URANIUM DEPOSITS OF THE CARLILE QUADRANGLE, CROOK COUNTY, WYOMING

By M. H. Bergendahl

Trace Elements Investigations Report 671

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
URANIUM DEPOSITS OF THE CARLILE QUADRANGLE
CROOK COUNTY, WYOMING*

By
M. H. Bergendahl

August 1957

Trace Elements Investigations Report 671

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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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**Total No. of copies: 39**
CONTENTS

Abstract ......................................................... 4
Introduction ....................................................... 4
General geology .................................................... 5
Uranium deposits .................................................. 6
  Carlile mine .................................................... 7
  Thorn Divide .................................................... 9
  Radioactivity anomalies ....................................... 10
References cited ................................................. 11

ILLUSTRATIONS

Figure 1. Geologic map of the Carlile quadrangle, Crook County, Wyoming. In envelope
Figure 2. Structure contour map of the Carlile quadrangle, Crook County, Wyoming. In envelope

TABLE

Table 1. Analyses of samples from the Carlile mine. 9
URANIUM DEPOSITS OF THE CARLILE QUADRANGLE, CROOK COUNTY, WYOMING

By M. H. Bergendahl

ABSTRACT

The uranium deposits in the Carlile quadrangle, southwestern Crook County, Wyo., are in relatively flat-lying sandstone beds in the lower part of the Inyan Kara group of Early Cretaceous age. The Carlile mine has the largest deposit in the quadrangle; the ore minerals are carnotite and tyuyamunite associated with carbonaceous material in a sandstone lens. At Thorn Divide, an unidentified black uranium mineral occurs with pyrite and carbonaceous material in two stratigraphic zones in the lower part of the Inyan Kara group. The mineralized area is in a small structural basin. Several radioactivity anomalies were found at various localities in the quadrangle.

It is believed that uranium was deposited from aqueous solutions, the movements of which were influenced by both local and regional structures. The lithologic features provided a proper chemical environment and affected the local rates of flow of solutions.

INTRODUCTION

Discoveries of uranium in the northern Black Hills during the past several years have given impetus to geologic mapping in this area. The Carlile quadrangle, occupying about 52 square miles in southwestern Crook County, Wyo. (fig. 1), is part of a regional program of geologic
studies that is concerned with providing detailed geologic maps, finding geologic guides to uranium deposits, and noting relationships between structure, lithologic characteristics, and uranium mineralization.

This report presents a generalized description of the uranium deposits. It is meant to be a summary, rather than a detailed analysis of the stratigraphy and economic geology of the quadrangle. A more detailed report is in preparation for publication by the U. S. Geological Survey.

The work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GENERAL GEOLOGY

All rocks exposed in the Carlile quadrangle are sedimentary and range in age from Late Jurassic to Recent. The quadrangle is situated along the periphery of the upwarped rocks that were involved in the Black Hills uplift, and part of the monocline that extends along the western flank of the uplift crosses the southwest corner of the quadrangle. The distribution and thicknesses of the sedimentary rocks are shown on the geologic map (fig. 1), and the structure is shown on the structure contour map (fig. 2).

Although most of the formations in the Carlile quadrangle are of marine origin, the rocks most widely exposed throughout the quadrangle are the continental and marginal marine sandstones, siltstones, and
mudstones that comprise the Inyan Kara group of Early Cretaceous age. Uranium deposits occur in the lower part of the Inyan Kara group; hence, greater emphasis was given to mapping and study of the lithologic units of this group. It was found possible to subdivide the upper formation of the group, the Fall River sandstone, into 4 distinct mappable units; the lower part of the Inyan Kara group was subdivided into two units.

URANIUM DEPOSITS

Most of the uranium deposits occur in the northeastern part of the quadrangle in an area of relatively flat-lying rocks. A small area of anomalous radioactivity in the Fall River sandstone was found in the northwestern part of the quadrangle along the westward-dipping limb of the Oil Butte anticline.

The deposits consist of tabular, irregularly-shaped concentrations of uranium minerals in sandstone, and the lateral dimensions of the deposits are many times their thickness. No preferred orientations or trends of ore bodies have been noted. Deposits above the ground-water table consist of a carnotite-tyuyamunite assemblage; those below the ground-water table contain black uranium minerals, probably uraninite or coffinite or both. A feature common to all deposits is the association of uranium minerals with carbonaceous material in sandstone.
Carlile mine

The Carlile mine is in the W\(\frac{1}{2}\) sec. 26, T. 52 N., R. 66 W. (fig. 1). The mine, owned by the Homestake Mining Company, was opened in 1952 and was operated intermittently until 1955, when mining ceased. The mine workings consist of about 700 feet of drifts, a stripped area of about 1.2 acres, and an open cut 180 feet wide and 650 feet long.

Originally there were four ore bodies. Three of them were in a long, narrow, southward-trending promontory, and the fourth was in a landslide block on the east side of the promontory (fig. 1).

The strata in the immediate area of the mine are practically flat-lying. The host rock for the ore is a sandstone lens in the upper part of the lower part of the Inyan Kara group. This lens ranges from 20 to 40 feet in thickness and can be traced away from the mine for a distance of less than 1 mile to the south, about 1.5 miles to the north, and 1 mile southwest. The ore-bearing sandstone is enclosed within relatively thick and impermeable claystone and mudstone beds.

A landslide block on the east side of the promontory that contains most of the mine workings (fig. 1), contains some ore that has been mined by an open cut.

The ore minerals at the Carlile mine are tyuyamunite and carnotite. They occur as fine-grained aggregates that fill interstices and coat sand grains and fragments of carbonized wood. Metarossite, coffinite(?),
doloresite(?), and rauvite(?) were reported by Bodine (1954, p. 21-28); and Evans and Mrose (1956, p. 1693) reported two new black vanadium minerals from the Carlile area, known as minerals "A" and "B."

The quartz grains of the sandstone are deeply etched and corroded, and uranium minerals coat the grains and fill the corroded embayments. A fine-grained mixture of calcite and gypsum cements the sandstone throughout much of the ore zone. Clusters of uranium minerals are not uncommon in this cement. Iron oxides are closely associated with uranium minerals. A few small pods of sandstone are impregnated with hematite, but elsewhere lesser amounts of iron oxide merely stain the sandstone yellow and brown.

The most conspicuous relationship is the occurrence of uranium minerals with the thicker seams of carbonaceous silt and carbonized wood. Where these seams are thin and feathery, there are no uranium minerals; but, where they thicken and coalesce, uranium is abundant.

Arsenic and selenium are more abundant in the ore than in rocks with negligible uranium content. Selenium has been concentrated up to several hundred-fold in the sandstone that is high in uranium; however, the concentration is erratic. Some uraniferous samples contain less than 10 times as much selenium as those that are barren of uranium. Arsenic, on the other hand, varies in close relationship to uranium in ore samples. Table 1 shows these relationships.

In most samples taken from the Carlile mine, uranium is present in slightly larger quantities than the measured radioactivity would suggest. Apparently the uranium is in fairly close equilibrium with its daughter products, and little if any leaching has taken place.
Table 1.--Analyses of samples from the Carlile mine.


<table>
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<th>Laboratory number</th>
<th>Field number</th>
<th>U (percent)</th>
<th>P₂O₅ (percent)</th>
<th>As (percent)</th>
<th>Zn (percent)</th>
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The ratio of V₂O₅ to U₃O₈ in samples containing 0.1 percent or more V₂O₅ ranges from 0.4:1 to 67:1, and the average V₂O₅ to U₃O₈ ratio for the deposit is 1.4:1. This leads to the assumption that local excesses of vanadium over uranium would be evidenced by the presence of vanadium minerals (rauvite, metarossite, doloresite); however, the gross mineralogy would be of the carnotite type.

Thorn Divide

In the N²₃ sec. 27, T. 52 N., R. 66 W., less than 1 mile west of the Carlile mine, concentrations of uranium minerals were found in two zones in the lower part of the Inyan Kara group. In 1955 the Shannon Oil Company drilled 18 holes offset around mineralized holes that were...
drilled previously by the U. S. Atomic Energy Commission. Five of these 18 holes penetrated zones of radioactive sandstone that contained more than 0.1 percent $U_3O_8$. These zones were 180 to 270 feet below the ground surface. The uranium mineral that was obtained from the core was an unidentified, black, sooty, yellow-weathering species. The uranium mineral was associated with pyrite and laminations of carbonaceous material.

An interesting feature of this deposit is the relation between structure and uranium occurrence. The structure contours (fig. 2) show that the $N_2^\frac{1}{2}$ sec. 27, T. 52 N., R. 66 W., where these holes were drilled, is an area of structural depression that has about 35 feet of closure.

Radioactivity anomalies

A small area of anomalous radioactivity in oil-stained sandstone in the upper unit of the Fall River sandstone in the $SE^1_4$ sec. 35, T. 52 N., R. 67 W., had a maximum radioactivity of 0.4 mr/hr over a background of 0.015 mr/hr. A sample of this sandstone contained 0.12 percent equivalent uranium and 0.007 percent uranium$^1$.

Analysts: C. G. Angelo (equivalent uranium) and H. H. Lipp (uranium), J. S. Wahlberg (V$_2$O$_5$) U. S. Geological Survey.

Two other areas of anomalous radioactivity, one in the $SW^1_4$ sec. 26, T. 52 N., R. 66 W., and another in the $NE^1_4$ sec. 35, T. 52 N., R. 66 W., are in the same sandstone bed that contains the Carlile deposits. At both of these localities carnotite is associated with
finely divided carbonaceous material. A sample of the sandstone at the anomaly in sec. 26 contained 0.18 percent uranium and 0.23 percent V_2O_5. The anomaly in sec. 35 had a maximum radioactivity of only 0.06 mr/hr, over a background of 0.01 mr/hr and was not sampled.

For analysts, see shelf on page 10.

REFERENCES CITED


Geologic map of Carlile quadrangle, Crook County, Wyo.

by

M. H. Bergendahl, R. E. Davis, G. A. Izett

Explanation

Sedimentary Rocks

\[ Ql_s \]

Talus and landslide debris derived locally from sedimentary rocks

\[ Qal \]

Alluvium
Silt, sand, and gravel; includes some low terrace deposits

\[ Qt \]

Stream terrace deposits
Silt, sand, and gravel

\[ Kcl \]

Lower unnamed member of Carlile shale
Dark-gray shale, non-calcareous; 50-150 feet thick

\[ Kg \]

Greenhorn formation
Dark-gray shale and thin-bedded buff limestone, with zones of calcareous septarian concretions at base and near top; 70 to 80 feet thick

\[ Kbf \]

Belle Fourche shale
Dark-gray to black shale with dark-purple siderite concretions in lower part and yellowish-gray calcareous concretions in upper part; thin beds of bentonite in lower part; about 700 feet thick
Mowry shale
Gray siliceous shale with abundant fish scales along partings; Clay Spur bentonite bed at top; about 180 feet thick

Newcastle sandstone
Light gray calcareous sandstone, light gray siltstone, light gray to black claystone, carbonaceous locally; lenticular beds of bentonite; thickness, 55-60 feet

Skull Creek shale
Black shale with scattered dark red sideritic concretions; a few sandstone lenses less than 1 foot thick in lower part; 250-260 feet thick

Fall River formation
Kru- light gray to tan, fine-grained, micaceous sandstone, light gray siltstone, silty claystone; locally uraniferous in northwestern Black Hills; bed of carbonaceous trash 4-6 inches thick at base; thickness of Kru - 6 to 45 feet, absent locally. Kr2 - buff to light gray sandstone, very fine-grained, micaceous, calcareous at base, contains calcite-cemented sandstone concretions, ferruginous sandstone concretions; forms a cliff; thickness, 30 - 45 feet. Krm - dull gray shaly siltstone and claystone, interlaminated; 45 feet thick. Krl - light gray to tan siltstone and sandy siltstone, micaceous, with seams of carbonaceous silty claystone; abundant vertical worm tubes and fucoidal impressions along bedding; upper beds impregnated with iron oxides; thickness, 25 - 40 feet.

Unconformity (?)
Lower part of Inyan Kara group

Kilm - variegated silty and sandy claystone with lenses of sandstone, some of which contain uranium ore bodies; highly polished pebbles and cobbles of chert, quartzite, and quartz occur locally in the claystone; lenses of carbonaceous claystone locally present at base and near top, also within sandstone lenses; upper 10 to 15 feet is predominantly claystone and silty claystone; nodules of limonite and partly oxidized siderite in uppermost 1 to 4 feet; thickness, 25 - 110 feet. Kils - light gray medium to coarse-grained, locally conglomeratic, sandstone, fine-grained in upper 3 to 10 feet; lenses of carbonaceous shaly claystone and siltstone interbedded with sandstone locally; forms rounded cliff; thickness, 25 - 110 feet.

Unconformity

Morrison formation

Variegated claystone, calcareous, except in upper 10 - 20 feet, where claystone is somewhat carbonaceous; thin beds of limestone are present within calcareous claystone interval; discontinuous bed of light gray calcareous sandstone, 1 - 20 feet thick, occurs about 30 feet above base of formation; a bed of wavy laminated sandy and cherty limestone, 1 - 2 feet thick forms the basal unit; thickness, 80 - 110 feet.

Redwater shale member of Sundance formation

Greenish gray shale, with several thin beds of coquoidal limestone and glauconitic calcareous sandstone; uppermost unit is composed of friable, calcareous, buff sandstone, although at 2 localities the sandstone is overlain by 6 feet of massive gypsum; thickness, about 175 feet.
Exposed contact

Approximate contact - contact covered
Located by incomplete exposures, float. Limits of accuracy - less than 10 feet vertically, within 40 feet or less horizontally.

Inferred contact - contact covered but rock unit is well exposed. Limits of accuracy - 15 feet or less vertically, 70 feet or less horizontally.

Fault, dashed where indefinite
U upthrown side; D downthrown side

Open cut

Filled area

Mine dump