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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

April 28, 1958

AEC - 463/8

Mr. Robert D. Nininger
Assistant Director for Exploration
Division of Raw Materials
U. S. Atomic Energy Commission
Washington 25, D. C.

Dear Bob:

Transmitted herewith are three copies of TEI-671, "Uranium deposits of the Carlile quadrangle, Crook County, Wyoming," by M. H. Bergendahl, August 1957.

This paper summarizes information on the uranium deposits of the area. This information will be incorporated in a more detailed and expanded report that is planned for publication as a Geological Survey bulletin.

Sincerely yours,

John H. Eric

for W. H. Bradley
Chief Geologist

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Geology and Mineralogy

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

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*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 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 fron 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 W½ 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.

(Analysts: C. G. Angelo, J. P. Schuch, Claude Huffman, J. S. Wahlberg, and G. T. Burrow, U. S. Geological Survey).

Laboratory number	Field number	U (percent)	P_2O_5 (percent)	As (percent)	Zn (percent)	Se (percent)
252314	B11	0.76	0.16	0.0110	0.0015	0.0470
252315	B13	1.93	.07	.0225	.0094	.0590
252316	B27	.44	.05	.0085	.0009	.0730
252317	B29	.006	.05	.0005	.0001	.0075
252318	B37	.13	.10	.0040	.0006	.0200

The ratio of V_2O_5 to U_3O_8 in samples containing 0.1 percent or more V_2O_5 ranges from 0.4:1 to 67:1, and the average V_2O_5 to U_3O_8 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 N½ 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 N½ 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 SE¼ 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[/].

/ Analysts: C. G. Angelo (equivalent uranium) and H. H. Lipp (uranium), J. S. Wahlberg (V_2O_5) U. S. Geological Survey.

Two other areas of anomalous radioactivity, one in the SW¼ sec. 26, T. 52 N., R. 66 W., and another in the NE¼ 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