GEOLOGICAL SURVEY CIRCULAR 358

URANIUM IN THE MAYOWORTH AREA JOHNSON COUNTY, WYOMING—

A PRELIMINARY REPORT

This report concerns work done on behalf of the U. S. Atomic Energy Commission and is published with the permission of the Commission.

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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Washington, D. C., 1954

Free on application to the Geological Survey, Washington 25, D. C.

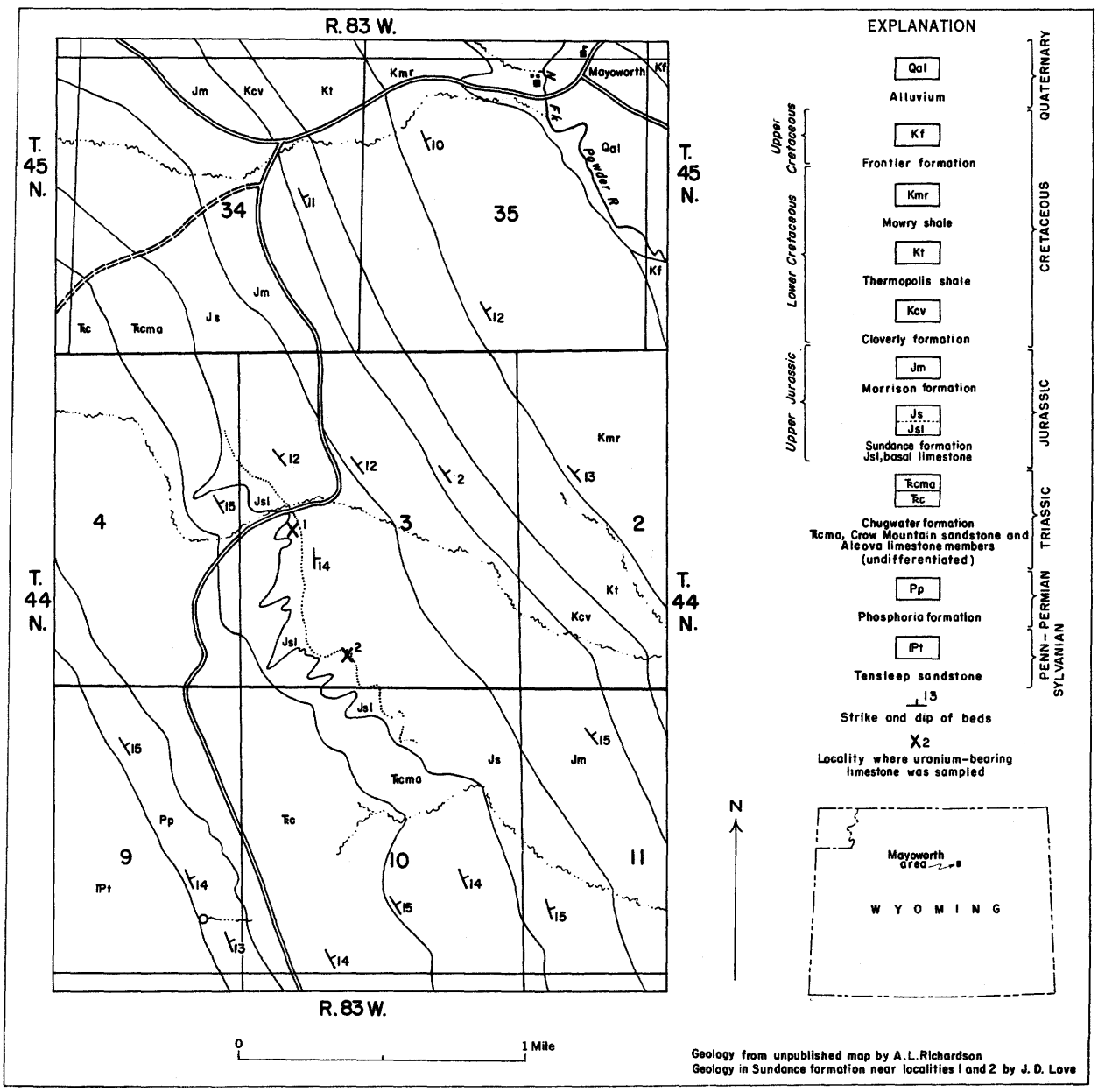

Figure 1. —Geologic map of Mayoworth area, Wyoming.

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ABSTRACT

The uranium mineral, metatyuyamunite, occurs in the basal limestone of the Sundance formation of Late Jurassic age along the east flank of the Bighorn Mountains, about 2 miles southwest of the abandoned Mayoworth post office. This deposit is of particular interest because it is the first occurrence of uranium mineralization reported from a marine limestone in Wyoming. The first uranium claims were filed in July 1953, by J. S. Masek, Dan Oglesby, and Jack Emery of Casper, Wyo. Subsequent reconnaissance investigations have been made by private individuals and geologists of the U. S. Geological Survey and Atomic Energy Commission.

The metatyuyamunite is concentrated in a hard gray oolitic limestone that forms the basal bed of the Sundance formation. A selected sample of limestone from a fresh exposure in the northernmost deposit known at the time of the field examination contained 0.70 percent equivalent uranium and 0.71 percent uranium. Eight samples of the limestone taken at the same place by the Atomic Energy Commission contained from 0.007 to 0.22 percent uranium. A chip sample from the weathered outcrop at the top of this limestone half a mile to the southeast contained 0.17 percent equivalent uranium and 0.030 percent uranium. A dinosaur bone from the middle part of the Morrison formation contained 0.044 percent equivalent uranium and 0.004 percent uranium.

Metatyuyamunite forms a conspicuous yellow coating along fracture planes cutting the oolitic limestone and has also replaced many of the oolites within the solid limestone even where fractures are not present.

Many radioactive anomalies in the basal limestone of the Sundance formation were examined in a reconnaissance along the outcrop for a distance of half a mile south of the initial discovery. Samples were taken for analysis only at the northern and southern margins of this interval. Outcrops farther north and south were not studied.

Sufficient data are not available to make even rough estimates of tonnage and grade of these deposits. The extent of the limestone, the approximate boundaries of the area of above-normal radioactivity, and the possibilities of other radioactive zones have not been thoroughly investigated. Although dinosaur bones in the Morrison formation were radioactive wherever they were tested, no significant amount of radioactivity was observed in adjacent rocks.

INTRODUCTION

The Mayoworth area is in the southwestern part of Johnson County, Wyo. (fig. 1). Several detailed stratigraphic sections were measured by the writer in this area in 1944 and additional studies were made in 1949-50 as part of oil and gas investigations of the Geological Survey. The first uranium claims were

filed in July 1953, by J. S. Masek, Dan Oglesby, and Jack Emery of Casper, Wyo. Subsequently, reconnaissance investigations of the area were made by private individuals and geologists of the U. S. Geological Survey and the U. S. Atomic Energy Commission (Geslin, 1953). The writer examined the uranium deposits to study their geology and to obtain data on their origin. No mining or detailed exploration has been done, as of April 1, 1954.

The writer is indebted to Robert S. Houston for the photograph of the polished section of mineralized limestone (fig. 4). Except where specified otherwise, the Denver laboratory of the U. S. Geological Survey made the chemical analyses. Alice D. Weeks of the Geological Survey identified the uranium mineral as metatyuyamunite.

Stratigraphic and structural studies of the Mayoworth area and the region directly north have been made by several geologists (Love and others, 1945a; Richardson, 1950, and Hose, in preparation).

Topographic maps of the area, scale 1:24,000, having a 20-foot contour interval, compiled for the Bureau of Reclamation, are not published but are available through the Bureau.

Reconnaissance examination of the Mayoworth area was made on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOGRAPHY

The Mayoworth area lies along the western margin of the Powder River Basin. Directly to the west, the land surface rises onto the east flank of the Bighorn Mountains. The altitude of the uranium deposit is about 5,450 feet. On the crest of the mountains 10 miles to the west, the altitude is about 8,000 (pl. 1). The area is drained by intermittent streams, all tributaries to the North Fork of Powder River. There are no towns, and the Mayoworth post office, which was in the northeast corner of the area (fig. 1), has been discontinued. At Mayoworth, a graded county road that crosses the area from south to north intersects an oiled road from Kaycee, which is the nearest town, 12 miles to the southeast. Alternating sets of hard and soft strata have been dissected into strike ridges and valleys, resulting in a rough topography. Vegetation is sparse and bedrock is comparatively well exposed. Livestock raising is the only industry.

GEOLOGY

The Mayoworth area is at the foot of the east flank of the Bighorn Mountains, where the rugged mountain topography flattens out into the Powder River Basin (pl. 1). The exposed rocks are of Triassic, Jurassic, and Early Cretaceous ages and have monoclinal dips of 10° to 15° to the northeast (fig. 1). The rocks probably were folded at the close of Paleocene time, when the principal arching of the Bighorn Mountains occurred. There may have been slight subsequent movement here, but it cannot be proved or disproved. Data from adjacent localities indicate that the Powder River Basin was largely filled with Eocene, Oligocene, and probably younger rocks (Love, 1952, pls. 2 and 3, and p. 5). Remnants of Oligocene and Miocene(?) tuffaceous claystones and sandstones occur on the crest of the Bighorn Mountains northwest of Mayoworth at altitudes of 7,500 to 9,000 feet. These remnants were laid down on a rugged topography (pl. 1) and are still essentially undeformed.

STRATIGRAPHY

Figure 2 presents summary descriptions and thicknesses of the rock units in the vicinity of the uranium deposits in the Mayoworth area. Richardson (1950) and Hose (in preparation) have described the stratigraphy of the Paleozoic and Mesozoic rocks of this area in some detail. Love and others (1945b) described the lithology and correlated sections of the Morrison, Cloverly, and Thermopolis formations.

The Chugwater formation, of Triassic age, directly underlies the Sundance formation in this area, is about 800 feet thick, and consists of 3 members. At the base is the Red Peak member, which is about 700 feet thick and composed of brick-red soft shale, siltstone, and silty sandstone. The uppermost 20 feet is massive red silty sandstone in the vicinity of the uranium deposits. Overlying the Red Peak member is the Alcova limestone member, which consists of gray to pink thin-bedded slabby limestone ranging in thickness from a feather edge to 2 feet. The Alcova limestone member is lenticular and wedges out, only to reappear at the same stratigraphic horizon farther along the outcrop.

Overlying the Alcova limestone member is the Crow Mountain sandstone member which consists of about 100 feet of salmon-pink massive to crossbedded fine-grained sandstone. The Crow Mountain was originally described by Love (1939). The member characteristically crops out in cliffs. In places where the Alcova limestone member is absent, it is difficult to distinguish the Crow Mountain sandstone member from the uppermost sandstone in the Red Peak member. The upper part of the Crow Mountain is commonly silty and soft and forms a slope capped by the resistant basal limestone of the overlying Sundance formation.

The Crow Mountain sandstone member has been mistaken for the somewhat younger Nugget sandstone of areas farther west by many geologists because both sequences have almost identical lithology.

The Gypsum Spring formation occurs along the east flank of the Bighorn Mountains farther north but wedges out at about the north boundary of the Mayoworth area.

The Sundance formation consists of two sequences, a lower one called the "lower Sundance," comprising about 200 feet of nonglauconitic sandstone and shale containing uranium-bearing oolitic limestone at the base, and an upper sequence called the "upper Sundance" composed of greenish glauconitic shale and sandstone about 150 to 175 feet thick. Both sequences contain marine fossils. The basal limestone of the "lower Sundance" is oolitic, hard, and forms a conspicuous ledge in the Mayoworth area but thins and disappears to the north and to the south. Its maximum thickness is about 20 feet. This limestone superficially resembles the nonoolitic Alcova limestone member of the Chugwater formation and has been mistaken for it

by some geologists. Peterson (1954) has described the Sundance rocks in this general region and illustrated oolitic beds in the upper part of the "lower Sundance."

The Morrison, Cloverly, and Thermopolis formations have been described (Love, and others, 1945b) and the lithology is summarized in figure 2.

URANIUM DEPOSITS

Uranium has been found in the basal limestone of the Sundance formation and in dinosaur bones in the overlying Morrison formation. Other rocks in the area were not examined in detail for uranium by the writer. An airborne survey has been made (Jones, 1952, p. 10) by the Atomic Energy Commission.

Description of localities

Locality 1 (NE¼NW¼SW¼ sec. 3, T. 44 N., R. 83 W.). —The site of locality 1 is the claim discovered and staked by J. S. Masek and associates, in the marine basal limestone of the Sundance formation of Late Jurassic age. The outcrops are on a northeastward-facing dip slope (fig. 3). Strata strike N. 30° W., and dip 12° northeast. The stratigraphic section, shown below, was measured at the place of best exposed uranium mineralization. Unit 1 is the oldest.

Unit no.	Lithologic character	Thickness (feet)
	Top of section.	
5	Shale, pale green, soft; forms valley at base of dip slope.	20+
4	Limestone, brown, oolitic, hard, but softer than underlying unit; irregularly bedded in upper half; contains metatyuyamunite in middle 2 feet (fig. 3); top of unit forms prominent dip slope (fig. 3); contains fragments of oysters, bryozoans, and other marine fossils.	4
3	Limestone, brown, oolitic, very hard, evenly bedded, weathering into conspicuous slabs one-half to 1 inch thick.	2.5
2	Limestone, grayish-brown, massive, very sandy, containing some small chert pebbles; highly oolitic.	2.5
	Contact between Sundance formation and Crow Mountain sandstone member of Chugwater formation. Contact is very sharp and even.	
1	Siltstone, brick-red, sandy, soft. Underlying strata are not exposed at this locality.	3+

Metatyuyamunite is visible in the middle 2 feet of unit 4 throughout a distance of 27 feet in an east-west direction and 7 feet in a north-south direction. The most conspicuous yellow coating is along fracture faces, but, as is shown in figure 4, the metatyuyamunite has replaced oolites within unfractured limestone. The most radioactive areas are along ferruginous brown clayey partings, where a scintillation counter shows 1.5 mr/hr. A 1-pound selected sample of the limestone taken for mineral identification contained 0.70 percent equivalent uranium, 0.71 percent uranium, and 0.56 percent V_2O_5. The average uranium content of this limestone face is much lower. Analyses of additional samples taken at locality 1 are shown in the table presented on p. 6 of this report. The replacement of the oolites indicates that uranium was introduced after the sediments were deposited. The limestone contains oysters, bryozoans, and other fossils of marine origin.

About 100 feet southwest of the largest mineralized exposure, and at the same stratigraphic position, metatyuyamunite is visible in an area about 6 feet in diameter. This area had not been dug out at the time of examination so its extent and thickness could not be determined.

On the same dip slope with these two mineralized spots are many other spots where radioactivity is considerably above background, but no metatyuyamunite is visible and no digging was done. At the time of examination, no drilling had been done in the area and the deepest pit was about 3 feet, so conclusions as to the economic possibilities of this locality are not warranted at present.

Locality 2 (SW¼SE¼SW¼ sec. 3, T. 44 N., R. 83 W.). —The site of locality 2 is about half a mile southeast of locality 1, along strike and in the same oolitic limestone bed at the base of the Sundance formation. A scintillation counter showed a maximum reading of 2.0 mr/hr (as compared with 1.5 mr/hr at locality 1) at the contact between the brown oolitic limestone and the overlying green shale. At this place a 1-pound sample of the limestone contained 0.17 percent equivalent uranium, 0.30 percent uranium, and 0.10 percent V_2O_5. The sample was taken from a bedding-plane surface and the limestone was so hard that it could be dug to a depth of only about 3 inches with the tools at hand. No uranium was observed in this near-surface sample, but the relatively high radioactivity suggests that if a pit or drill hole were put down at this spot, uranium minerals might be found.

Radioactivity much higher than background was recorded in many places along the dip slope of this limestone for the next quarter mile to the south. At one place a maximum radioactivity of 1 mr/hr was observed. Lack of time prevented more detailed reconnaissance or mapping of the extent of this oolitic limestone, but it is likely that the richest and most extensive uranium deposits were not found.

In the middle part of the Morrison formation about 2 miles southeast of locality 2 (NE¼ sec. 14, T. 44 N., R. 83 W.), radioactive dinosaur bones occur in considerable abundance in a medium-grained gray and brown sandstone (fig. 2). A sample of bones contained 0.044 percent equivalent uranium, 0.004 percent uranium, and 0.08 percent V_2O_5. The sandstone in which the bones are embedded shows radioactivity slightly above background and the underlying green and dully variegated claystone is slightly more radioactive than the sandstone.

Neither the Morrison formation nor the overlying Cloverly formation, or the Muddy sandstone member of the Thermopolis shale has been examined in sufficient detail for radioactivity by the writer to justify any conclusion as to the possibility of uranium deposits in these rocks. Carbonaceous material occurs in the sandstones, and lenticular beds of lignitic material are present in several places. Jones (1952, p. 10) indicates that he made complete radiometric flight coverages of outcrops of the Sundance, Morrison, and Cloverly formations and the Muddy sandstone member, throughout this region without discovering any anomalies. This survey would suggest that the radioactivity in the vicinity of localities 1 and 2 is difficult to detect from the air, an observation that has been corroborated by commercial geologists who flew the area after uranium was discovered.

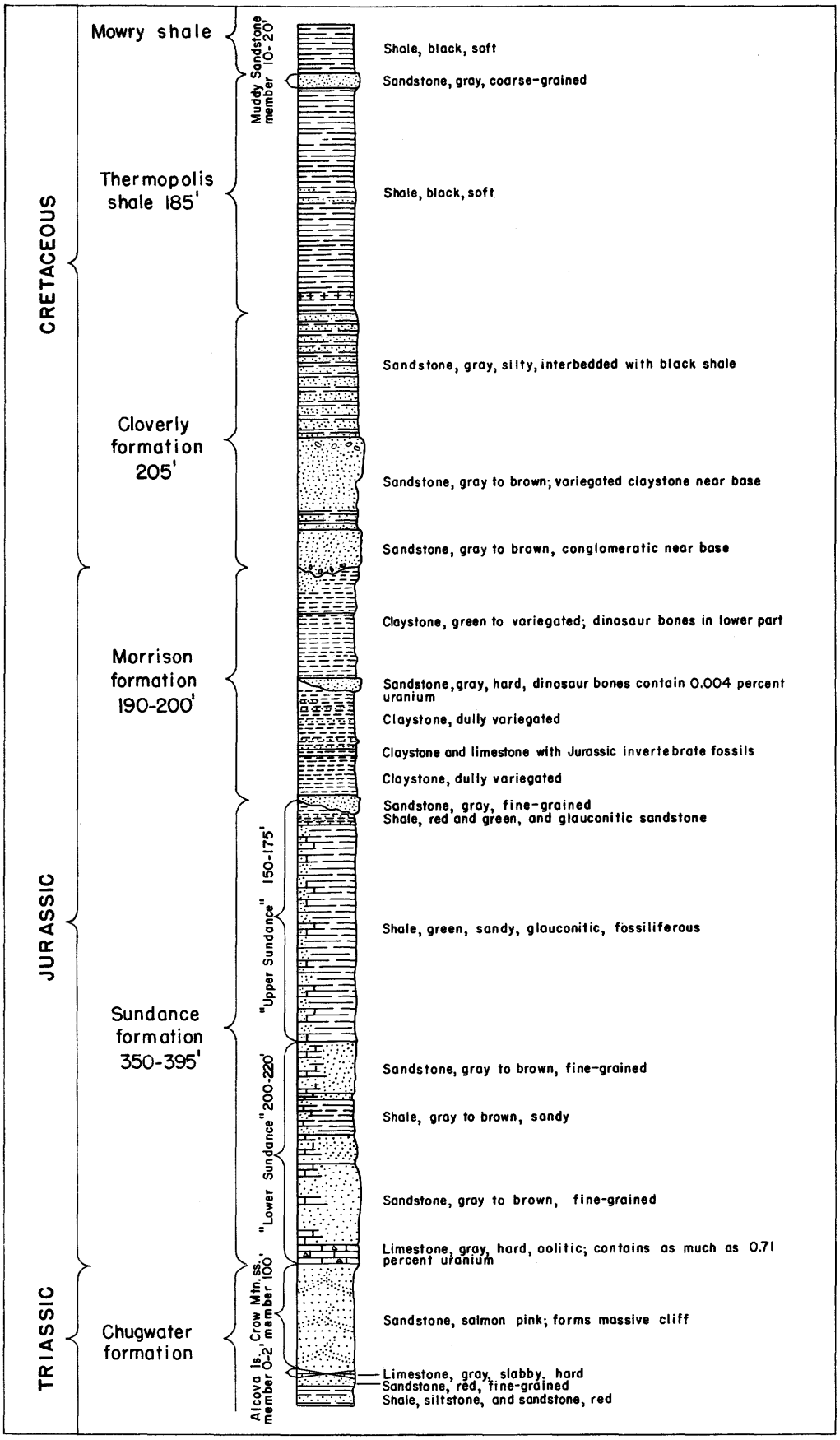

Figure 2. —Stratigraphic section of rocks near Mayoworth, Wyoming.

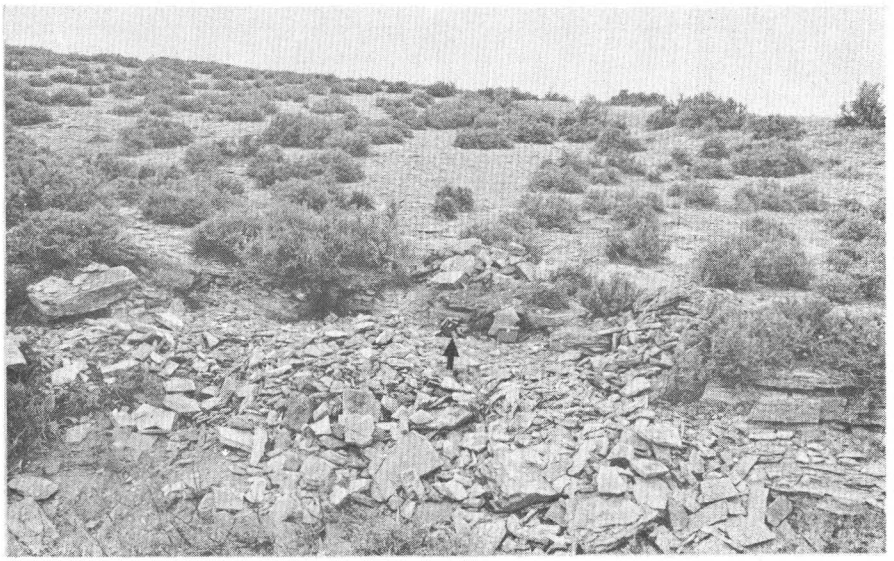

Figure 3.—Uranium locality 1 in oolitic basal limestone of Sundance formation. Slope in background is stripped dip slope on top of basal limestone. Arrow indicates camera case for scale. A selected sample at this point contained 0.71 percent uranium.

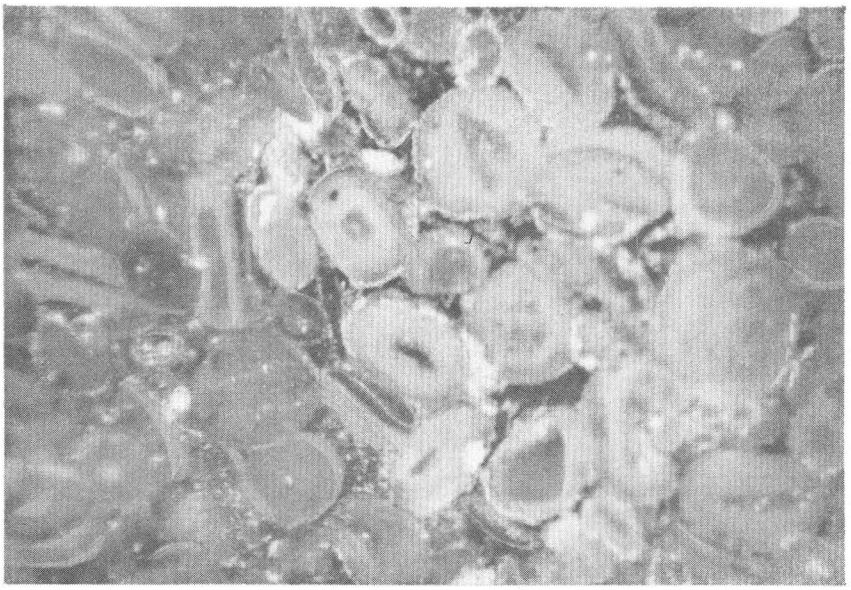

Figure 4.—Photomicrograph x 40 of polished surface of oolites in basal limestone of Sundance formation replaced by metatyuyamunite at locality 1. Light-colored oolites and parts of oolites, and white irregular deposits between oolites are metatyuyamunite.

ANALYSES OF SAMPLES FROM MAYOWORTH AREA[1]

Laboratory sample no.	Locality	eU (percent)	U (percent)	V_2O_5 (percent)	Location (fig. 1), lithology, and formation
99511	1	0.70	0.71	0.56	NE¼NW¼SW¼ sec. 3, T. 44 N., R. 83 W., oolitic limestone in basal part of Sundance formation.
93857[2]	1	.015	.019	.08	Do.
93858[2]	1	.10	.017	.07	Do.
93859[2]	1	.012	.007	.12	Do.
94559[2]	1	.017	.025	.20	Do.
94560[2]	1	.17	.18	.17	Do.
94561[2]	1	.21	.22	.12	Do.
94562[2]	1	.12	.17	.24	Do.
94563[2]	1	.30	.040	.29	Do.
99510	2	.17	.030	.10	SW¼SE¼SW¼ sec. 3, T. 44 N., R. 83 W., oolitic limestone in basal part of Sundance formation.
99512	---------	.044	.004	.08	NE¼ sec. 14, T. 44 N., R. 83 W., dinosaur bone in Morrison formation.

[1]Samples analyzed in Denver laboratory, U. S. Geological Survey. Analysts: Furman, Mountjoy, Schuch, Wilson, Fennelly, McGurk, and Meadows.
[2]Samples collected by geologists of the Atomic Energy Commission, suboffice, Douglas, Wyo.

ORIGIN OF URANIUM IN THE MAYOWORTH AREA

The origin of the uranium in the Mayoworth area has not been determined and can only be inferred from a study of regional relationships. As shown in figure 4, metatyuyamunite has replaced some of the limestone oolites, in addition to being concentrated along fracture planes that developed after the limestone was lithified. The area is essentially unfaulted, although a thrust fault is present a short distance to the north. The folding probably took place at the close of Paleocene time. It is reasonable to assume that most of the fracturing occurred at the time of folding. There is no evidence of vein deposits other than, perhaps, the metatyuyamunite concentrated along fractures, or of Mesozoic or Tertiary igneous activity of any kind in the region. Reflection seismograph and magnetometer surveys of the Powder River Basin have not indicated any buried intrusive rocks younger than pre-Cambrian. The nearest outcrop of pre-Cambrian rocks is 6 miles to the north on an anticlinal nose called "The Horn," which is separated from the Mayoworth area by a thrust fault, south of which is a syncline (Love and Weitz, 1951).

Slightly more than 1 mile northeast of the map area (fig. 1), in the SE¼SW¼SE¼ sec. 24, T. 45 N., R. 83 W., the Stanolind Oil and Gas Co., Brock No. 1 dry hole was drilled to a depth of 4,011 feet, starting in the Frontier formation of Late Cretaceous age and bottoming in the Madison limestone of Mississippian age. A radioactivity log of this test shows no zones of abnormally high radioactivity in any formation penetrated.

A study of radioactivity logs in the Powder River Basin indicates that the basal part of the Sundance formation is typically not radioactive. However, a conspicuous exception is in the Little Buck Creek oilfield, 130 miles to the southeast, where the basal sandstone in the Sundance formation is moderately radioactive at a depth of 4,500 feet. This sandstone is in a comparable stratigraphic position and about the same age as the oolitic limestone in the Mayoworth area.

It seems pertinent to make a comparison of the structural and stratigraphic relationship, because the origin of radioactivity in the Sundance formation in the Mayoworth and Little Buck Creek areas probably is similar, and because the sedimentary record at Little Buck Creek is more complete. At the north end of the Hartville uplift is a northward-plunging anticline in Paleozoic and Mesozoic rocks, named the Lusk Dome by Denson and Botinelly (1949). This dome is 12 miles south of the Little Buck Creek oilfield. The White River formation of Oligocene age was deposited in deep valleys and on rugged topography cut in the rocks on this northward-plunging structural nose. The basal sandstone in the Sundance formation is very porous and permeable and outcrops of this sandstone are directly overlain by the White River formation. Radioactivity logs show that the White River formation in this area is radioactive, and eight samples taken from it southeast of Little Buck Creek show equivalent uranium contents averaging 0.003 percent, having a maximum of 0.008 percent. Radioactivity anomalies in the White River formation have been reported by Mallory (1953) 6 miles north and 7 miles southwest of Little Buck Creek.

Water samples taken by M. L. Troyer (personal communication, 1953) from the White River formation of this general area contain moderately high concentrations of uranium. In past geologic time uranium probably was leached out of the White River formation as readily as at present, and was carried in solution in ground water downdip along the porous basal sandstone of the Sundance formation. This sandstone contains hydrocarbons in small quantity in the Little Buck Creek oilfield, and it is possible that uranium was deposited where the hydrocarbons were concentrated. It is also conceivable that the structure of the area prohibited further migration of the uranium-bearing ground water.

It is possible to account for the uranium deposit in the Mayoworth area in the same manner. Many remnants of tuffaceous claystone, sandstone, and conglomerate of the Oligocene White River formation (pl. 1) occur about 13 miles to the northwest, on top of the Bighorn Mountains, at an altitude of about 8,000 feet. These rocks are slightly radioactive (Love, 1952, p. 17). They were deposited on a surface of high relief. Similar remnants are present on Pumpkin Buttes, 40 miles to the east, at an altitude of 6,000 feet (pl. 1). These remnants, thought to be the source rocks for the uranium deposits in the underlying Wasatch formation (Love, 1952, p. 17-19), contain as much as 0.007 percent uranium. The strata at Pumpkin Buttes are of early Oligocene (Chadronian) age on the basis of the following vertebrate fossils (M. J. Hough, personal communication, 1954): Hyracodon? priscidens, Hyracodon sp., Archaeotherium sp., Trigonias osborni, Mesohippus cf. M. westoni, Leptomeryx sp., and a rhinocerotid, probably Subhyracodon.

The White River formation probably extended eastward from the crest of the Bighorn Mountains to Pumpkin Buttes (pl. 1). The White River strata were deposited across the upturned and eroded edges of the Jurassic rocks about 2,500 feet structurally higher than the uranium deposit near Mayoworth. It is known that the uranium-bearing oolitic limestone grades laterally into coarse-grained sandstone. The limestone is directly underlain by the soft, porous, and permeable Crow Mountain sandstone member of the Chugwater formation which is 100 feet thick. Uranium leached from the White River formation could easily have migrated in solution in ground water down-dip along these porous rocks and have been deposited in the oolitic limestone. The factors that caused deposition in the limestone are not known. Some of the brown color, which is associated with the greatest radioactivity, may be caused by the presence of hydrocarbons.

Metatyuyamunite from the White River formation occurs at several localities and is the principal mineral in a few of the deposits in the underlying Wasatch formation of the Pumpkin Buttes area (M. L. Troyer, personal communication).

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