central part of the area to about 6,100 feet in the western and 6,300 feet in the eastern parts. The surface relief is generally slight to moderate, but steep washes and abrupt rims make access difficult locally. The vegetation in the area consists of juniper and piñon on the rock outcrops and abundant sagebrush on the alluvial flats. The climate is semiarid and water is scarce except after melting of the winter snows and after rainstorms.

Access to the Atkinson Mesa area is by two unimproved roads which connect with Colorado Highway 141 about 2 miles northwest of Uravan; one traverses east along Atkinson Creek and the other climbs directly onto the southwestern corner of the Mesa. The drill sites in the area are connected by a network of truck trails.

This report summarizes the results of the Geological Survey exploration and contains a brief description of the geology and ore deposits of the Atkinson Mesa area. The work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOLOGY

Sedimentary rocks of Mesozoic age are exposed in and surrounding the Atkinson Mesa area. These rocks are, from oldest to youngest; the Upper Jurassic Morrison formation, the Lower Cretaceous Burro Canyon formation, and the Upper and Lower Cretaceous Dakota sandstone.

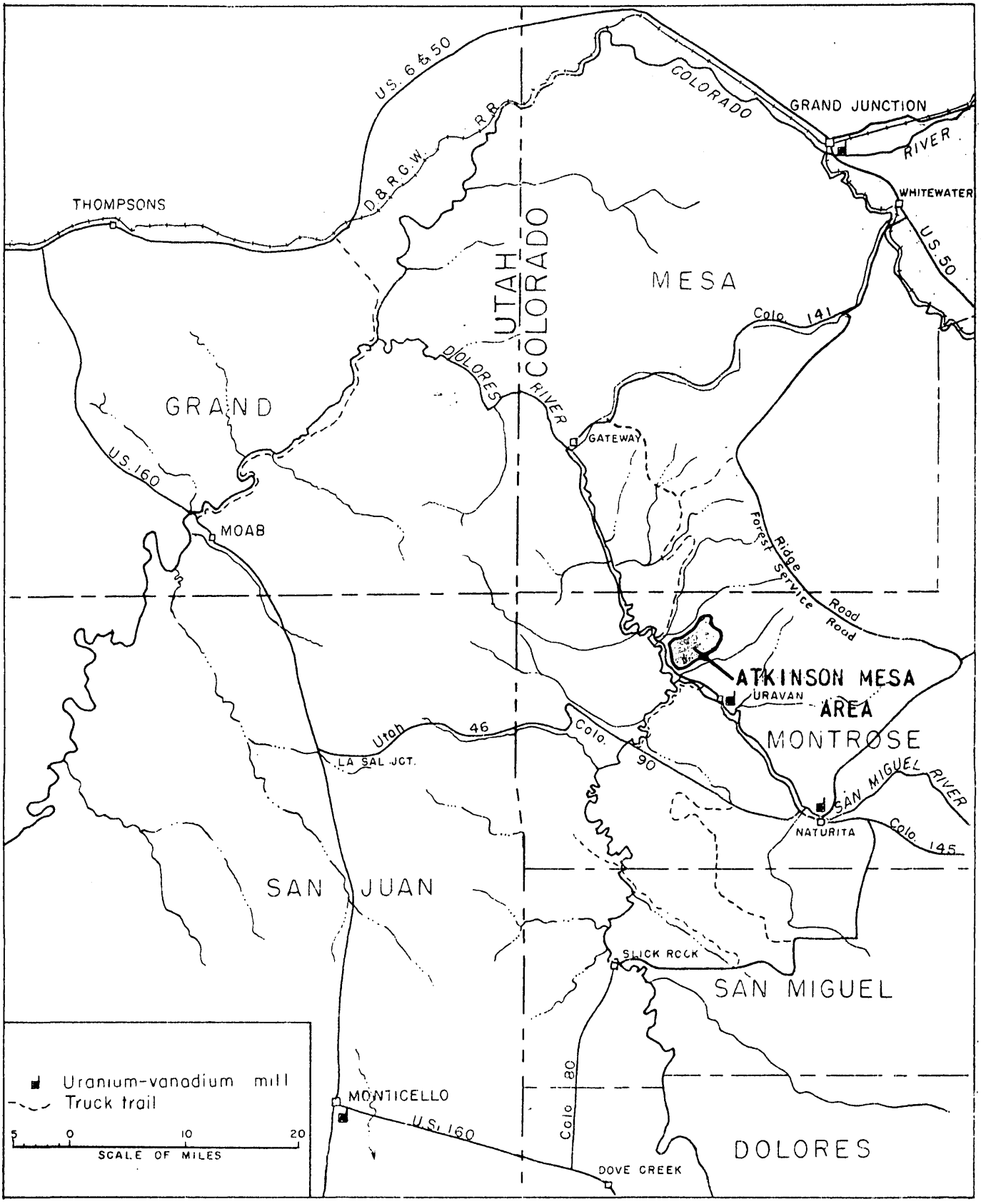

Figure 1. INDEX MAP OF PART OF THE COLORADO PLATEAU SHOWING THE LOCATION OF THE ATKINSON MESA AREA, MONTROSE COUNTY, COLORADO

The rocks are slightly folded into the northwest-trending and plunging San Miguel syncline, dipping toward the synclinal axis at angles of about 5^{o} on both flanks. A small normal fault with a maximum displacement of 40 feet extends from the Dolores bench into the southeastern corner of Atkinson Mesa (fig. 2). Very minor slump faulting occurs along the Mesa rim.

The Morrison formation is divided into the Salt Wash and Brushy Basin members. The Salt Wash member is about 300 feet thick and consists of sandstone lenses with interbedded mudstone lenses. The Brushy Basin member, which conformably overlies the Salt Wash, consists largely of variegated red, green, and blue-gray claystone with interbedded sandstone lenses, some of which are conglomeratic. It is about 360 feet thick. Except for the uppermost Brushy Basin rocks, the Morrison formation is not exposed in the map area shown in figure 2 but is exposed to the south and west of the mapped area, on the adjoining Dolores bench. The Burro Canyon formation, which is about 40 feet thick and consists of conglomeratic sandstone with shale lenses, and the Dakota sandstone, which is about 50 feet thick and consists of sandstone with some conglomeratic lenses, form a prominent rim surrounding the Atkinson Mesa area. The stratigraphy of the Morrison and related formations has been discussed in detail by Craig and others (1951).

The uppermost series of sandstone lenses of the Salt Wash contains most of the uranium-vanadium deposits on Atkinson Mesa. This unit, consisting of three main lenses with interbedded mudstone, is called the "ore-bearing sandstone". It ranges in total thickness from a few feet to more than 100 feet. Most of the mineralized rock and all of the important deposits are contained in the upper and lower sandstone lenses. The ore-bearing sandstone is fine- to medium-fine grained and is dominantly light brown, light gray, and light red. In the vicinity of the large deposits only light brown and light gray sandstones occur; with them are generally associated limonite spots or disseminated pyrite.

Mudstone which overlies, underlies, or is within the ore-bearing sandstone is predominantly red. The mudstone within the ore-bearing sandstone occurs as thin seams and splits, pebbles, flakes, and in the interstices between the sand grains. Mudstone in contact with the ore-bearing sandstone above, below, and near large masses of mineralized rock is commonly blue green or blue gray. The cause of this variation

from the dominant red is as yet undetermined. The "alteration" of the mudstone from red to blue green or blue gray persistently extends for some distance beyond the limits of mineralized rock and is therefore a useful target in exploration.

Some carbonaceous matter, consisting of coal-like, charcoal-like, and residual petroliferous material, is found in the ore-bearing sandstone. Although these materials are often associated with bodies of mineralized rock, there are many instances where the carbonaceous debris occurs abundantly with no apparent relation to mineralized material; as a result, the occurrence of such debris is useful only as a minor geologic guide in exploration in the Atkinson Mesa area.

A general discussion of the geology and habits of the uranium and vanadium deposits of southeastern Colorado is given by Fischer (1942). A description of the "Uravan mineral belt", an elongate strip in which the uranium-vanadium deposits are larger and of higher grade than in other areas, is given by Fischer and Hilpert (1952). This "mineral belt" trends about north across Atkinson Mesa, and all of the large deposits in the Atkinson Mesa area are within its boundaries.

ORE DEPOSITS

The ore deposits consist largely of sandstone impregnated with uranium- and vanadium-bearing minerals. In addition, the ore minerals impregnate mudstone and replace carbonaceous material.

The principal uranium-vanadium minerals are the "blue-black" type. The main uranium-bearing mineral in this type of ore probably is coffinite and/or uraninite (Stern, oral communication). The main vanadium-bearing minerals are thought to be corvusite--$V_2O_4 \cdot 6U_2O_5 \cdot nH_2O$, and montroseite --VO(OH). Carnotite--$K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$-- is locally abundant in the deposits but is not the most important ore mineral. The minerals are present as coatings on individual sand grains and as interstitial particles between the grains. The richest ores are a very dark blue or black and the lighter-colored mineralized rock is generally of lower grade.

The ore deposits are essentially tabular or lens-shaped masses which approximately parallel the bedding planes, but which may be cross-cutting in detail. Narrow elongate ore bodies, locally referred to as "rolls", may occur, but exploration on Atkinson Mesa and the adjacent Dolores bench suggests that such

pod-like masses are not as abundant as elsewhere in the Uravan mineral belt. No persistent trends are demonstrated by the elongate axes of the ore deposits in the Atkinson Mesa area. Mineralized fossil logs may be present within the ore deposits; such occurrrences have been noted in the deposits of the Dolores bench.

The ore deposits on Atkinson Mesa range in size from a few tons to several thousand tons. They are irregular in outline and range in areal extent from a few hundred square feet to several hundred thousand square feet.

The ratio of uranium to vanadium in most of the Colorado Plateau deposits is about 1-6. The ratio on Atkinson Mesa may be somewhat higher inasmuch as the other deposits within the Uravan mineral belt have proved to have a ratio of about 1-5 (Shoemaker, oral communication).

GUIDES TO ORE

Certain geologic features, deducible from drill cores, have been found to be commonly associated with bodies of mineralized rock. Weir (1952) gives a detailed analysis of these features. The guides to ore used on Atkinson Mesa are modified versions of those presented by Weir. No single geologic feature is persistent enough to be used alone in defining ground as "favorable, semifavorable, or unfavorable" for ore deposits, but by evaluating all the various features a reasonably accurate delimitation can be made.

The following geologic criteria are useful guides to ore on Atkinson Mesa:

1. The mudstone associated with the ore-bearing sandstone has been "altered" from red to blue-green or blue-gray in the vicinity of the deposits. This "alteration" decreases outward from the masses of mineralized rock for a few hundred feet and constitutes an extensive target.

2. The sandstone near the ore deposits is light-brown or light-gray, with little or no red mudstone associated with it.

3. The sandstone in the vicinity of the deposits commonly contains abundant limonite spots, widespread limonite stain, or disseminated pyrite. Pyrite being altered to spots of limonite is present in many specimens of drill core.

4. The ore deposits occur where the total thickness of the ore-bearing sandstone is greater than 40 feet. However, the deposits do not have any detailed relationship to the thickness, which ranges from less than 20 feet to over 100 feet.

5. The presence of carbonaceous material, both radioactive and nonradioactive, in the ore zone is considered a relatively poor guide. Mineralized sandstone is associated with it in some places, but not everywhere.

Careful evaluation of all these geologic features in an area where the holes are spaced 750 to 2,000 feet apart gives a generalized outline of the favorable ground, which serves as a guide for closer-spaced drilling.

In addition to these guides, several other geologic features were plotted on maps and analyzed in an attempt to develop new guides to exploration. These features were: gamma-ray values at the contact of the ore-bearing sandstone and the underlying mudstone, maximum drill-hole gamma-ray values, structural contours, mudstone-sandstone ratios, and "transmissibility" values for the ore-bearing sandstone. Of these various features, the most promising one was the "transmissibility" values which were calculated for the ore-bearing sandstone in each drill hole. These values depend upon the thickness of the ore-bearing sandstone and the permeability of the various lithologic units within the sandstone. The permeability values used are approximations developed by testing in the laboratory specific examples of the rock types generally encountered in the drill holes. This laboratory work was begun by D. A. Phoenix in 1951 and is being continued by D. A. Jobin of the Geological Survey in Grand Junction, Colo. The contouring of these values on Atkinson Mesa revealed areas of relatively high transmissibility to be associated with the ground known to be underlain by mineralized rock. None of the other features were considered to be potentially valid guides to finding ore in the Atkinson Mesa area.

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